LB-520

LOW COST TELEVISION RECEIVER

LICENSE DIVISION LABORATORY

RADIO CORPORATION OF AMERICA

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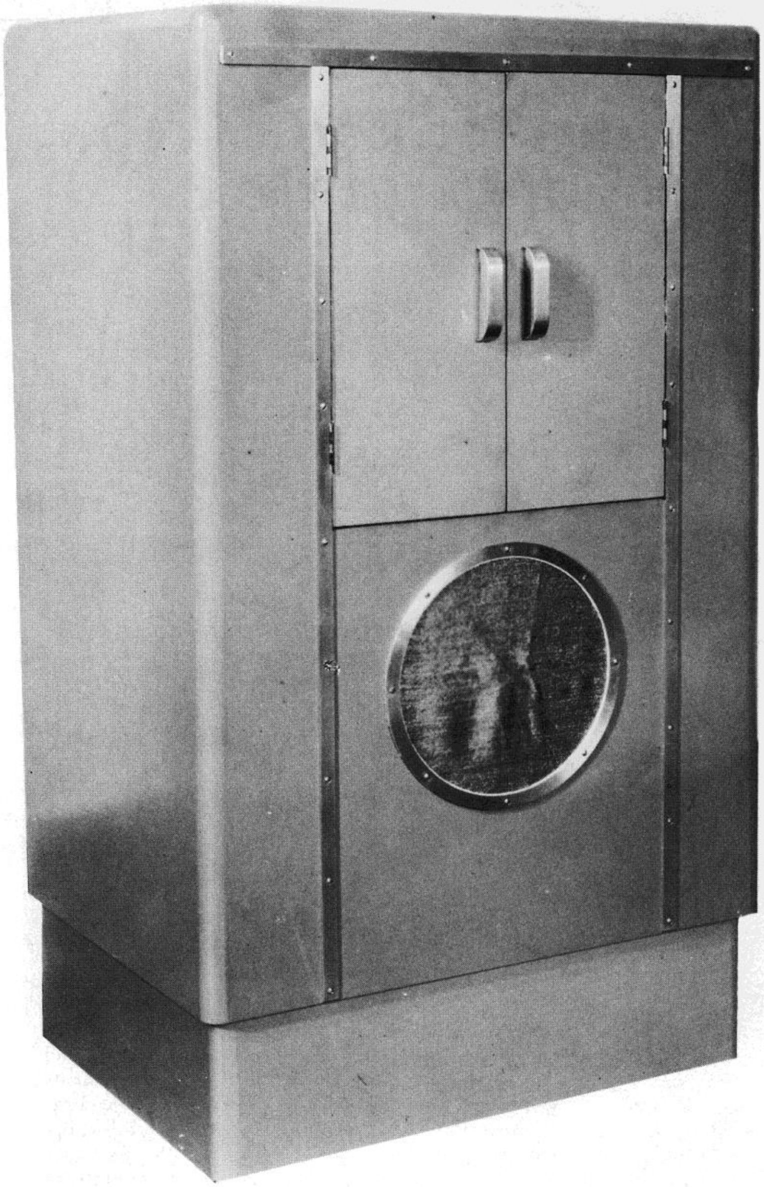
REPORT

LB - 520

Low Cost Television Receiver

Approved

Arthur Van Dyck



TWO HUNDRED DOLLAR

RADIOVISION RECEIVER

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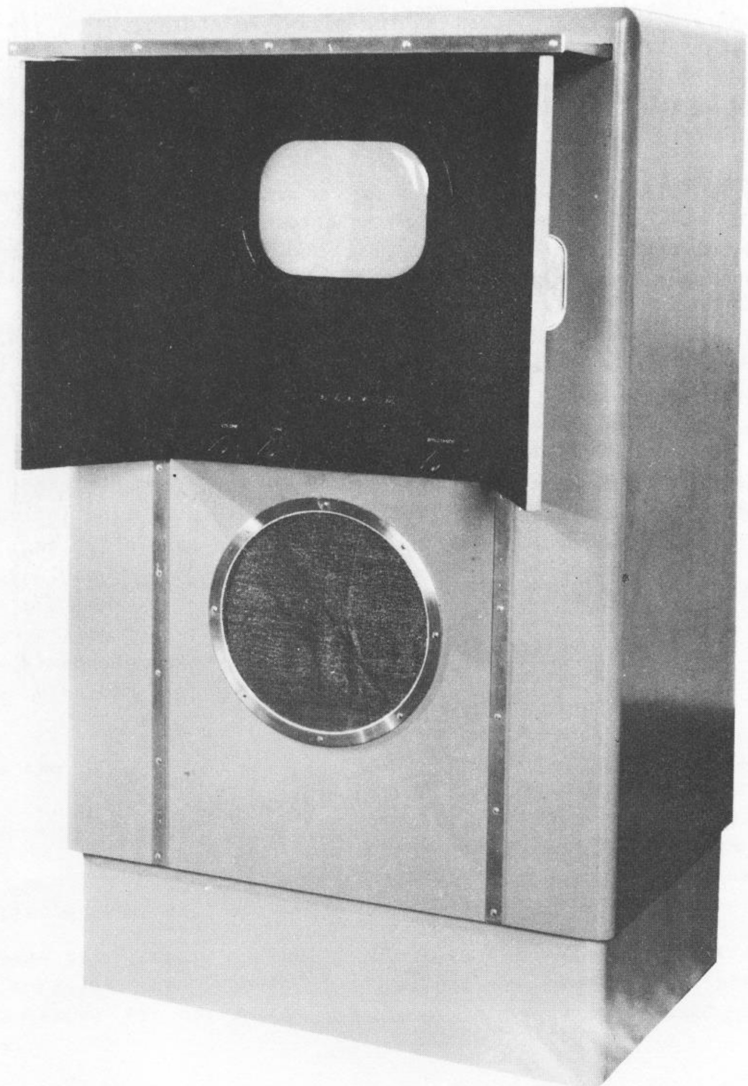


Introduction

The television receivers introduced on the market in the beginning year of regular service were naturally high in price. It is of course axiomatic that large public sale is vitally dependent upon lower prices. Experience in sales of radio receivers and similar household devices indicates that the "threshold price level" for sales in reasonably large quantities is about two hundred dollars.

This laboratory, believing that supply of such a receiver is the most important need now facing the television industry, has attempted to determine a design of television receiver which would have the best possible performance obtainable under 1940 development, production and cost conditions, and would have a list price not over two hundred dollars.

This bulletin describes the resulting design. It utilizes the 9" tube, but otherwise has performance features commercially equivalent to the best available in today's knowledge of the art. Several features of design, novel over previous commercial television receivers, and assisting toward lower cost, are included.

While the model built and described does not include the broadcast band, or any other of the possible combinations, one or more of these undoubtedly should be included in commercial designs. A section of the report describes some of these possibilities.

Low Cost Television Receiver

General Description

Photographs of the completed receiver are shown. The 9" short kinescope is mounted above the receiver chassis, which performs all the functions for television sight and sound. A power supply chassis is mounted at the bottom of the cabinet.

The receiver chassis has a five channel push-button selector switch with a sixth button for "off". Pressing any one of the station buttons turns the set on. The dimensions of this chassis are 10" x 14" x 3". Fifteen tubes perform the following functions:

1 - 6AC7/1852	Converter
1 - 6J5GT	Oscillator
1 - 6AC7/1852	1st Picture and Sound I-F
1 - 6SK7	2nd Sound I-F
1 - 6SQ7	Sound detector, 1st I-F Amp, AVC
1 - 6V6GT	Sound output
1 - 6AC7/1852	2nd Picture I-F
1 - 6H6	Video detector, sync. clipper
1 - 6AC7/1852	Video output
1 - 6H6	Automatic brightness control
1 - 6F8G	Sync. amp., Noise clipper
1 - 6N7	Vertical sawtooth generator
1 - 6N7	Horizontal sawtooth generator
1 - 6J5GT	Vertical output
1 - 6L6	Horizontal output

The power supply has one 2X2/879 rectifier supplying 5000 volts for the kinescope, and one 5U4G for medium (300) voltage. The chassis is 10" x 12" x 3".

The front panel controls are:

- Contrast
- Brightness
- Sound volume
- Tone
- Push-button station selector and "off" switch

Eight controls are located at the rear of the receiver chassis. These are adjustable for speed, size, linearity, and centering for horizontal and vertical deflections.

The receiver was designed to operate primarily on 441 line, 30 frame, 60 field transmissions. The range of the controls is sufficient, however, to permit synchronization with any number of frames from 15 to 30 per second (30 to 60 fields) and any corresponding number of lines per frame up to 625 lines. Also, it provides synchronization for transmissions of 30 frames per second with numbers of lines up to 507 lines per frame. Readjustment of some of the controls is required when changing from one combination of frames per second and lines per frame to another.

The focus control is located at the back of the power supply chassis.

In some cabinet arrangements, it may be desirable to change the location and availability of some of these controls, particularly the focus adjustment.

Suggested Combinations

While the receiver described is for television picture and sound only, it is obvious that the investment in cabinet, speaker, and electrical circuits may be utilized to include such extra services as broadcast band and short wave bands.

One or both of these services may be added with much less expense than would be necessary for supplying these functions in a separate cabinet, and the commercial advantage of the single cabinet may be very considerable. In fact deletion of extra functions is likely to be justifiable only in cases where maximum emphasis on price is necessary.

A method of applying the broadcast band which is very economical is shown in Fig. 1. This requires but one added tube and the indicated circuit component, and may cost the manufacturer as low as $2. Switching difficulties are not severe for the type of circuit. The short wave bands may be added here for the same cost as their addition to a broadcast band receiver would represent.

Circuits for reception of frequency modulation stations may likewise be installed and many of the television circuits used again for this service.

