

44A TRANSMISSION MEASURING SYSTEM

TYPE L1 CARRIER SYSTEM

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(G) 40 Kc Amplifier	11	1.01 The 44A Transmission Measuring System (J64044A) provides a means for measuring single frequency signals, noise and crosstalk, over a wide range of power values, in the fre- quency range from 50 kc to 3500 kc. It is in- tended for use in the maintenance of L1 carrier telephone systems operating over coaxial cables. It will frequently be referred to in this sec- tion as the 44A TMS.	
(H) Wide 40 Kc Band Filter	11	1.02 The following is a specification of the capabilities of the 44A Transmission Measuring System:	
(I) Detector Monitor Panel	11	Frequency range - 50 kc to 3500 kc	
(J) Variable Preselector	13	Power measuring range	
(K) Control Panel	16	Terminating a Line - 0 dbm to -110 dbm	
(L) Bridging Transformer	16	Bridging a line - +20 dbm to -90 dbm	
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(A) General	19	Range -70 dbm to -110 dbm - + 2 db	
(B) Measurements Using Detector Alone	20	Accuracy of noise measurement - + 2 db	
(C) Measurements Using Variable Preselector and Detector	20	Accuracy of frequency setting - + 2 kc	
5. MAINTENANCE	21	1.03 Using the 600 cycle pass band, the 44A TMS may be used, with limitations, for the measurement of noise, modulation, etc. in individual channels of a working L1 system. In such cases the measuring range will be limited	
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by modulation produced within the measuring system itself, from speech, carrier leaks, pilot frequencies and signaling tones. In general it will not be possible to measure below -65 to -70 dbm at the output of a repeater, in the presence of this interference. However at specific frequencies slightly lower levels may be reached particularly when the adjacent speech channels are idle.

1.04 The system is mounted in a mobile console with a sloping face on which appear most of the operating controls. A photograph of the unit is shown in Fig. 1. It weighs about

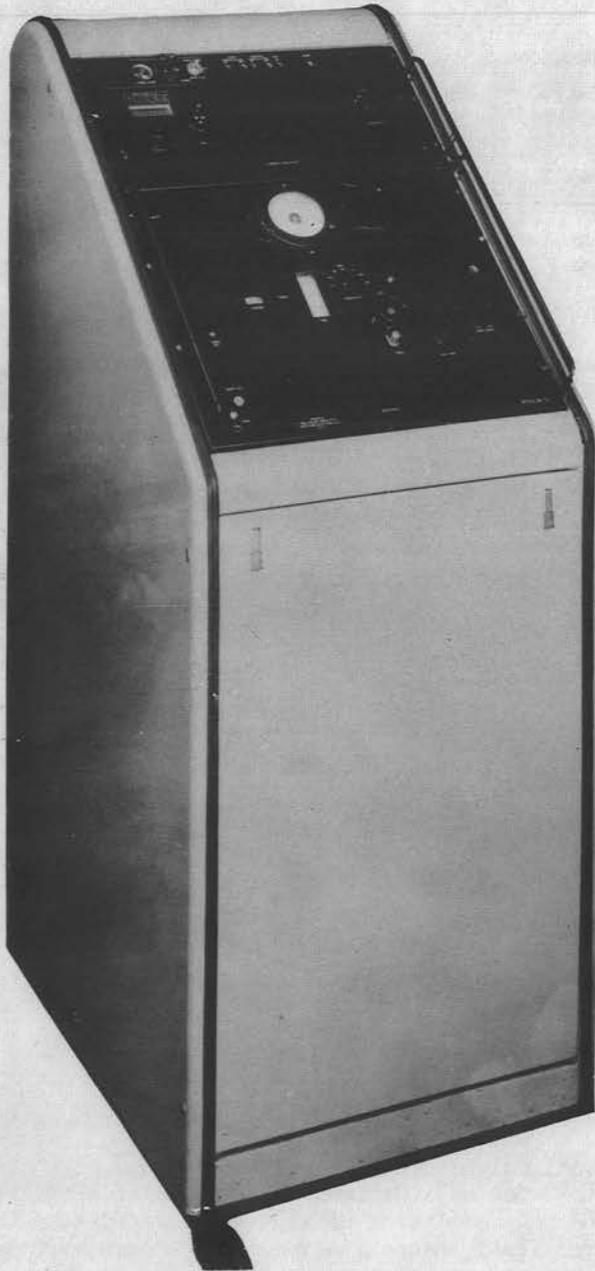


Fig. 1 - Front View of 44A Transmission Measuring System

265 pounds. It is 30" deep and 24" across the front. The height is 60" in the back and 40" in the front.

1.05 A 53A mobile oscillator or equivalent is required for the power calibration of the 44A TMS.

1.06 The system uses 115 volts, 60 cycle a-c power. The power cord may be connected to a receptacle on the control panel or to a similar receptacle in the lower part of the back of the console. A regulated rectifier supplies 300 volts d-c and another regulated unit supplies 6.3 volts a-c to the heaters. A small non-regulated 6.3 volt a-c supply is included for auxiliary needs. The total power drain including the ventilating fan is 325 watts.

1.07 The electron tubes and varistors in the system should not be removed from their sockets while the power is turned on. To do so may result in damage to the varistors which are silicon type crystals, causing considerable loss in sensitivity.

Caution: The 44A Transmission Measuring System employs voltages which are higher than those usually found in the telephone plant. Maintenance work on the System should be done by experienced personnel and only after all necessary precautions have been taken.

2. DESCRIPTION

(A) General

2.01 The principal units of the 44A Transmission Measuring System are shown in the block diagram of Fig. 2. They are the following:

- (1) A heterodyne detector which will measure power from 0 dbm to -70 dbm and which is continuously adjustable with respect to the input frequency over the range

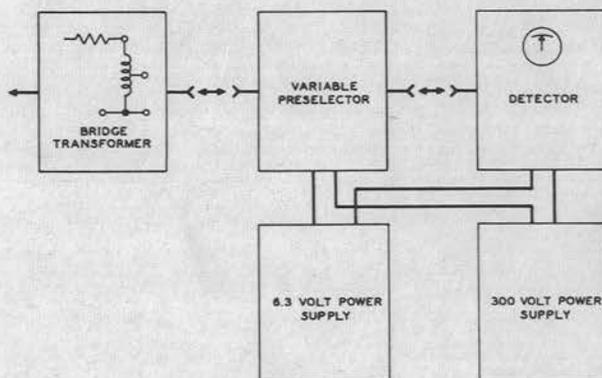


Fig. 2 - Block Diagram

from 50 kc to 3500 kc. This part of the system will ordinarily be used to measure pilot channels and other single frequencies which are at a relatively high level.

(2) A variable preselector (144A Amplifier) which is connected ahead of the detector when required. It has a maximum gain of 40 db, thereby extending the range of measurement to -110 dbm. It is continuously tunable over the range from 50 kc to 3500 kc. It is intended for use in the measurement of low level signals, noise and crosstalk. When applied to a working LL system the range of measurement may be limited by modulation from other line signals having power values much greater than that being measured.

(3) A bridging transformer (216A Repeating Coil) which permits measurements to be made on working coaxials with a minimum

effect to through transmission. The loss through the transformer to the test set is 20 db and the bridging loss to the through transmission is less than .1 db.

(4) A power supply unit J86223, L1, which provides a regulated a-c voltage of 6.3 volts for the heaters of the various tubes in the circuit.

(5) A power supply unit J86219A, L2, which provides a regulated d-c voltage of 300 volts for the plates and screens of the various tubes in the circuit.

2.02 The panels on the sloping face of the console, are shown in Fig. 3. On the top is the control panel, containing the power switch, fuses and jacks. Below the control panel are the Variable Preselector Unit and the Detector Unit.