Sensitivity

Picture overall sensitivity was measured with a carrier input modulated 50% at 400 cycles, and applied through a 100 ohm dummy antenna. Output was held at 15 volts peak to peak potential at the grid of the kinescope.

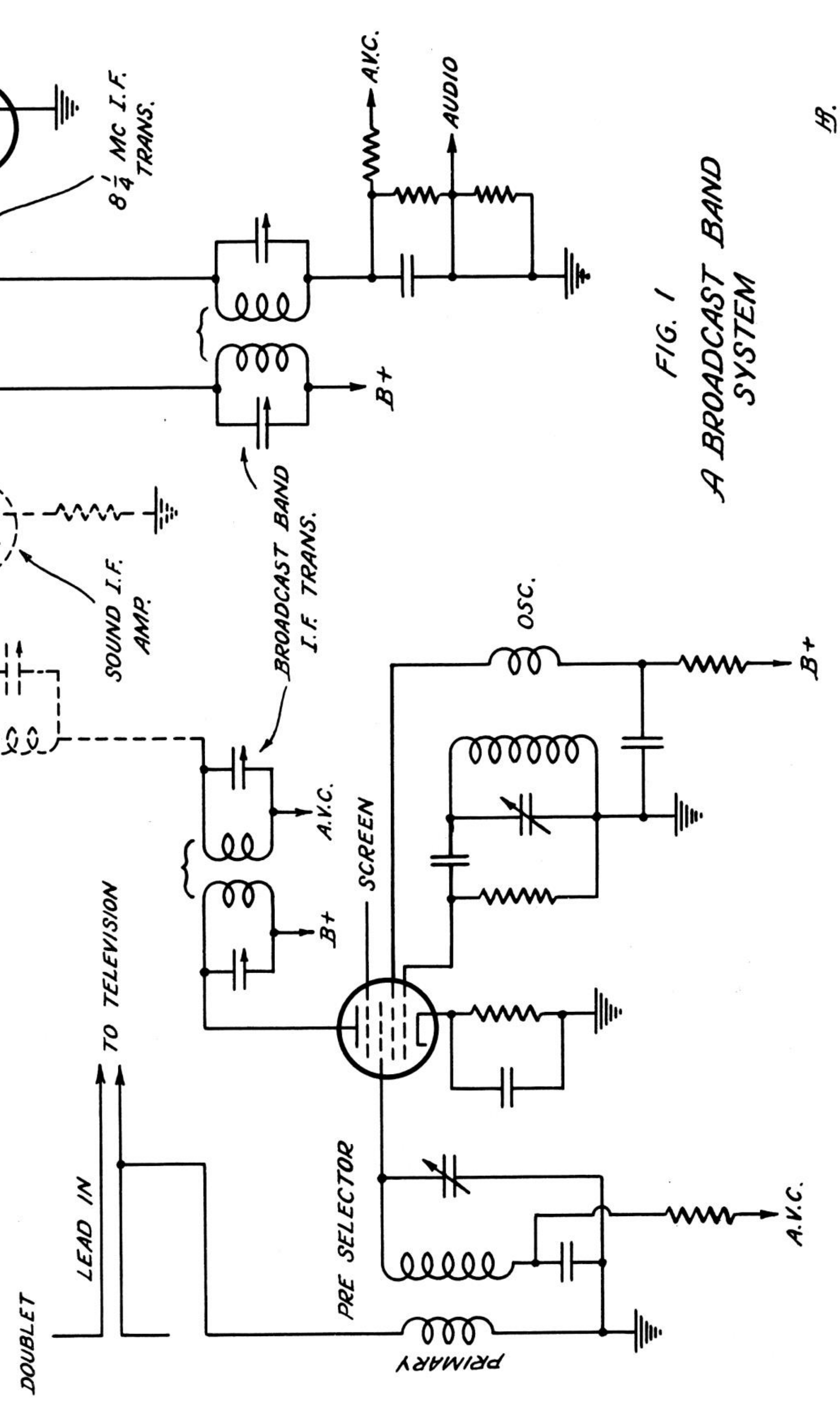


FIG. 1
A BROADCAST BAND SYSTEM

NOTE:
RADIO-TELEVISION SWITCH MAY DISCONNECT TUBES NOT NEEDED FOR SERVICE DESIRED

Sound sensitivity was similarly measured with a 30% modulated input and an output of 0.5 watts. Results were:

Channel No.	Sound Freq.	Picture Freq.	Sound Sensitivity	Picture Sensitivity
1	49.75 mc.	45.25 mc.	65 µv.	90 µv.
2	55.75	51.25	65	95
3	71.75	67.25	140	160
4	83.75	79.25	150	200
5	89.75	85.25	170	180

Station Selector

Channel selection is accomplished by means of push buttons. The five lowest frequency channels are available in this receiver with the circuits shown in Fig. 2. These channels, and the frequencies they cover are:

Channel No.	Frequency
1	44-50 mc.
2	50-56
3	66-72
4	78-84
5	84-90

Two other channels, 96-102 mc., and 102-108 mc., are included in the present television spectrum. It has been assumed by many individuals in the industry that these last two channels will be much less used than will the lower channels, and need not be provided for in receiver design. Although this is a speculative consideration, these bands are at present still inactive, and since their inclusion would add considerable complexity to the selector switching circuits, it is considered justifiable to omit them in this receiver. If final channel assignments (by F.C.C.) are different from the above, but are still between 40 and 100 mc., the methods, circuits, etc. described will still be applicable.

The push-button switch has a sixth button for turning off the receiver. Pressing any one of the station buttons turns the receiver on. The other controls may in consequence be left at desired settings.

The oscillator is plate tuned and operated on the high side of the signal carrier frequency. Channel selection is made by shunting individually adjustable inductors across the plate winding of the oscillator coupler. Specifications are given in Fig. 3 for all oscillator and pre-selector inductances.

Lead length should be restricted to a minimum. The highest frequency channel switch section is nearest the oscillator tube and transformer. Pressing any button severs connection in the switch arm from all portions of the switch used for lower frequency channels. The switch is shown in Fig. 2 in the 5th channel position. The other elements of the switch are disconnected from the resonating circuits at points A, and stray capacitance effects of the switch are held at a minimum in the higher frequency bands.

Oscillator voltage is injected into the converter grid through stray capacitances in the switch and wiring. A capacitor of 1 µµf. was added between the high potential ends of the oscillator and converter to increase the injected voltage in the lower bands. Without this capacitor the injection at the two lower bands was approximately 1 volt.

With this 1 µµf. capacitance added the peak oscillator voltage on the converter grid was measured to be:

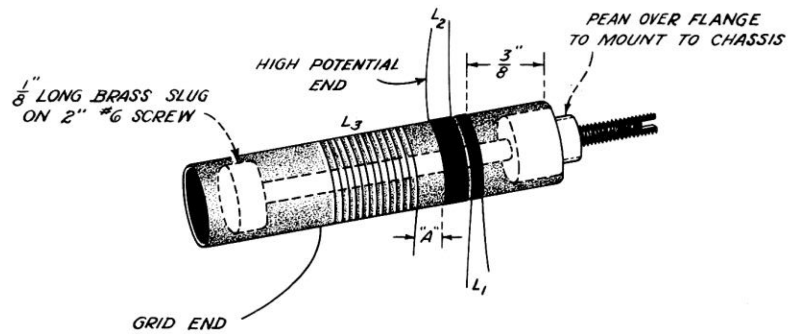
Channel No.	1	2	3	4	5
Peak Voltage	3.5	4	2.8	2.4	1.8

The converter bias of 5 volts provides for the usually encountered station signal inputs without developing grid current in the converter.

The pre-selector comprises a two tuned circuit band-pass filter. The grid section is inductance tuned in order to obtain a high grid impedance. The first tuned section is capacitance tuned since the magnitude of L_2 does not affect the gain properties of the system. The inductance adjustment is accomplished by means of a brass slug which is operated near the high potential end of the grid coil only. It should not be necessary to bring the tuning slug into the center of the grid coil. When the slug movement is confined to the grid end of the coil its position has very minor effect on coupling between L_2 and L_3. Thus the three inductors, L_1, L_2, and L_3 may be wound on a single form. Placement of components about the switch is indicated in the photographs.

All station selector adjustments are available without removing the chassis from the cabinet. The oscillator inductors may be tuned from the

PRE-SELECTOR INDUCTORS

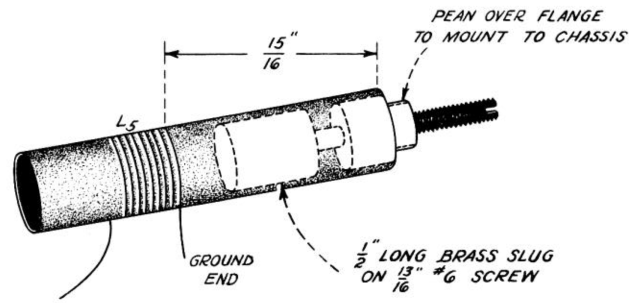


TRANSFORMER	"A"	L_1 TURNS	L_2 TURNS	L_3 TURNS	L_3 SPACING TURNS PER IN.
CHANNEL 1	0"	4	12	13	22
CHANNEL 2	0"	3	12	10	22
CHANNEL 3	$\frac{1}{16}$"	3	7	5	22
CHANNEL 4	$\frac{1}{16}$"	2	$5\frac{1}{4}$	3	16
CHANNEL 5	$\frac{3}{8}$"	2	$4\frac{1}{4}$	3	16

WOUND WITH #26 E WIRE ON TUBING 2" LONG AND $\frac{3}{8}$" DIA. WITH $\frac{1}{32}$" WALL

L_4 = 9 TURNS OF #26 E WIRE ON $\frac{3}{8}$" DIA. FORM

OSCILLATOR INDUCTORS



INDUCTOR	TURNS	WIRE SIZE	SPACING TURNS PER IN.
CHANNEL 1	9	#26 E	24
CHANNEL 2	7	#26 E	24
CHANNEL 3	$2\frac{1}{2}$	#26 E	24
CHANNEL 4	$1\frac{1}{2}$	#26 E	12
CHANNEL 5	2	#18 E	12

WOUND ON TUBING 2" LONG AND $\frac{3}{8}$" DIA. WITH $\frac{1}{32}$" WALL

L_6 = 8 TURNS OF #18 E. WIRE ON $\frac{3}{8}$" DIA. TUBING TAPPED $2\frac{1}{2}$ TURNS FROM GRID END

FIG. 3

OSCILLATOR AND PRE-SELECTOR INDUCTORS

HB.

front of the cabinet by pulling out the "trap door" in the panel and inserting a screwdriver in the shaft to be varied. This is expected to be a service adjustment.

The advisability of providing an oscillator trimming adjustment, available as a control knob, may be determined after consideration of the magnitude and effects of frequency drift. If it is not found to be absolutely necessary it should be omitted, as its proper adjustment is usually confusing to the layman.

Temperature and humidity effects on the components, particularly the switch and tube socket, will be the biggest factors in frequency drift.

Picture I.F. Amplifier

The first consideration in the amplifier design is to determine the necessary number of stages. Band width and gain are the two conflicting factors.

Three stages using 6AC7/1852 tubes will supply both in super abundant quantities. Two stages will supply both to highly satisfactory degree. The simplicity of construction and economy of the two stage amplifier influenced decision to incorporate it in this receiver. If increase in gain or bandwidth is desired, either an extra stage may be added, or the transformers may be re-designed for three resonant circuit operations along the lines indicated in LB-478, page 5. This design will improve the gain of the first and second transformer 3 db. each. It may not be applied to the last transformer because the loading on that transformer is chiefly derived from the diode detector.

The two stage amplifier is indicated in the schematic diagram, Fig. 2. The transformers are of similar construction to those described in LB-478. They are intended for mounting to trimmer capacitors between tube sockets of succeeding stages as described in LB-478. No coil shields are required for any electrical reason. Details on the transformers are given in Fig. 4, and the method of assembly is shown in the photograph, Fig. 5.

The circuits are so arranged that two trimmer adjustments are required for each transformer or a total of six adjustments, four of which are for trap circuits, and two for desired signal circuits.

The primary circuits are all self tuned. As explained in LB-478 this may be done successfully only if circuit capacitances and inductances are held to close limits. The inductance tolerance offers the least difficulty as coils may be readily wound to 2%, which is adequately close. Tube socket plus coil and wiring capacitances will account for approximately 1/4 the total primary capacitance. These may be held quite closely, particularly if the lead from plate to transformer is made short.

The remainder of the capacitance is in the output section of the tube. A representative number of tubes should be measured to determine the variation to be expected. The variation is usually not very large. If necessary, some tubes falling outside the limits considered acceptable may be used in the video stage. If the transformers are designed for tubes of average capacitance the circuits should function properly without the need of adjustment.

The secondary windings for the first and third transformers are shunted by trimmers. The secondary winding of the second transformer is self tuned.

Overall selectivity is shown in Fig. 6. The band width is 3.75 mc. for 10 db. down on the low side of the 12.75 mc. carrier.

The two 8.25 mc. traps for the accompanying sound i.f. produce 50 db. attenuation.

The adjacent channel sound channel, 14.25 mc., is attenuated 60 db. Two traps are provided for this frequency. Overall gain from converter to second detector output at 12.75 mc., with the converter biased as shown in the schematic, measured 64 db.

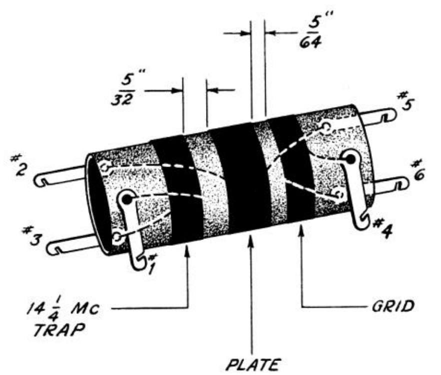
Video Circuits

The video output stage consists of a 6AC7/1852 video output tube and a 6H6 diode automatic brightness control tube.

Other combinations may be considered as alternative systems. The advantages of this method are the good automatic birghtness control action, small and constant plate current drain, and good stage gain.

Stage gain is enhanced by the high G_m tube and the low output capacitance of the plate circuit. A 4200 ohm load resistor was used, producing a gain of 31.5 db.

TRANSFORMER #1

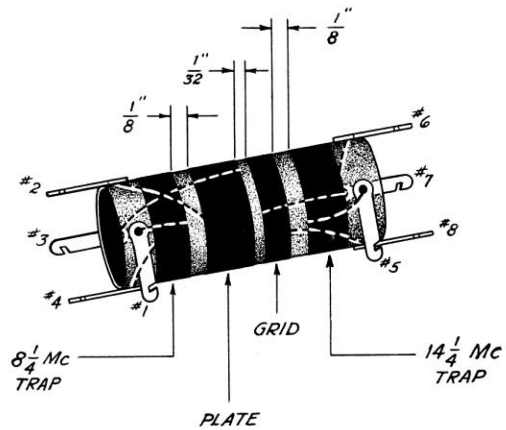


WINDING	TURNS	INDUCTANCE
14¼ Mc TRAP	23	13.7 μh
PLATE	31	23 μh
GRID	19	10 μh

M_1 (14¼ Mc TRAP TO PLATE) 3.2 μh
M_2 (PLATE TO GRID) 4.15 μh

CONNECT:
#1 TO HIGH SIDE OF TRAP CAPACITOR
#2 TO PLATE
#4 TO GRID

TRANSFORMER #2

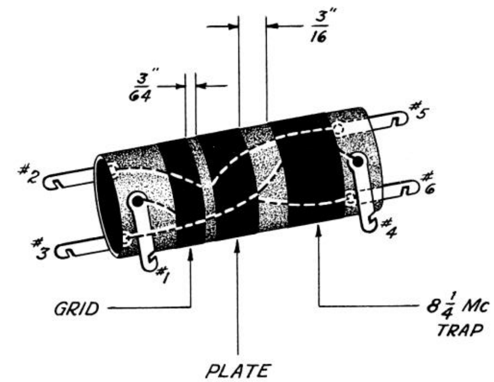


WINDING	TURNS	INDUCTANCE
8¼ Mc TRAP	28	19.5 μh
PLATE	37	28.8 μh
GRID	20	10.9 μh
14¼ Mc TRAP	28	19.5 μh

M_1 (8¼ TRAP TO PLATE) 4.5 μh
M_2 (PLATE TO GRID) 6.0 μh
M_3 (GRID TO 14¼ Mc TRAP) 3.1 μh

CONNECT:
#1 TO HIGH SIDE OF TRAP CAPACITOR
#2 TO PLATE
#5 TO HIGH SIDE OF TRAP CAPACITOR
#8 TO GRID

TRANSFORMER #3



WINDING	TURNS	INDUCTANCE
GRID	19	10.6 μh
PLATE	35	27.5 μh
TRAP	40	34.4 μh

M_1 (GRID TO PLATE) 5.4 μh
M_2 (PLATE TO TRAP) 4.8 μh

CONNECT:
#1 TO GRID
#4 TO HIGH SIDE OF TRAP CAPACITOR
#6 TO PLATE

FIG. 4
PICTURE I.F. TRANSFORMERS

NOTE: ALL TRANSFORMERS WOUND WITH #36 E. WIRE ON TUBING $\frac{5}{8}$" DIA. AND $1\frac{1}{2}$" LONG

B.