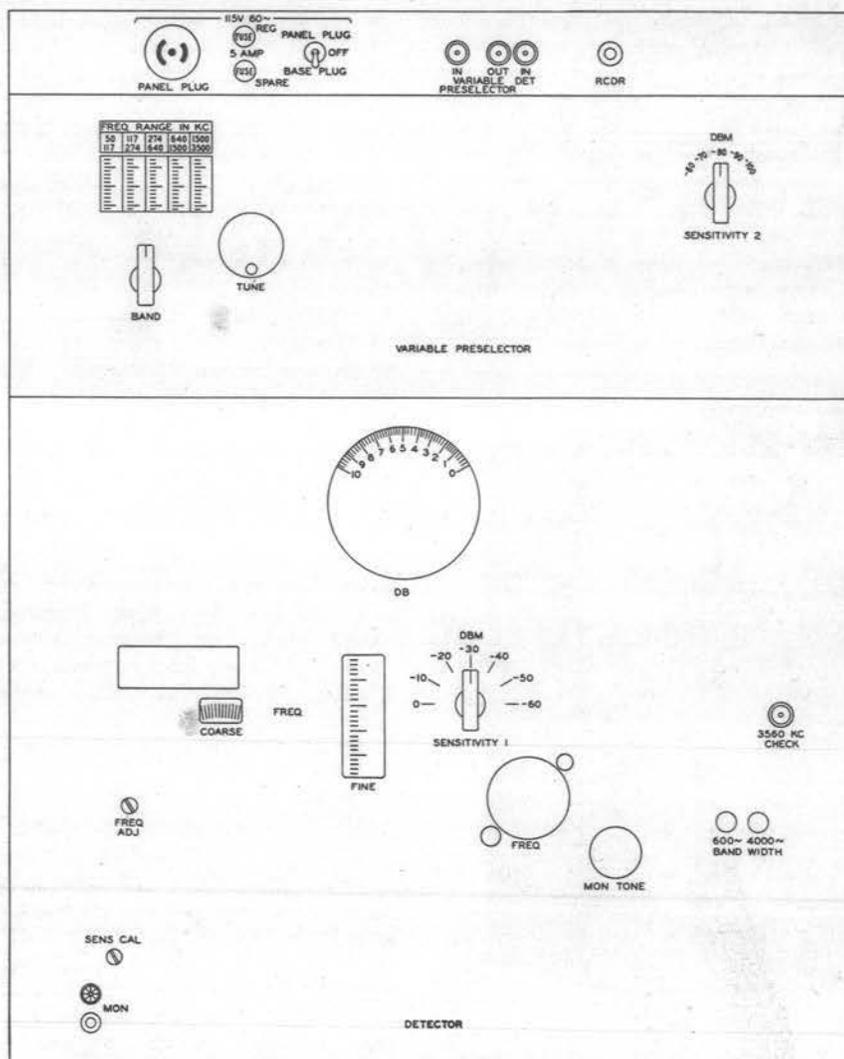


Fig. 3 - Face Panels of the Console

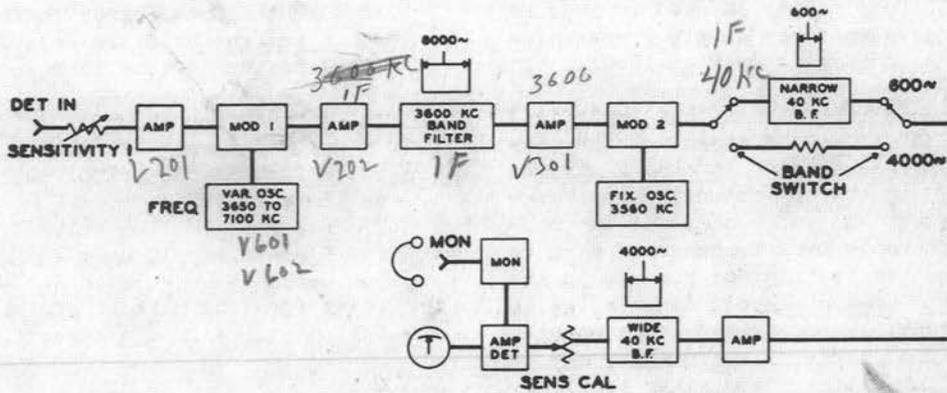


Fig. 4 - Block Diagram of Detector

2.03 The Detector Unit will be used in practically all measurements involving the 44A TMS. A block diagram showing the general make-up of the unit and the functions of the various operating controls is given in Fig. 4. A photographic view of the interior is shown in Fig. 5.

2.04 Connection is made to the input of the detector in the jack designated DET IN on the control panel. The signal passes from there through a similar jack on the Detector Unit to the attenuator which is designated SENSITIVITY 1 on the face panel. This attenuator, which has a loss of 0 to 60 db in 10 db steps, serves to bring the input signal

always to a level somewhere between -60 dbm and -70 dbm at the grid of the first tube. The amplifier immediately following has a small gain and also functions as a limiter. In this way, it protects the modulator following, by restricting the amount of power that can be applied to it under accidental circumstances.

2.05 In the first modulator the input signal is modulated with the variable frequency oscillator. The frequency range of this oscillator is 3650 kc to 7160 kc. It is adjusted so that the difference from the input frequency under measurement is always 3600 kc, thus producing 3600 kc in the output of the modulator. The film scale of the oscillator is calibrated in terms of the input frequency, which is the true oscillator frequency minus 3600 kc. The variable air condenser which controls the frequency of the oscillator circuit is designated FREQ on the panel. FREQ ADJ is a small trimmer condenser used in adjusting the frequency to the film scale.

2.06 The 3600 kc product resulting from the modulation goes through another single stage amplifier, thence to a band filter which passes 3600 kc but rejects all other products of the modulation. From the band filter, the signal passes through another two stage amplifier to the second modulator.

2.07 In the second modulator the 3600 kc signal is modulated with a frequency of 3560 kc from the fixed frequency oscillator. This results in an output product of 40 kc. The 40 kc signal goes to the BAND WIDTH switch which determines the band width of the circuit for any particular measurement. If it is set to 600 CYCLES the signal passes through a 40 kc band filter having a pass band of only 600 cycles. This narrow band is intended principally

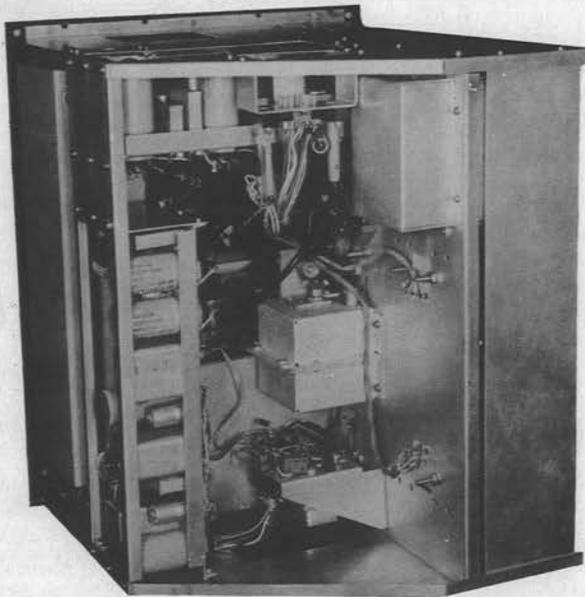


Fig. 5 - Interior View of Detector

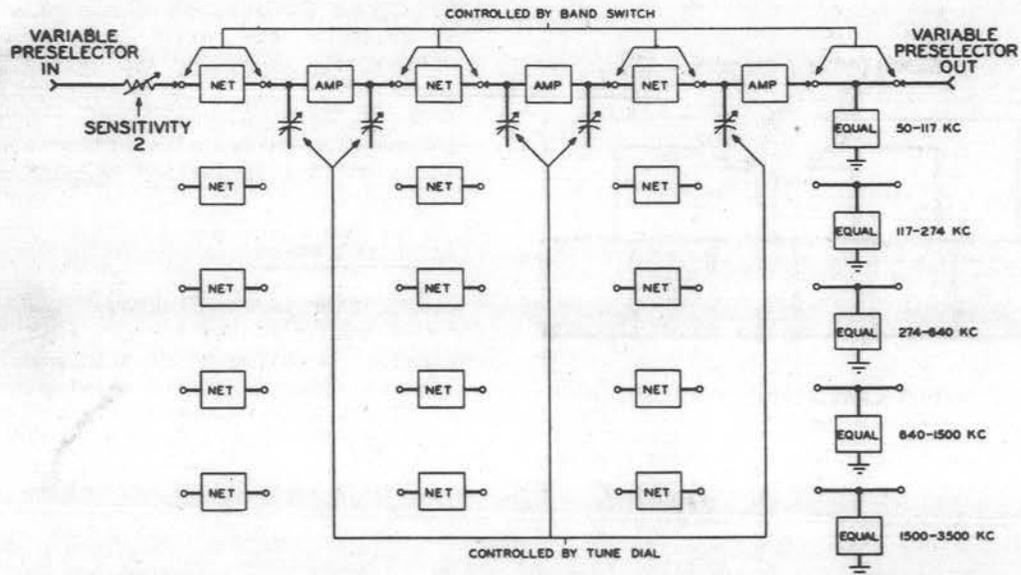


Fig. 6 - Block Diagram of Variable Preselector

for noise measurements. If the switch is set to 4000 CYCLES the signal goes through a pad having a loss equal to the narrow band filter at midband.

2.08 From the switch the signal goes through a three-stage amplifier and then through another 40 kc band filter having a band width of 4000 cycles. This filter determines the band width when the BAND WIDTH switch is set to 4000 CYCLES.

2.09 Following the band filter is another three stage amplifier and a crystal rectifier. The latter converts the signal into a direct current which registers on the DB meter which is on the detector panel. Between the band filter and the amplifier is a potentiometer designated on the panel as SENS CAL. It is used in calibrating the $\frac{1}{4}$ TMS against a known power input.

2.10 Bridged on the amplifier is a monitoring circuit consisting of a self-oscillating modulator. It generates a frequency of 39 kc and modulating with the 40 kc signal it will produce an output of approximately 1000 cycles. By means of headphones, this signal may be heard at the MON jack. A small adjustment of the frequency may be made by means of the MON TONE control. The insertion of a plug in the MON jack will make the meter circuit inoperative.

2.11 A block diagram of the Variable Preselector is shown in Fig. 6. This unit provides additional gain and selectivity when it is desired to measure noise or signal powers between -70 dbm to -110 dbm. The band width of the selective circuit ranges from about 5

kc at the lowest frequencies to about 75 kc at 3500 kc. In use it will always be placed ahead of the detector unit by connecting from VARIABLE PRESELECTOR OUT to DET IN.

2.12 The signal to be measured is connected to VARIABLE PRESELECTOR IN. From here it passes through a 5 db pad and an attenuator, SENSITIVITY 2, which has four 10 db steps. In operation the attenuator will normally be set so that the signal level at its output will always be between -105 dbm and -115 dbm. Following the attenuator is a three stage amplifier which is equipped with a series of input and interstage tuned circuits to provide the required selectivity. There are five different tuned circuits or networks for each stage providing five frequency ranges or bands. An equalizer for each frequency range is provided in the output stage in order to obtain uniform gain for all frequencies in that range. The selection of the proper networks and equalizer for each range is made by the switch designated BAND.

2.13 All of the tuned circuits are made continuously variable over their frequency range by means of air condensers. These condensers are ganged together so that all stages are changed in unison. The two interstage networks are double tuned circuits requiring two condensers each and the input tuned circuit requires one. All are under control of the dial designated TUNE. Since the variable preselector will be used only in conjunction with the detector the indicating facilities of the latter are used in adjusting the TUNE dial to the proper frequency.

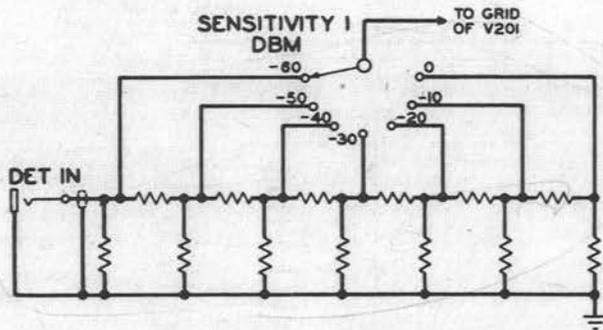


Fig. 7 - Attenuator at Input to Detector

(B) Detector Attenuator

2.14 The attenuator at the input to the detector is the standard on which all measurements, using the detector, are based. Its accuracy requirements are, therefore, very high. It has a total loss of 60 db.

2.15 The circuit is shown in Fig. 7. From this circuit it will be seen that the attenuator acts as a voltage divider, the adjustable tap going to the grid of V201 under the control of the switch. The switch is designated as SENSITIVITY 1 on the panel.

2.16 There are six blocks in the attenuator, each 10 db. Allowing for the zero setting this provides seven steps, 0, 10, 20, 30, 40, 50 and 60 db. These correspond to input levels of -60, -50, -40, -30, -20, -10 and 0 dbm respectively and the switch SENSITIVITY 1 is so designated. The resistors which make up the attenuator are a new type, specially designed for accuracy over the frequency range of the 44A TMS. The resistors are mounted di-

rectly on the switch to minimize the wiring. In addition, the switch is made in two sections effectively dividing the attenuator into two parts. This eliminates any significant coupling between the input and output which might cause a measuring error. The attenuator, at maximum loss setting, is correct to within $\pm .1$ db.

(C) MOD 1 Panel

2.17 After passing through the variable attenuator the signal goes to the MOD 1 panel. The circuit of this panel is shown in Fig. 8. It consists of a single stage of amplification V201, a modulator MOD 201, and another single amplification stage V202. V201 and V202 are 403B electron tubes while MOD 201 is a 403B varistor of the silicon crystal type.

2.18 While V201 produces a small amount of gain to the input signal, one of its chief functions is to act as a limiter, thereby protecting the crystal modulator against accidental overloads. It is a wide band amplifier and provides a uniform gain to input signals over the frequency range from 50 kc to 3500 kc. The wide band uniformity is achieved by using plate circuit compensation in the form of the inductance L201. This inductance is variable over a wide range and is adjusted in the factory to give the amplifier a flat gain characteristic. It is expected that this inductance will not ordinarily require adjustment in the field.

2.19 The function of the modulator, MOD 201, is to modulate the incoming signal with a variable frequency from a heterodyne oscillator, so that one of the modulation products will always be 3600 kc. The heterodyne oscillator which is described under (D) Variable Frequency Oscillator covers a range from 3650 kc to 7160 kc. If the input signal is 50 kc

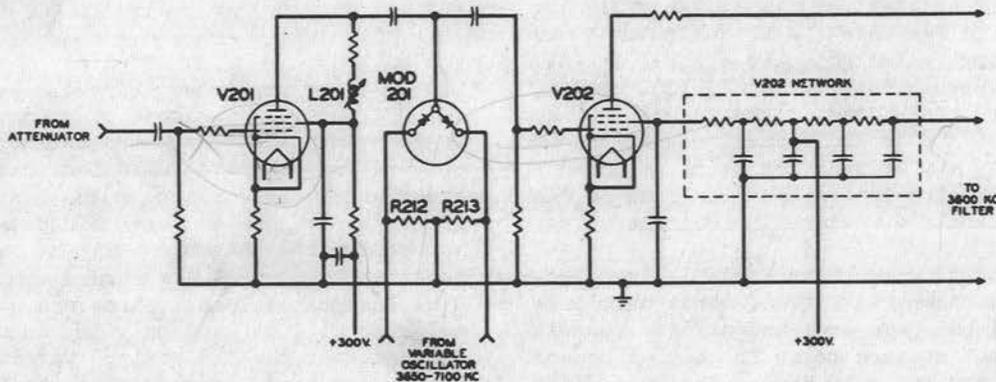


Fig. 8 - First Modulator

the oscillator will be set at 3650 kc with a resultant 3600 kc modulation product. If the input signal is 3500 kc the oscillator will be set at 7100 kc also giving a 3600 kc modulation product.

2.20 The modulator is a 403B Varistor. It consists of two silicon type crystals, selected to have similar electrical characteristics and mounted in a plug-in unit like an electron tube. Together with resistors R212 and R213 they form a balanced bridge. The input signal is connected between the apex of the bridge and ground while the variable oscillator is connected across the other corners. The oscillator output of .7 to .8 volts r.m.s. across the modulator, is high in comparison with the level of the signal to be measured. This results in the conversion loss of the modulator bridge being substantially independent of small changes in the output of the oscillator as the frequency changes.

2.21 The loss of the modulator to the signal frequency is 14 db. That is, the 3600 kc output frequency will be down in level by that amount from the input frequency. The balance of the modulator bridge will be in the order of 30 db or better. This degree of balance will serve to minimize the amount of the heterodyne oscillator frequency which gets into the modulator output.

2.22 V202 amplifies the output of the modulator before passing the signal along to the next stage in the circuit. The V202 network is a filter for plate and screen voltages to minimize the introduction of extraneous noises.