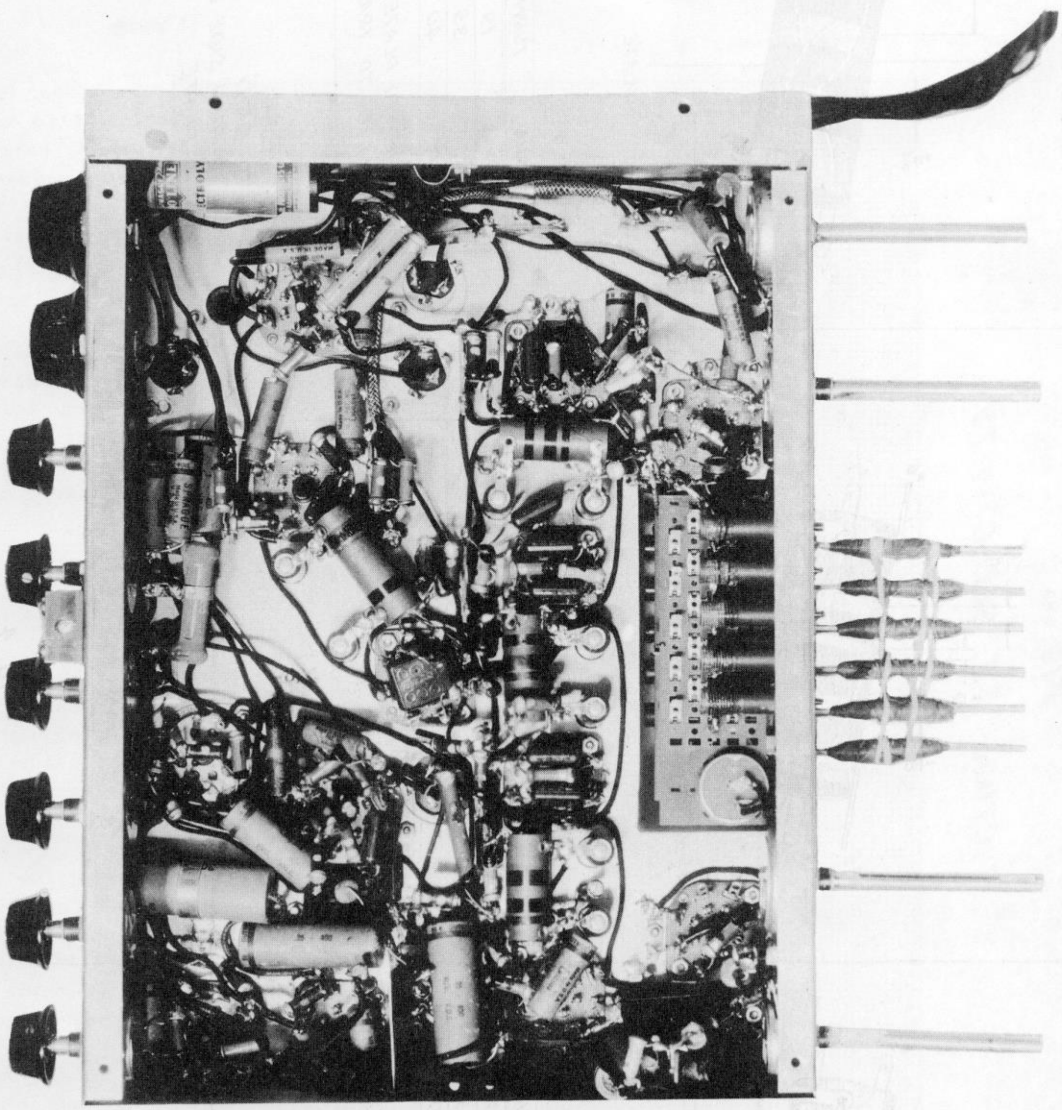
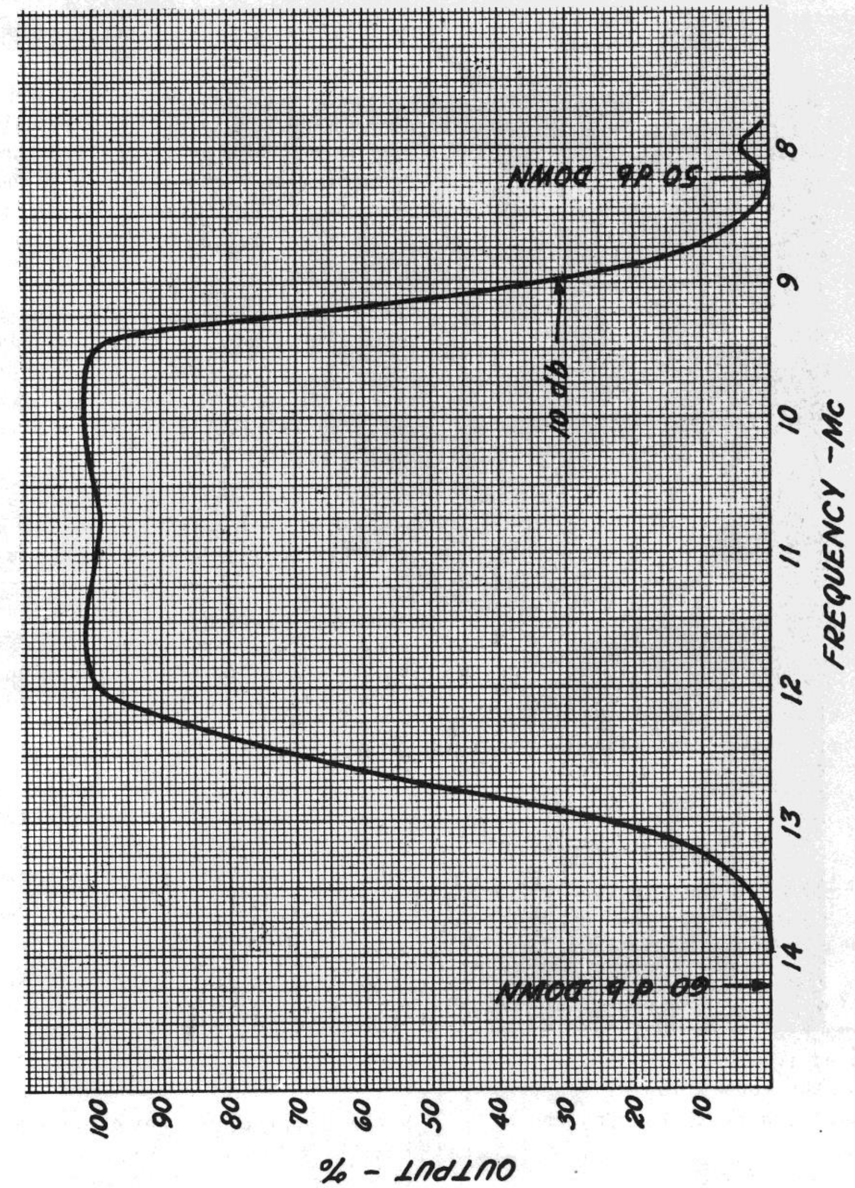


FIG. 5

FIG. 6

PICTURE I.F. SELECTIVITY



The video detector load network has a single series peaking inductor and load resistor of 5000 ohms. Response characteristics for both the video stage only and the overall video circuits are shown in Fig. 7.

Sound I F

The converter and first i-f tubes amplify the sound i.f. as well as the picture signal. The first sound trap is coupled to the plate winding of the second transformer and serves as a pickup point for the 6SK7 sound i-f amplifier. The sound i-f transformer is shown in Fig.8. Selectivity of the sound i-f system is shown in Fig. 9.

AVC was applied from the sound second detector back to the 6SK7 i-f amplifier. In cases where the picture and sound signals are very similar in strength, any large sound signal will be attenuated by the picture AVC, and the extra AVC action of the sound circuits will not be necessary.

Audio System

The audio amplifier comprises a single 6V6GT output and 6SQ7 first audio amplifier detector and AVC. The output capabilities of this single tube seem quite adequate for television service, since excessive volume may be had at any distance from the receiver which is within the visual range.

Combinations which supply both radio and television service (as discussed in this bulletin) should have an audio amplifier which meets the requirements of both services. The 6V6GT output is adequate for many radio receiver designs in the medium price range.

The output current supply for the power tube is isolated from the main B+ potential by a 1500 ohm resistor connected to the first hum filter choke. This prevents the modulation of the picture by surges of audio current changing the B+ voltage.

Synchronizing Circuits

Received signals are frequently, if not usually, marred by ignition and spark interferences. These interferences generally take the form of pulses exceeding in height the supersynchronizing pulses, but existing for a much shorter time. The noise pulses may be reduced in magnitude to a height comparable to the supersynchronizing pulses by means of a noise clipper in the synchronizing circuits.

The utility of some form of noise clipping is so great that it is virtually essential to provide this function in any receiver design.

First clipping takes place in the 6h6 circuit, wherein the supersynchronizing pulses are skimmed off the i-f output. A resistance capacitance filter removes the stray i.f. and video portions of the signal. The pulses in the presence of large spark voltages then resemble section (a) of Fig. 10.

This potential is applied to the grid of the amplifier directly, no coupling capacitor and grid resistor being used. This avoids the positive charging effect of the high voltage spark pulses which would greatly influence the gain of the amplifier.

The output of the amplifier, which is similar in character to Fig. 10 (a) but reversed in potential and larger in magnitude, is shown in (b). This voltage is applied to the grid of the noise clipper through an RC network. The spark pulses, now negative, do not charge the grid capacitor in the manner of positive pulses, and a coupling capacitor may be used for this service.

Output of the second clipper is taken from the cathode circuit. This tube is operated at low potential and plate current cutoff is produced by negative excursions below the dotted line in Fig. (b). Output is then as shown in (c). The spark pulses while still existing, are no higher than the synchronizing pulses.

Under test it may be observed that spark pulses 100 times higher than the synchronizing pulses are reduced at the second clipper to the same height as the synchronizing pulses.

Noise clipping does not provide absolute picture stability but improves stability and increases the noise to signal ratio at which the receiver will still function satisfactorily. The latter ratio may easily be improved tenfold by this means.

The output voltage of the second clipper is 0.25 volts. This is separated by the networks shown