(D) Variable Frequency Oscillator

2.23 The variable frequency oscillator, which supplies the carrier voltage for the modulator in the MOD 1 panel, is mounted in a

shielded container directly behind the front panel so that controls may be brought out and the frequency scales made visible. It is mounted immediately adjacent to the MOD 1 panel so that interconnecting leads will be as short as possible.

2.24 The circuit of the variable frequency oscillator is given in Fig. 9. It consists of the oscillator stage, V601, and an amplifier stage, V602. V601 is a double triode electron tube, coded 396A. The two triodes in this tube are coupled by a common cathode circuit and the plate circuit of the output half is coupled back to the grid of the input half by C606. The frequency of oscillation is controlled by the inductance, L601, and the variable capacitance, C604, plus the other capacitances in the circuit. C604 is designated FREQ on the panel. A small trimmer capacitance, C605, is used to adjust the frequency to the scale of C604. It is designated FREQ ADJ on the panel. It is equipped with a 50:1 reduction gear to facilitate the adjustment.

2.25 The amplifier stage V602 is a 403B electron tube. It acts as a buffer between V601 and the modulator and steps up the oscillator output to the voltage needed for satisfactory operation of the modulator. The output transformer T601 matches the output impedance to that of the modulator.

2.26 The entire oscillator circuit is designed to give a high degree of stability to the output frequency. L601 is a high Q inductance coil with a low temperature coefficient. C604 and the other capacitances which determine the oscillator frequency are likewise chosen to have minimum temperature coefficients. C611 and C610 form a voltage divider to couple V601 and V602. The capacitance of C610 is made high with respect to C611 so that the oscillator will be practically independent of the amplifier circuit.

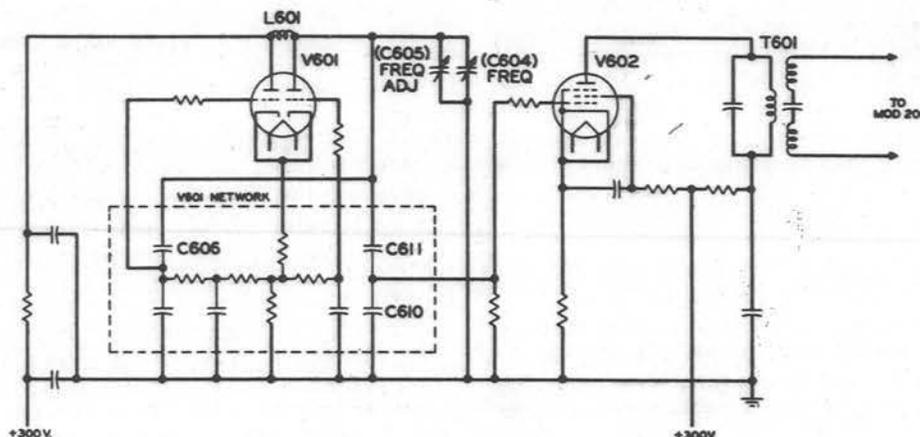


Fig. 9 - Variable Frequency Oscillator

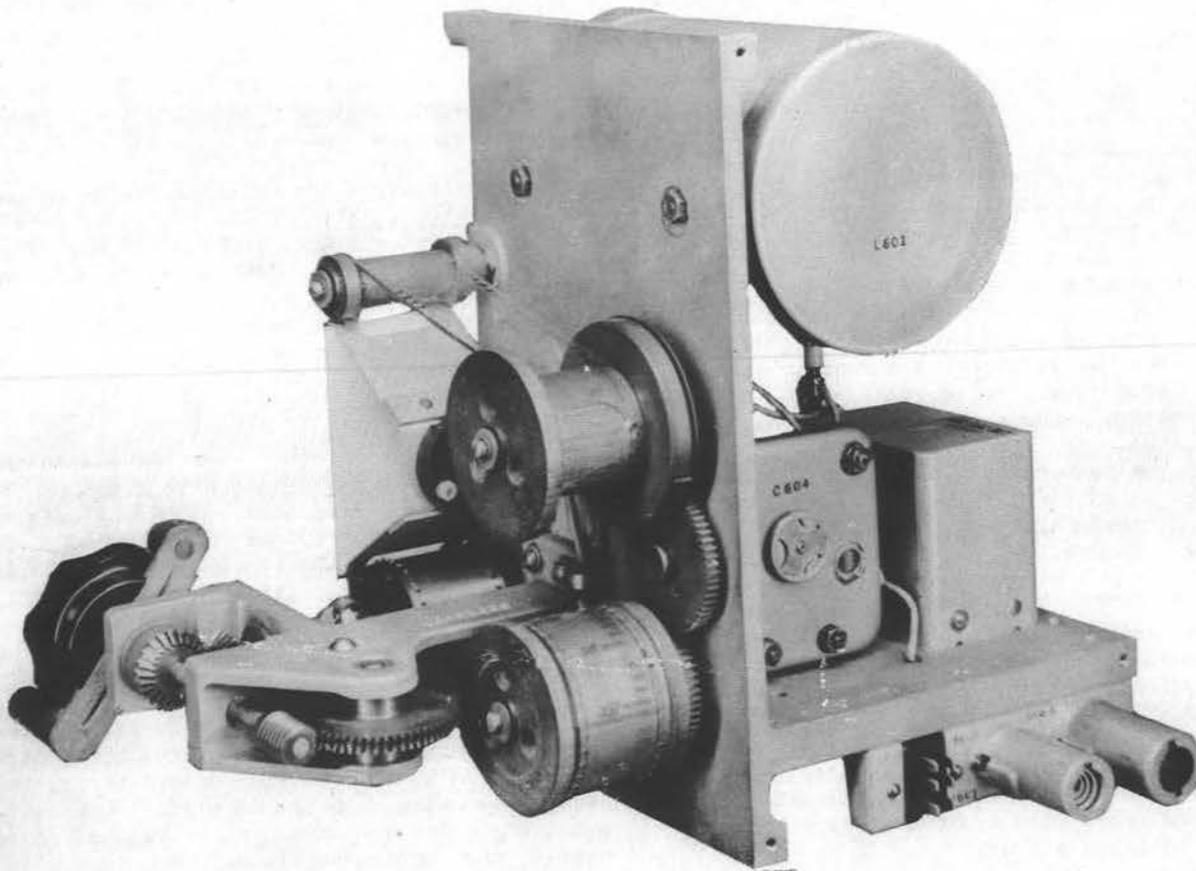


Fig. 10 - Film Drive Mechanism of Variable Frequency Oscillator

2.27 A photographic view of the film drive mechanism of the Variable Frequency Oscillator is shown in Fig. 10. The variable air capacitor, C604, which controls the oscillator frequency capacitor, is driven by a crank appearing on the face panel. This crank is coupled to the capacitor shaft through reduction gearing allowing for very precise settings. Also coupled to the crank mechanism is a film scale 55 feet long, calibrated in terms of the input signal frequency. The oscillator frequency at any setting of the film scale is such that it will produce a 3600 kc modulation product with an input signal of the calibrated frequency. Thus, with the film scale set at 1000 kc, the actual oscillator frequency is 4600 kc. Scale divisions are located every 2 kc and the frequencies are given at each 10 kc point.

(E) MOD 2 Panel

2.28 The panel designated MOD 2 comprises a 3600 kc band filter, a two stage 3600 kc amplifier, a second modulator for converting the signal frequency to 40 kc and a heterodyne oscillator for supplying the second modulator.

2.29 The circuit exclusive of the heterodyne oscillator is shown in Fig. 11. At the input is a crystal type band filter whose mid-band frequency is 3600 kc. It is receptive over a band about 8 kc wide. This filter will pass the 3600 kc signal produced in the initial modulation process. It will reject the original signal frequency, any leak from the variable frequency oscillator and other products generated in the first modulator. Small trimmer capacitors at each end of the filter are adjusted at the factory. These capacitors will not ordinarily require adjustment in the field. The loss characteristics of a representative filter are given in Fig. 12. Beginning at points about 5 kc away on both sides of midband, the loss increases rapidly, reaching a value of 80 db or more when 100 kc away. Within the pass band the loss is very uniform, the deviation between +2 kc and -2 kc being less than $\pm .05$ db.

2.30 There may be occasional spurious responses in the suppression range of this type of filter which will result in reduced losses over very narrow bands. These will, however, always be far enough away from the pass band to have no significant effect on the system performance.

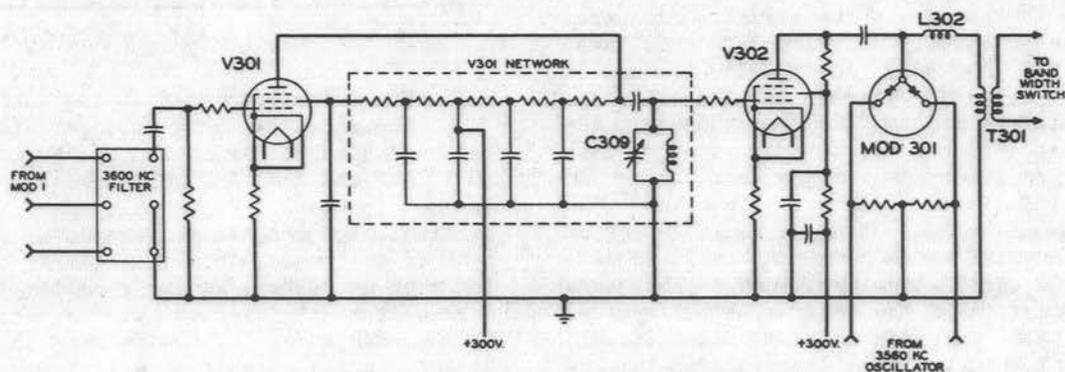


Fig. 11 - 3600 Kc Filter and Second Modulator

2.31 The 3600 kc signal from the band filter passes to the two stage amplifier made up of V301 and V302. Each of these tubes is the 403B type. V302 provides only a limited gain and like V201 on the MOD 1 panel, one of its functions is to act as a limiter in protecting the crystals in MOD 301 against accidental overload. The V301 network provides a filter for the plate and screen voltages on the V301 tube. In addition, it contains a shunt tuned to antiresonance at 3600 kc. This tends to filter off any low frequency noise (40 kc band)

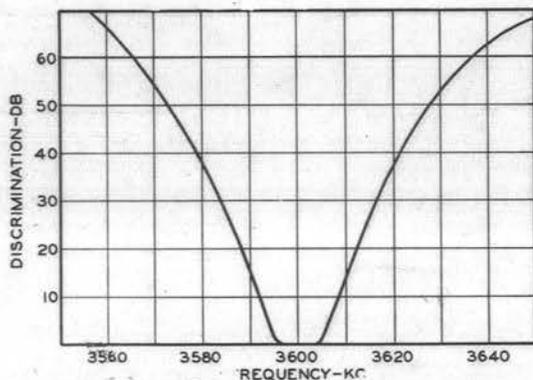


Fig. 12 - Typical Discrimination Characteristic of 3600 Kc Band Filter

which might be present and which could pass unrestricted into the 40 kc circuit following the MOD 2 panel.

2.32 From V302 the 3600 kc signal passes to the second modulator, MOD 301. The purpose of this modulator is to convert the signal frequency from 3600 kc to 40 kc before passing it along the circuit for further amplification. The modulator circuit is identical to that on the MOD 1 panel, using the 403B varistor in a balanced bridge circuit. The heterodyne oscillator supplies a frequency of 3560 kc. This modulates with the input signal of 3600 kc, to produce an output of 40 kc. The oscillator differs from that used with the first modulator in that it operates at a single fixed frequency. Inductance L302 is placed in the modulator output to maintain a high impedance at 3600 kc. This reduces any shunting effect that might be caused by low impedances in the 40 kc circuit which follows. The output transformer, T301, matches the output impedance to that of the filter and pad circuits which come immediately after.

2.33 The circuit of the fixed frequency heterodyne oscillator which supplies the second modulator is shown in Fig. 13. A 396A

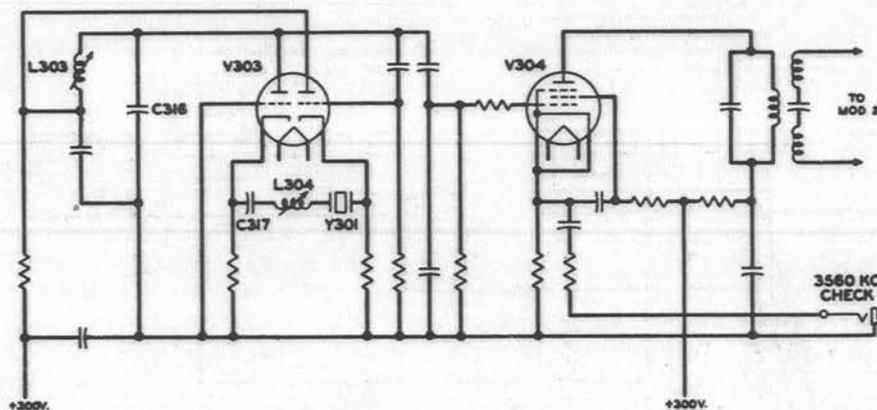


Fig. 13 - 3560 Kc Oscillator

double triode, V303, is used to generate the signal as in the case of the variable frequency oscillator previously described. In this case, however, the frequency controlling element is a crystal connected between the two cathodes. This crystal maintains the frequency very accurately at 3560 kc. Variations due to temperature and other causes are less than + 100 cycles. Inductance L304 and capacitor C317 constitute an auxiliary tuned circuit in series with the crystal which permits a small adjustment in the oscillating frequency. This range of adjustment is of the order of ± 700 cycles. L303 and C316 comprise another tuned circuit resonant at 3560 kc. The frequency of the oscillator is accurately set at the factory to 3560 kc and should require no further adjustment in the field.

2.34 The amplifier stage, V304, associated with the 3560 kc oscillator is a 403B electron tube. The circuit is almost identical with that for the variable frequency oscillator. The output voltage supplied to the modulator is between 1.0 and 1.5 volts r.m.s., high enough to make the conversion loss of the modulator independent of slight changes in voltage.

2.35 A very small amount of the 3560 kc output is taken off the cathode of V304 and brought out to a jack on the face panel. The jack is designated 3560 KC CHECK. Since this frequency is held accurately at 3560 kc it may be used to adjust the film scale of the variable oscillator where more accurate standards are not available. A 3560 kc point is inscribed on the film scale for this purpose.

(F) Band Width Switch and Narrow 40 Kc Band Filter

2.36 For most measurements the band width of the detector unit will be determined by the band pass of the 40 kc filter between the 40 KC AMP and the DET MON panels. This band is 4000 cycles. In certain cases, however, particularly for noise measurements, a narrower band is desirable. This is obtained by switching a 40 kc filter, having a band width of 600 cycles, into the circuit at the output of the second modulator. The wide band 40 kc filter is left in the circuit at all times.

2.37 The switching circuit is shown in Fig. 14. The switch, of the push button type, appears on the face panel and is designated BAND WIDTH. It has two positions designated respectively 4000 CYCLES and 600 CYCLES. When operated to the 600 CYCLES position the signal passes through the narrow 40 kc band filter. When operated to the 4000 CYCLES position the signal passes through a pad having a loss very nearly equal to the midband loss of the filter. For a single frequency signal tuned to the middle of the narrow band filter the difference in response for the two switch positions will not exceed .5 db.

2.38 The narrow band filter is intended to permit noise measurements on a working LL carrier system. In such a measurement the selected band is subject to interference from other signals on the line in adjacent channels. To minimize this interference the filter losses

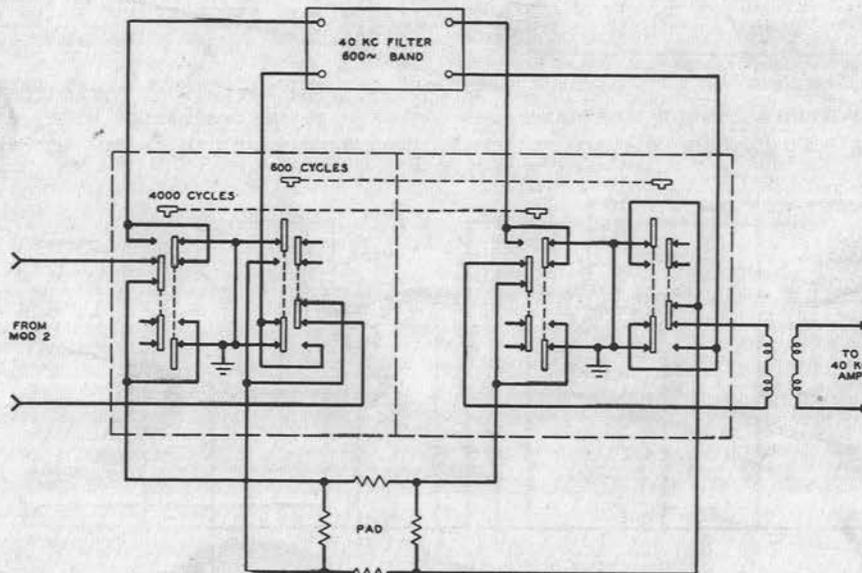


Fig. 14 - Band Width Switch and 40 Kc Filter with 600 Cycle Band

must increase sharply outside the band. Fig. 15 shows the loss characteristic of a typical filter.