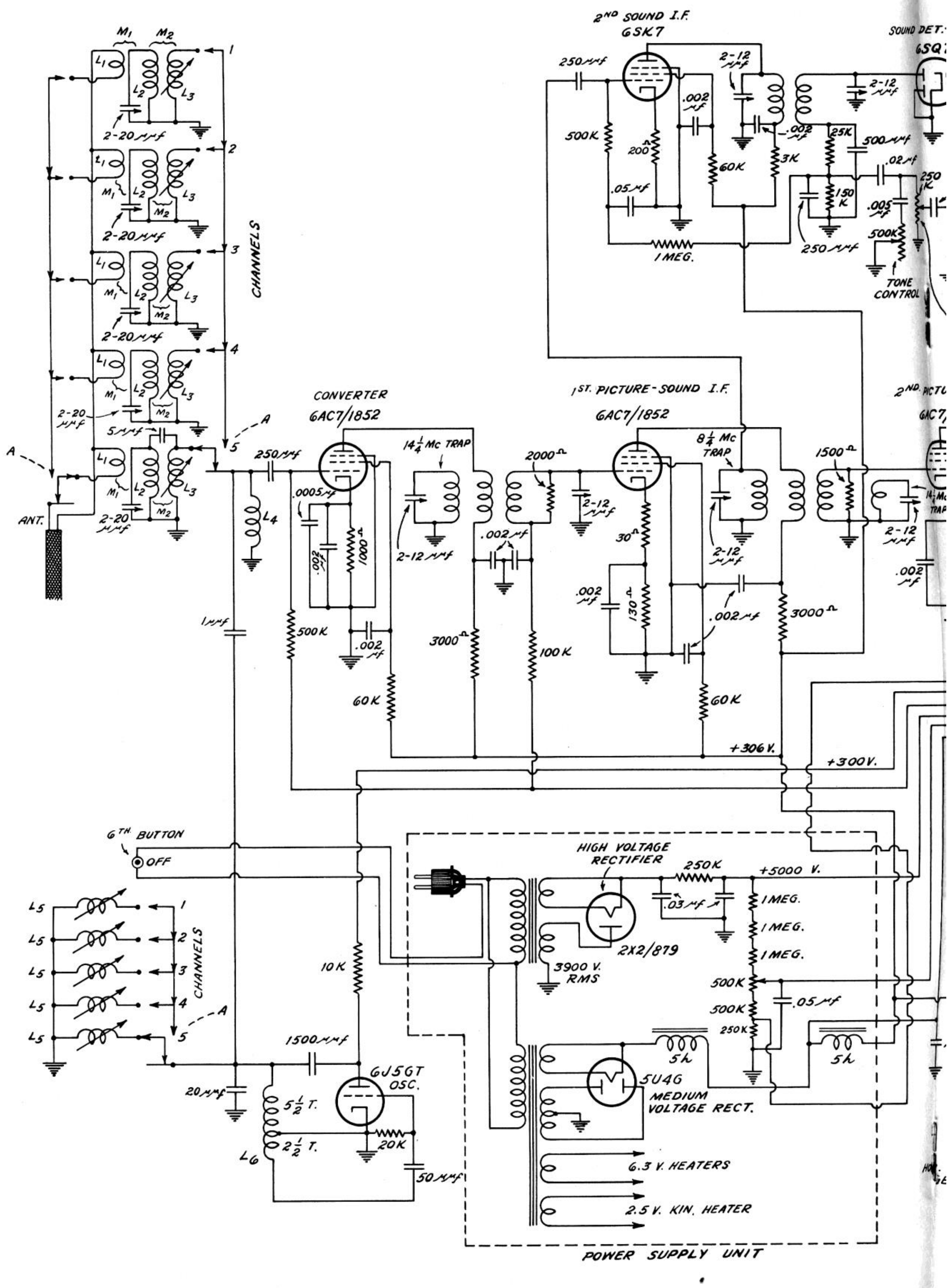


FIG.

LOW COST TELEVIS

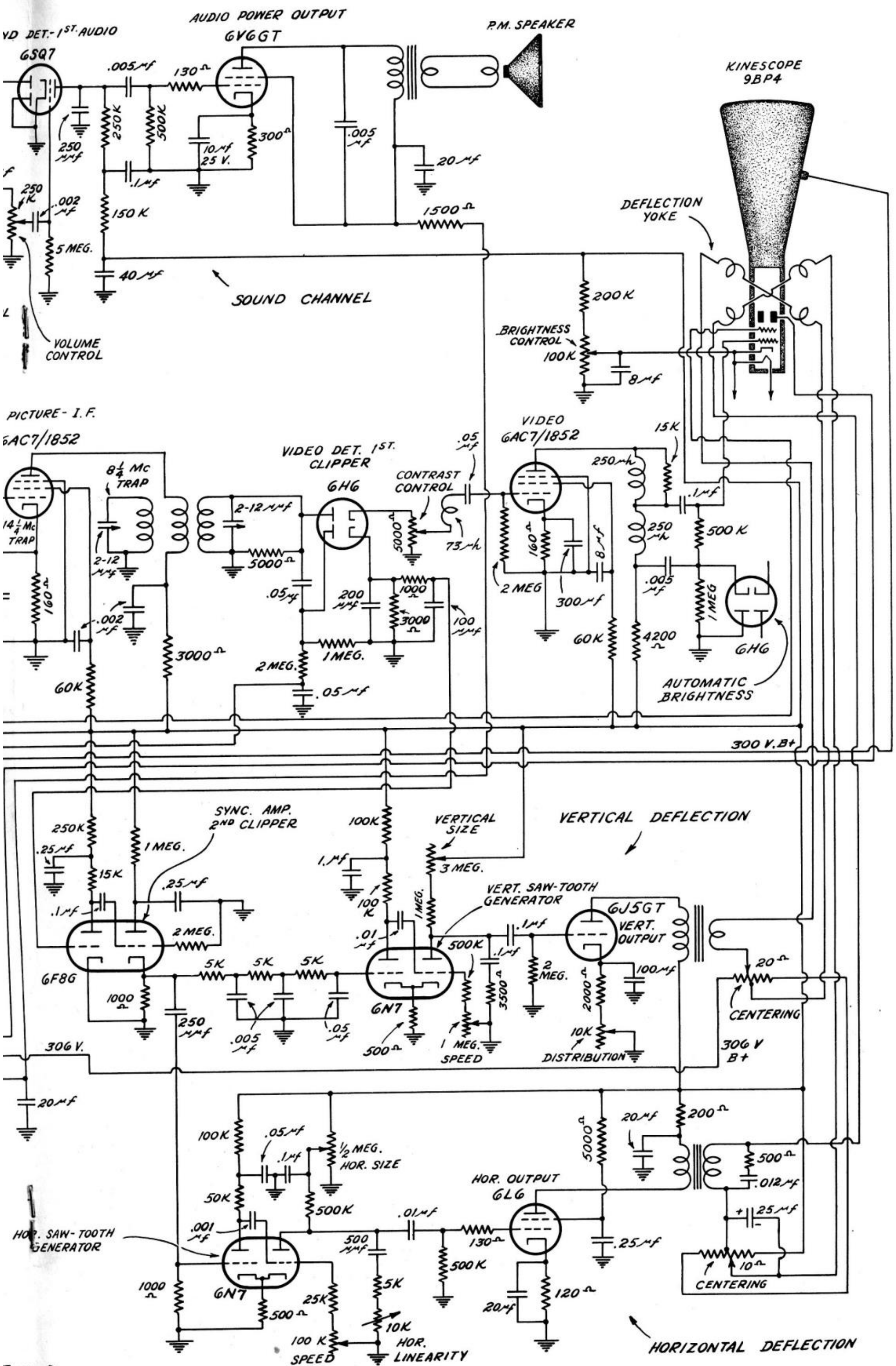


FIG. 2

VISION RECEIVER

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FIG. 7
VIDEO RESPONSE

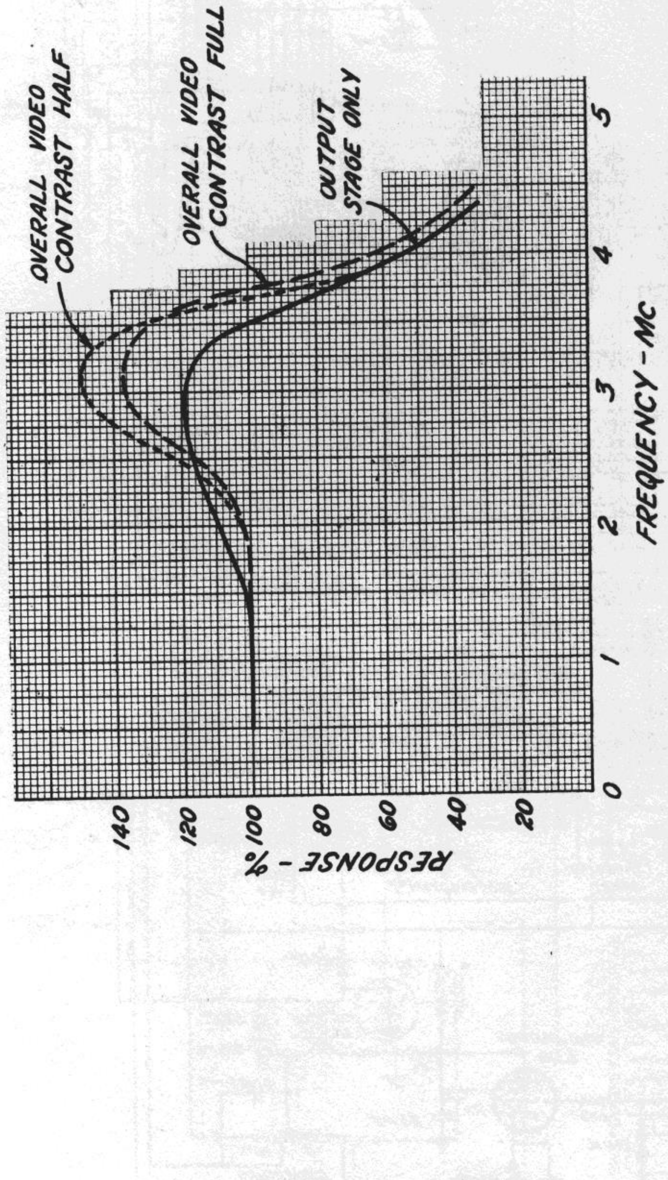
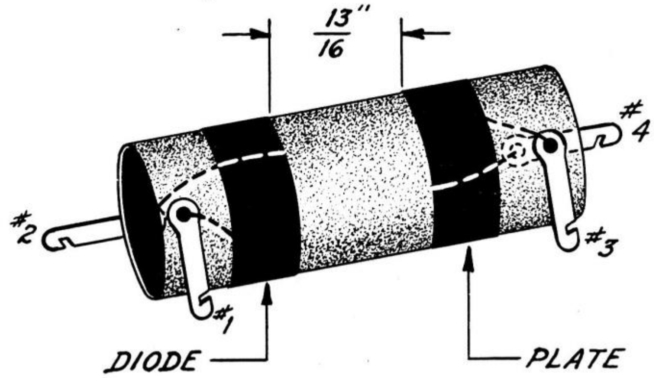


FIG. 8
SOUND I.F. TRANSFORMER
WOUND WITH #36E WIRE ON
TUBING 5/8" DIA. AND 1 3/4" LONG



WINDING	TURNS	INDUCTANCE
DIODE	31	22.6 μh
PLATE	31	22.6 μh
M (GRID TO DIODE) 0.5 μh (APPROX.)		

CONNECT:
#1 TO DIODE
#3 TO PLATE

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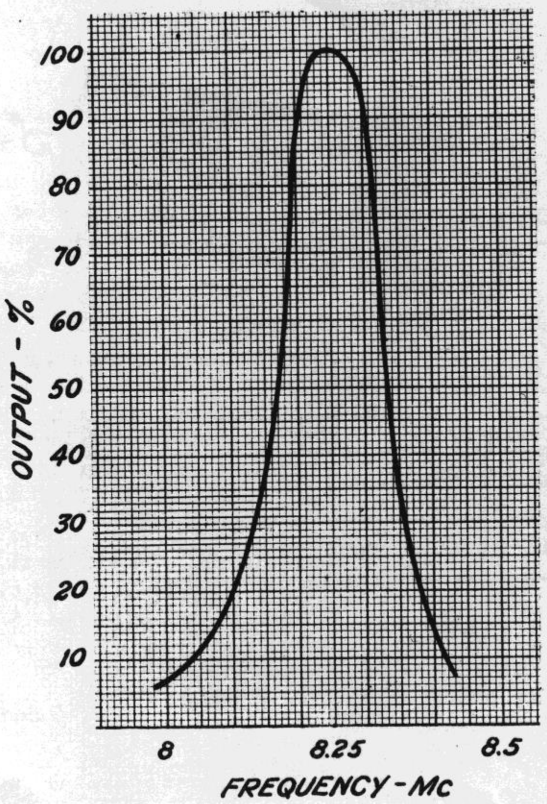
FIG. 9
SOUND I.F. SYSTEM SELECTIVITY



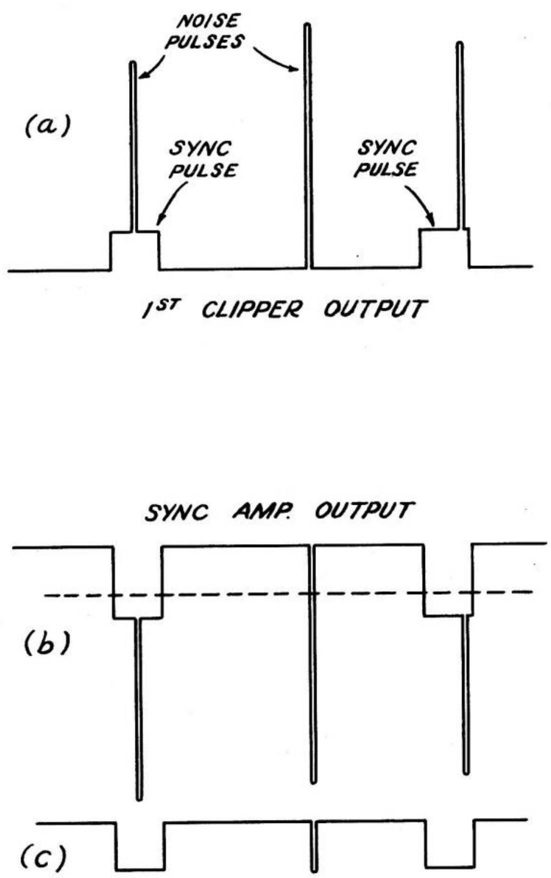
in the schematic diagram and applied to the horizontal and vertical sawtooth generators.

Kinescope

The receiver was designed to operate with a short 9" diameter kinescope with 5000 volts second anode potential. In developing the receiver an experimental RCA 9BP4 tube was used. This tube has a 55° deflection angle as does the short 7" diameter kinescope 7AP4. The deflection system will operate with any 55° angle tube using anode voltages of the same order of magnitude.

OUTPUTS OF SYNCHRONIZING CIRCUITS

FIG. 10



NOISE CLIPPER OUTPUT

The choice of the kinescope type is influenced by desired picture size, brightness and overall length. At a given anode potential, the smaller the picture size the brighter will be the picture. The shorter tubes have a decided advantage in permitting use of smaller cabinets and have some advantage in brightness.

The long type kinescopes 9AP4 and 12AP4 may be used if desired, but because of the smaller deflection angle, would require modification of the yoke and deflection output system.

The short 9" diameter tube used in this receiver produces pictures of satisfactory brilliance in a fairly well lighted room with 5000 volts second anode potential.

The use of relatively low second anode potential of course produces less brilliance than a higher potential, but is economical in that it decreases the insulation requirements of the high voltage supply, gives greater freedom from corona, and may reduce the cost of the deflection system. Accordingly it is recommended that the size kinescope chosen be tried at various second anode potentials within its operating range in deciding on the second anode potential for a particular receiver design.

The 9BP4 is quite adequate for 30 frame, 60 field pictures. Reception of low frame frequency signals will be attended by flicker when the tube is operated at normal brightness.

Deflection Yoke

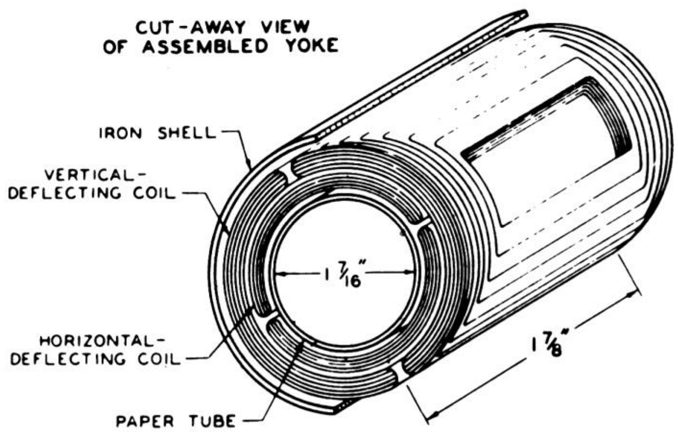
The type of yoke used in this receiver was chosen because it may be readily constructed in the laboratory and has good performance. Its choice is not intended to influence one way or another the selection of type of yoke in production. The design is similar to that described in the RCA Radiotron data booklet on the 7AP4 kinescope.

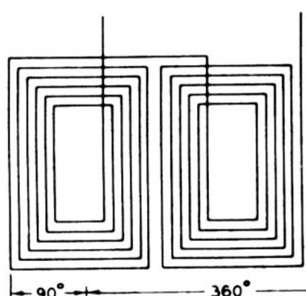
In Fig. 11 the yoke construction is shown, taken from the 7AP4 booklet, but with the changes and modifications necessitated by the different output system used.

The yoke used has 1.5 mh. inductance for the two horizontal windings measured in series, and 44 mh. for the two vertical windings. Because of the low inductance, capacitance of the coil is a minor factor.

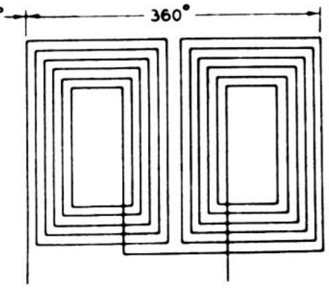
DEFLECTING YOKE FOR WIDE-ANGLE DEFLECTION

CUT-AWAY VIEW OF ASSEMBLED YOKE





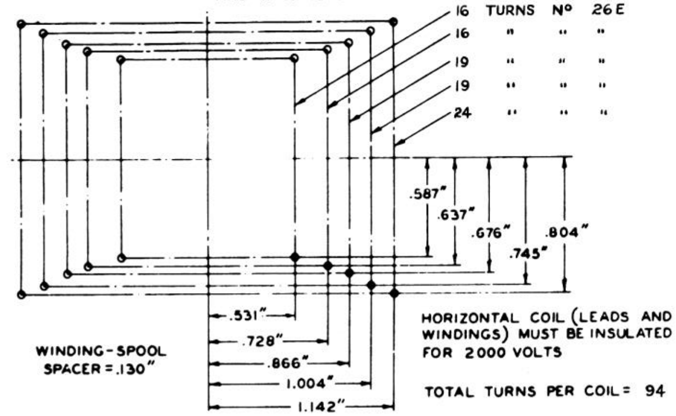
SCHEMATIC DIAGRAM OF HORIZONTAL WINDINGS
94 TURNS EACH COIL



SCHEMATIC DIAGRAM OF VERTICAL WINDINGS
500 TURNS EACH COIL

WIDE-ANGLE YOKE DATA
FOR RCA-7AP4

HORIZONTAL COIL FORM AND WINDING DATA

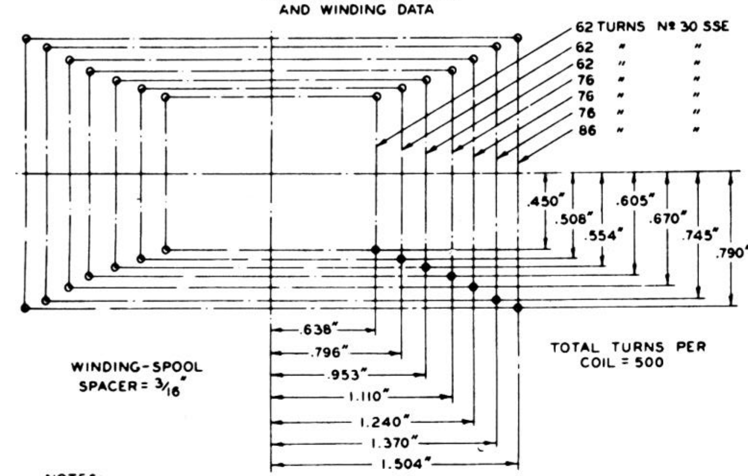


HORIZONTAL COIL (LEADS AND WINDINGS) MUST BE INSULATED FOR 2000 VOLTS

TOTAL TURNS PER COIL = 94

FIG. 11

VERTICAL COIL FORM AND WINDING DATA



TOTAL TURNS PER COIL = 500

NOTES:
IRON SHELL = 3 LAYERS OF .020" TO .030" SWEDISH IRON
DRILL HOLES FOR PINS WITH Nº 55 DRILL
INSULATION AND SHIELD = 1/32" BETWEEN HORIZONTAL AND VERTICAL COILS

Saw-Tooth Generators

Two types of sawtooth generators were considered for this receiver, and were subjected to comparative tests. One was the cathode coupled multi-vibrator system shown on the schematic, and the other was the blocking oscillator circuit using transformers.