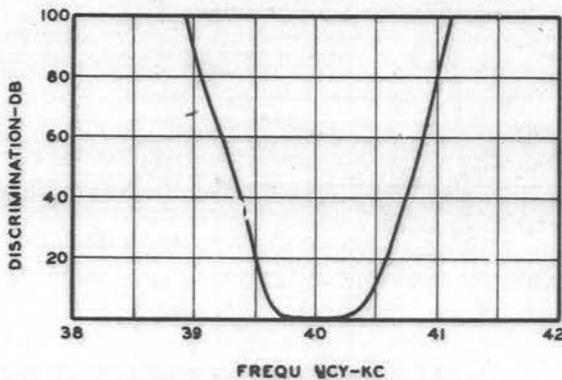


Fig. 15 - Discrimination Characteristic of 40 Kc Band Filter with 600 Cycle Band

(G) 40 Kc Amplifier

2.39 Following the switching circuit is the 40 KC AMP panel. The circuit of this panel is shown in Fig. 16. It is a three-stage amplifier consisting of V401, V402 and V403, which are 403B electron tubes. Individual cathode feedback in each stage and over-all interstage feedback through R416 provide flat transmission and a high degree of gain stability. Plate and screen battery filters are provided in individual networks for each tube. The network associated with V402 has the plate circuit tuned to 40 kc to provide selectivity against the high frequencies used in the second modulator. The capacitance C407 in this network is adjusted at the factory.

(H) Wide 40 Kc Band Filter

2.40 The 40 kc band filter shown in Fig. 17 has a pass band of 4000 cycles. It determines the band width over which the detector unit is receptive when the BAND WIDTH switch is set to 4000 CYCLES. It is connected at the output of the 40 KC AMP and filters out any unwanted frequencies outside the band before passing the signal along to the DET MON panel.

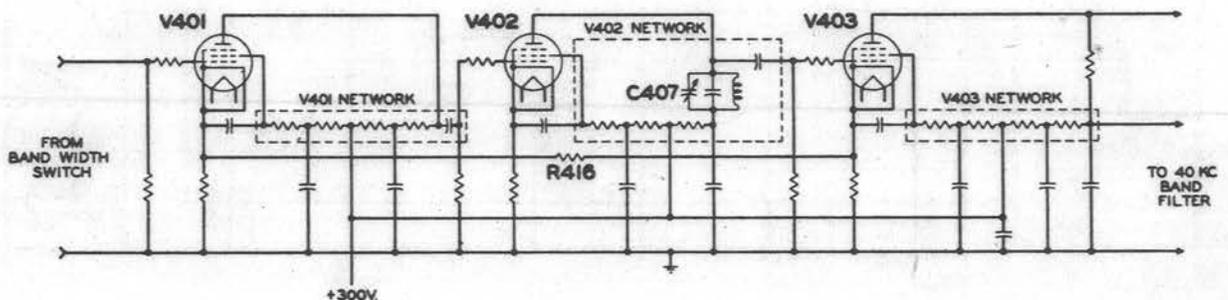


Fig. 16 - 40 Kc Amplifier

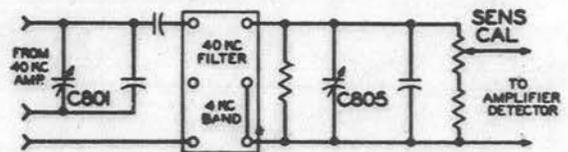


Fig. 17 - 40 Kc Filter with 4000 Cycle Band

2.41 To make the detector independent of slight changes in the frequencies of the heterodyne oscillators the pass band of the filter is very flat, the maximum deviation being less than $\pm .05$ db between frequencies 1500 cycles each side of mid-band. Fig. 18 shows the discrimination characteristic of a representative filter.

2.42 The extreme flatness of the filter requires a precise termination. The adjustable capacitors on each side of the filter, C801 and C805, permit an accurate adjustment of the circuit capacitance. This adjustment is made at the factory and should not be disturbed.

2.43 At the output of the filter is a potentiometer which is connected to the grid of the first tube in the succeeding amplifier stage. This potentiometer is designated SENS CAL on the face panel of the detector. It is used to adjust the signal to a reference reading, usually 0 db, in calibrating the detector prior to a measurement. The potentiometer has a nominal range of 20 db which should be adequate to take care of changes due to tube replacements, aging and other long term factors. It is adjusted by a screwdriver inserted through a hole in the panel.

(I) Detector Monitor Panel

2.44 The DET MON panel follows the wide 40 kc filter circuit. It consists of a three-stage amplifier and a rectifier circuit. Bridged on the output of the second stage of the amplifier is a monitoring circuit which makes the signal audible to the operator when he considers it desirable.

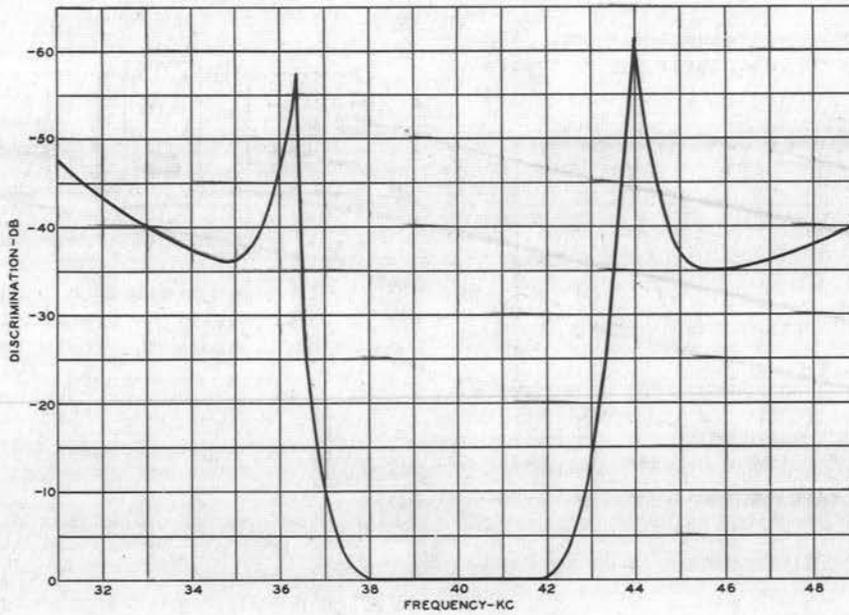


Fig. 18 - Discrimination Characteristic of 40 Kc Filter with 4000 Cycle Band

2.45 The amplifier consists of V501, V502 and V503 which are 403B electron tubes. It is very similar to the three-stage amplifier described above as the 40 KC AMP. The circuit is shown on Fig. 19. Plate and screen battery filters are provided for each tube. The V502 and V503 networks have, in addition, elements which tune the circuits to 40 kc. Capacitances C507 and C512 are adjusted at the factory. Individual cathode feedback in each stage and overall interstage feedback provide flat transmission and high gain stability.

2.46 The 40 kc output of V503 is rectified by the germanium crystal rectifiers CR501 and CR502 coded 400A. The rectified signal appears on the panel meter designated DB. The fundamental component of the rectified signal

flows in the cathode of V503 which is connected to the cathode of V501 by the feedback resistor, R515. This feedback results in a linear relation between the applied input voltage and the direct current output of the rectifier.