Neither system demonstrated a very marked superiority over the other for stability and freedom from ignition disturbance, although the transformer coupled type appeared slightly better for these qualities. Since performance was quite similar after design precautions were taken, the cathode coupled system was chosen for this receiver with the approximate savings of the two transformers.

The transformer type is definitely the more easily applied. It required some 5 volts for synchronization whereas the other system will sync. well on 0.1 volts. This means that stray potentials which might influence synchronization must be reduced or isolated more for the cathode coupled system. Precautions in chassis layout are necessary to provide that interaction between horizontal, vertical, and synchronizing circuits is reduced. The blocking oscillator type deflection circuit may be chosen in some cases where it is felt that the slightly lower susceptibility of this type to synchronizing on stray pulses counter balances the additional cost.

The arrangement of circuits provided in this receiver is shown in Fig. 2. It was found desirable to keep the voltages of the deflecting circuits well isolated from the synchronizing circuits.

Horizontal Output

A single 6L6 output stage transformer coupled and damped by resistance-capacitance is used as shown in the schematic, Fig. 2. This provides ample deflection of the kinescope operated at 5000 volts anode potential.

Power dissipation within the 6L6 should be kept within the ratings for the tube. These are 2.5 watts screen, and 19 watts for the plate. The screen dissipation may be held within the limits by a series resistor to reduce the screen potential. In this receiver the series resistor keeps the screen at approximately 250 v. at 8 ma. or 2 watts. The plate dissipation is 70 ma. at 300 volts minus the circuit (transformer-yoke-damper) losses. This is well within the 19 watt limit.

If it is found desirable to operate the picture tube at a higher potential, such as 7000 volts, this deflecting system will not provide much margin of maximum size. Some increase in output could be obtained by using tube damping instead of resistance capacitance damping. The circuit constants would have to be modified appreciably after this substitution.

The output transformer was constructed to the following specifications:

<u>Laminations:</u>
Type E & I, 15 mil transformer iron, center core 3/4" wide, 1 1/8" long, stack 3/4"

<u>Plate winding:</u>
Insulate 1/8" from core to reduce capacitance
Wind next to core, 510 T No. 32 enamel
Start of winding is "Plate" lead

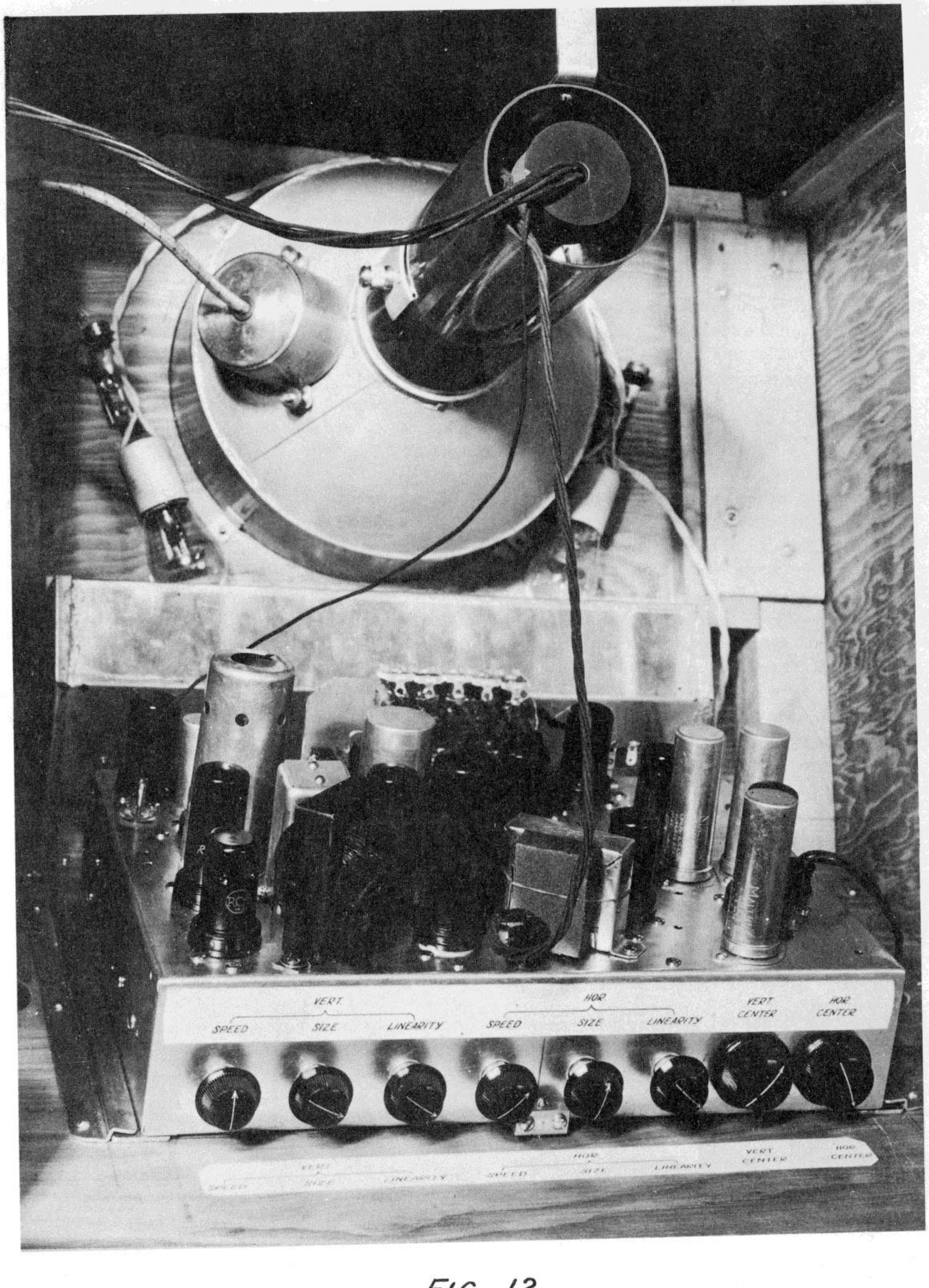
<u>Secondary:</u>
Wind over plate winding
73 turns No. 22 enamel

The load impedance working out of the high r_p tube is a determining factor in deflection amplitude.

This inductive impedance in conjunction with the effective output capacitance is the largest determinant of return time. Hence the reflected impedance of the yoke should be large enough to just obtain adequately short return time in order to produce maximum sensitivity.

The resistance-capacitance damping also contributes somewhat to return time, but since deflection output proved ample for the service intended, the economy over tube damping justifies its use.

The yoke impedance for the horizontal deflection coils was 1.5 millihenrys. The 7 to 1 turns ratio of the output transformer produces a reflected load of 73.5 millihenrys. Yoke and lead capacitance when joined to the plate by the step-down transformer were quite negligible. Most of the effective load capacitance was in the output transformer and in the tube and leads. Return time measured about 13%. Output transformer capacitance was approximately 50 μμf. Shorter return time, if desired, may be had by


VERT.
SPEED
SIZE
LINEARITY
HOR
SPEED
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VERT
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FIG. 12