2.47 The meter is mounted on the face panel of the detector unit. It is calibrated to read the changes in output current in terms of db. Full scale deflection is equivalent to a current flow of 1.5 milliamperes. To facilitate reading, it is designed with a scale linear in db. A scale adjusting circuit controlled by R530, applies a small biasing current to the meter to make the scale read precisely at the 0 and -10 db points. The biasing current may be applied in either direction, as required, dependent upon the direction of the

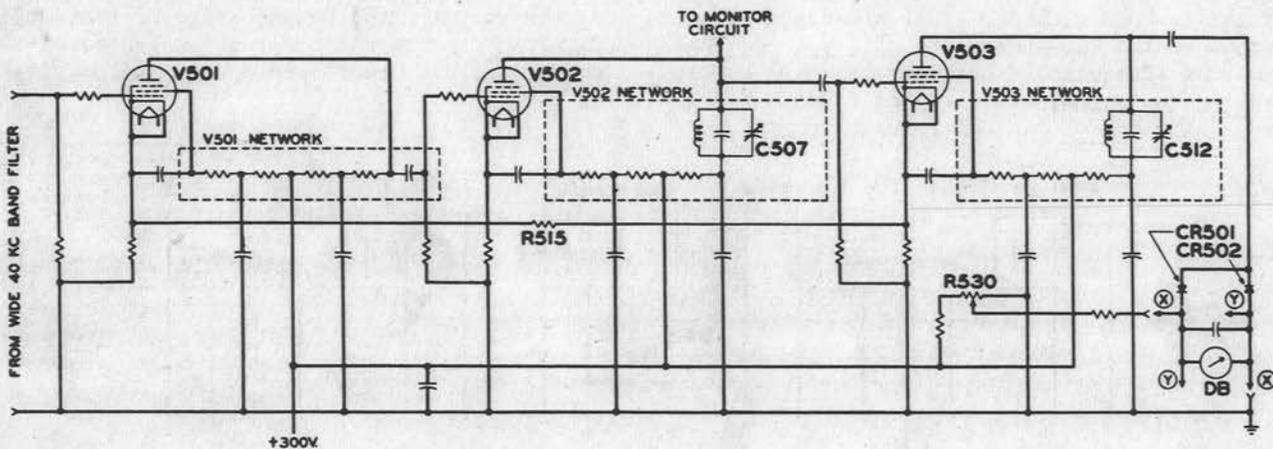


Fig. 19 - Amplifier-Rectifier Circuit

error in the meter itself. The selection between X and Y wiring is made at the factory and should not require any change unless the meter is replaced.

2.48 The monitor circuit is shown on Fig. 20.

It consists of a double grid 6SA7 electron tube, V504, which is connected to function as a self-oscillating modulator. One grid is coupled to the cathode through a tuned circuit so that it will oscillate at a frequency of about 39 kc. The other grid is connected through a potentiometer, R525 to a tap on the plate of V502. The 40 kc signal derived from this tap modulates with the 39 kc generated within the tube and produces a frequency of 1 kc in the output. The air capacitor MON TONE is controlled from the face panel and permits a small adjustment of this frequency. It may be heard by plugging the 528 type telephone receiver into the MON jack.

2.49 The circuit is normally inactive, the plate voltage to V504 being connected to open contacts on the MON jack. The contacts are closed and the circuit made operative when the plug is inserted. This precaution is taken so that when measurements are made with the meter there will be no possibility of interference from the 39 kc generated by V504. Additional contacts on the MON jack operated by the plug insertion light the MON lamp and short-circuit the meter.

2.50 The jack designated RCDR is in series with the meter and provides a ready means of connecting a recorder into the circuit where continuous observations over a long period of time are required.

(J) Variable Preselector

2.51 The variable preselector, coded as the 114A Amplifier, is a three-stage amplifier. The first two stages use 9003 electron tubes and the last stage is a 403B electron tube. It is mounted on the sloping face of the console just above the detector. A rear view of the preselector with the cover removed is shown in Fig. 21.

2.52 The selectivity is provided by continuously tunable input and interstage units. To satisfactorily cover the frequency range from 50 kc to 3500 kc, five different sets of input and interstage units are provided as follows:

Band No. 1	50 kc to 117 kc
Band No. 2	117 kc to 274 kc
Band No. 3	274 kc to 640 kc
Band No. 4	640 kc to 1500 kc
Band No. 5	1500 kc to 3500 kc

It will be noted that the ratio between the highest and lowest frequency in each band is about 2.34. An equalizer is provided in the output stage of the amplifier for each of the above bands. An adjustment is provided for each band, to set the amplifier gain at 40 db. A single master switch designated BAND on the face panel, selects all the necessary elements in changing from one band to another. This is a cam operated switch requiring a complete rotation of the control knob on the face panel to change from one band to another. A photographic view of the uncovered switch is shown in Fig. 22. The band for which it is set is indicated by a lighted dial on the variable air capacitor.

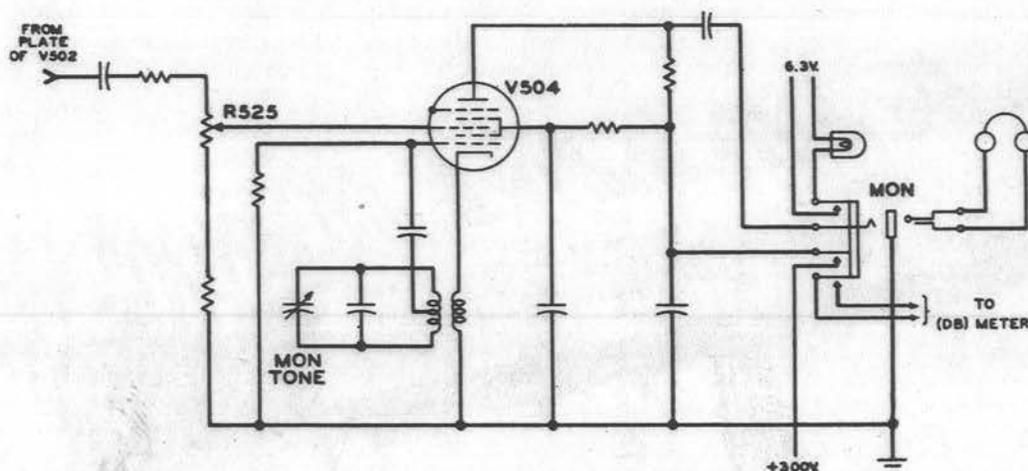


Fig. 20 - Monitoring Circuit

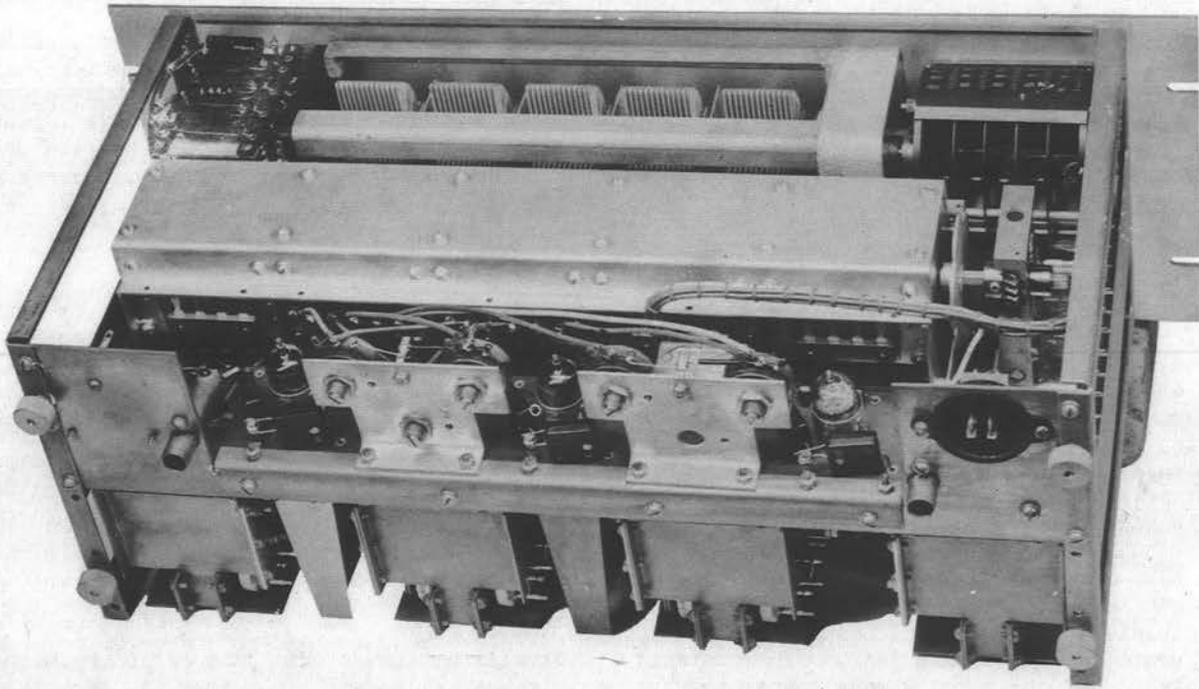


Fig. 21 - Interior View of Variable Preselector

2.53 The signal to be measured is connected to the jack on the control panel designated VARIABLE PRESELECTOR IN. This goes to a masking pad of 5 db to insure a proper impedance to the signal. Following this is an adjustable attenuator which is used for changing the over-all gain of the preselector in making a measurement. This attenuator has a total loss of 40 db in steps of 10 db as shown in Fig. 23. It is under the control of a switch designated SENSITIVITY 2 on the face panel. The over-all gain will be 40 db when all the attenuator is removed and 0 db when it is all in the circuit. The five attenuator steps of