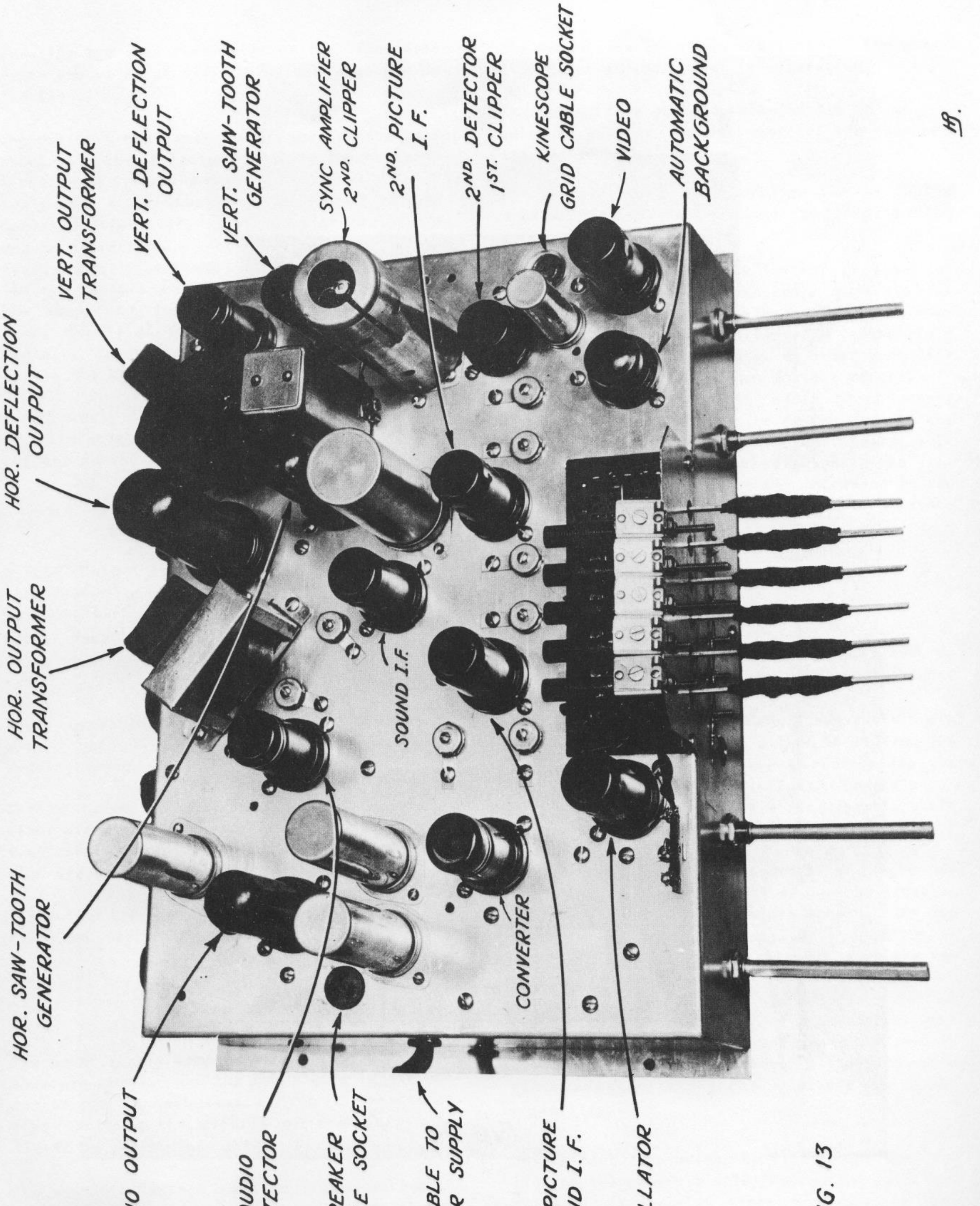
HOR. SAW-TOOTH GENERATOR
HOR. OUTPUT TRANSFORMER
HOR. DEFLECTION OUTPUT
VERT. OUTPUT TRANSFORMER
VERT. DEFLECTION OUTPUT
VERT. SAW-TOOTH GENERATOR
SYNC AMPLIFIER 2ND. CLIPPER
2ND. PICTURE I. F.
2ND. DETECTOR 1ST. CLIPPER
KINESCOPE GRID CABLE SOCKET
VIDEO
AUTOMATIC BACKGROUND
SOUND I. F.
CONVERTER
AUDIO OUTPUT
AUDIO DETECTOR
SPEAKER CABLE SOCKET
CABLE TO POWER SUPPLY
1ST. PICTURE SOUND I. F.
OSCILLATOR
HJ.

FIG. 13

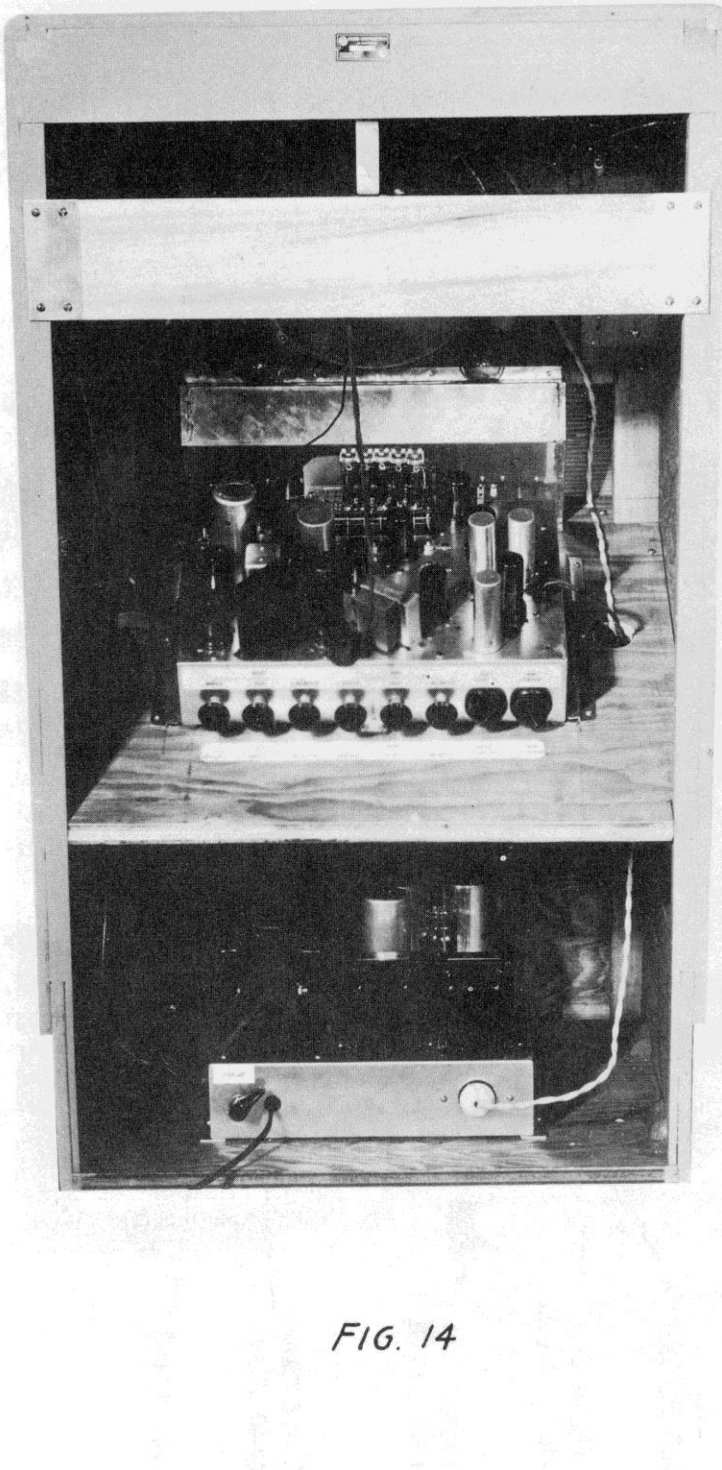

FIG. 14

lowering the step-down ratio of the transformer by an amount which still provides adequate deflection.

The output transformer primary impedance acts in shunt with the reflected yoke load to reduce deflection by diverting the a-c plate current from the yoke. At the same time the leakage reactance operates effectively in series with the yoke to reduce deflection. Increasing the transformer impedance will increase leakage reactance, hence the two factors must be weighed in determining the amount of turns on the transformer. The turns specified for this receiver are experimentally determined optimum, although the number is not very critical.

A "B" supply filter is used for the output stage to eliminate effects of horizontal deflection current on the vertical deflecting system.

Vertical Output

A 6J5GT output tube is coupled through a 16 to 1 step-down transformer to the yoke. The output is ample for deflecting the 5000 volt beam and may be made to deflect 7000 or more volts by increasing the load impedance of the discharge tube.

Heavy bypassing of the cathode is essential to obtain good linearity, approximately 100 μfd. proving ample.

The centering control is unbypassed and has a minor effect on linearity, so the linearity control should be adjusted after the centering and size are set to nearly correct position.

The output transformer is the RCA Mfg. Company's No. 32900 vertical output transformer.

Power Supply

The power supply components were assembled on a separate chassis and the unit placed in the bottom of the cabinet remote from the kinescope, thus avoiding the effects of transformer hum fields on the picture tube.

The economic factors involved in considering the question of making a single or separate chassis for power supply and receiver will not necessarily be the same for all manufacturers. The question deserves individual consideration.

The low voltage portion supplied 210 ma. at 306 volts as well as heater power for the receiver and kinescope.

The high voltage portion supplied 5000 v. to the second anode of the kinescope and focusing voltage for the first anode.

The amount of power supply filtration shown on the schematic diagram is entirely adequate for a transmission system having a field frequency equal to an integral multiple or submultiple of the power line frequency, as under such circumstances a stationary hum pattern occurs. If the receiver is used on 50 cycle power supply with a 60 field transmission system or with any field frequency which is not an integral submultiple of the power supply frequency, the filter condensers must be greatly increased in capacitance if the hum is to be kept to an unobjectionable point.

Cabinet

Some novel features have been included in the receiver cabinet and are shown in the photographs.

The doors and the slidable shelf above the doors serve as shields to screen direct light from the kinescope face and to prevent reflections are deal black on the inner surface. Something of this type is believed to have considerable utility.

Mounting the receiver chassis at an angle decreases the required length of door by grouping the controls near the picture screen. The use of doors is felt to enhance the appearance of the direct viewing type receiver when the receiver is not in use.

The controls on the front of the receiver have fluorescent illumination and are thus readily discernible in a darkened room without necessitating any glare of light to interfere with screen visibility.

This effect is provided by filling the stencilling of the controls with fluorescent paint and allowing ultra-violet light from sources concealed in the cabinet to fall on them.

The ultra-violet light source is from two 110 volt gaseous ionization type lamps similar to the familiar round bulb neon lamps but filled with argon gas in place of neon gas.

The kinescope face is provided with safety glass and rectangular mask.

Conclusion

This bulletin has described a television receiver which has a sensitivity of the order of 100 microvolts and is capable of providing horizontal detail equivalent to about 375 lines with the 441 line, 30 frame, 60 field system, and is therefore able to furnish a picture of good entertainment value in almost any location. This high level of performance has been obtained by simplification wherever that could be accomplished without sacrifice. As a result it is felt that the receiver can be duplicated to sell for less than $200 and provide entirely satisfactory home television reception. Because the additional cost of including at least the broadcast band on the receiver chassis, as suggested above, is so slight, it is believed that this feature will prove essential from a commercial standpoint. The design details of this portion of the receiver may be varied to meet individual requirements.

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