0 db, 10 db, 20 db, 30 db and 40 db are however designated in terms of the input power which will give a 0 db reading on the meter of the detector for that particular attenuator setting when the SENSITIVITY 1 switch is set at -60 dbm. These designations are -100 dbm, -90 dbm, -80 dbm, -70 dbm and -60 dbm. Allowing for the 5 db loss in the masking pad, the power at the output end of the attenuator will always be between -105 dbm and -115 dbm.

2.54 From the attenuator the signal goes to the preselector amplifier which is shown on Fig. 24. The input stage is a single tuned

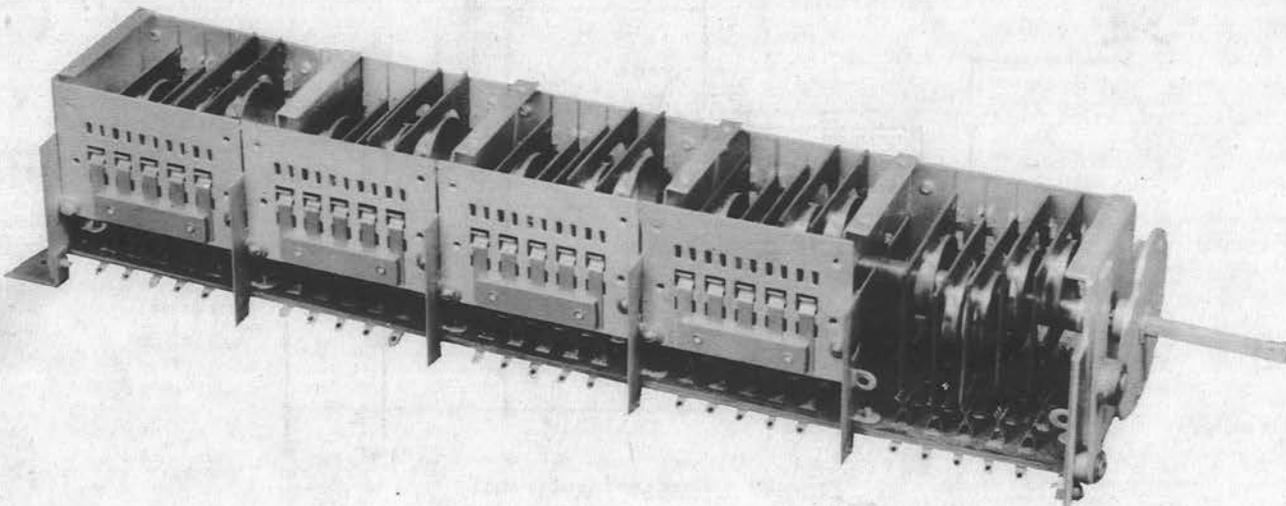


Fig. 22 - Interior View of Band Switch

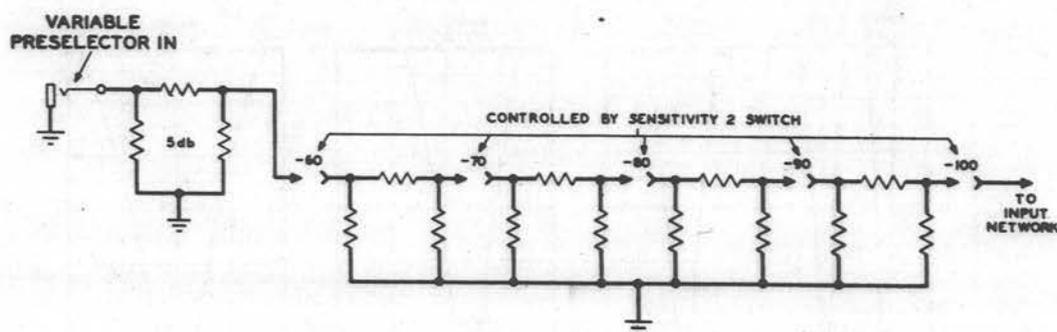
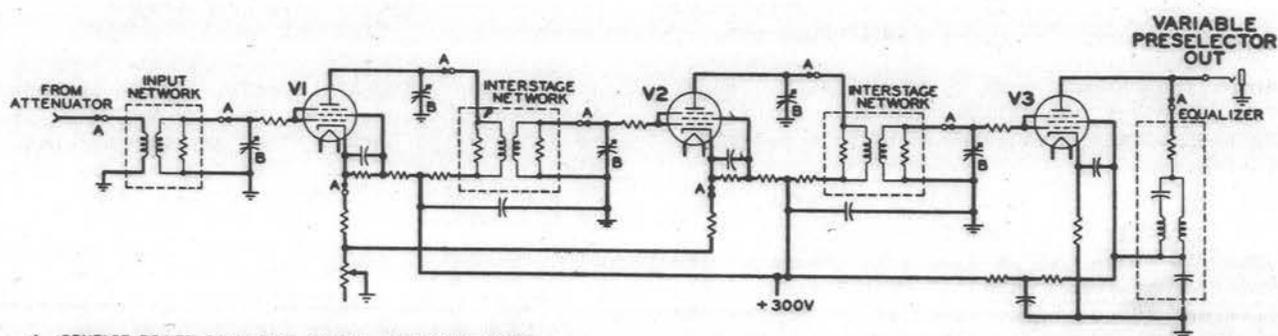


Fig. 23 - Attenuator at Input to Variable Preselector



A. CONTACT POINTS ON MASTER SWITCH DESIGNATED "BAND"
 B. CONDENSERS GANGED ON SINGLE CONTROL DESIGNATED "TUNE"

Fig. 24 - Schematic of Variable Preselector

circuit with the tuning condenser on the electron tube side. Any one of five networks is selected for this stage by the BAND switch, the choice depending upon the frequency of the input signal. The tuning condenser, controlled by the TUNE dial is common to all five.

2.55 From the input tuned circuit the signal goes to the first tube V1. The gain of this stage is controlled by a cathode resistor which is changed by the BAND switch for each of the five frequency bands. Part of the cathode resistor for each band is adjustable which permits an accurate setting of the gain when calibrating. The adjustable part is also common to the cathode of V2. These resistors, designated P1 to P5, are adjusted by a screw-driver through holes in the back cover of the amplifier. The rear door of the console must be removed to make them accessible.

2.56 Following V1 is the first interstage tuned circuit coupling to the grid of V2. This is a double tuned circuit. Again the selection of the proper network is made by the BAND switch and the tuning condensers are common to all five selections. The gain of the

V2 stage is controlled by the cathode resistor which, as mentioned above, is in part common to V1.

2.57 The interstage unit between V2 and V3 is identical with the first interstage unit and is controlled by the BAND switch in the same way. There is no gain control in the V3 stage.

2.58 The equalizer unit in the output of the V3 stage provides a separate equalizer for each of the five bands. The purpose is to make the over-all transmission substantially the same for all frequencies in a given band. The proper equalizer for each band is selected by the BAND switch.

2.59 From the equalizer the signal passes to the jack designated VARIABLE PRESELECTOR OUT on the control panel.

2.60 The selectivity of the amplifier, as determined by the input and interstage tuning is a function of the frequency. From Band No. 1 tuned to its lowest frequency to Band No. 5 tuned to its highest frequency the band width

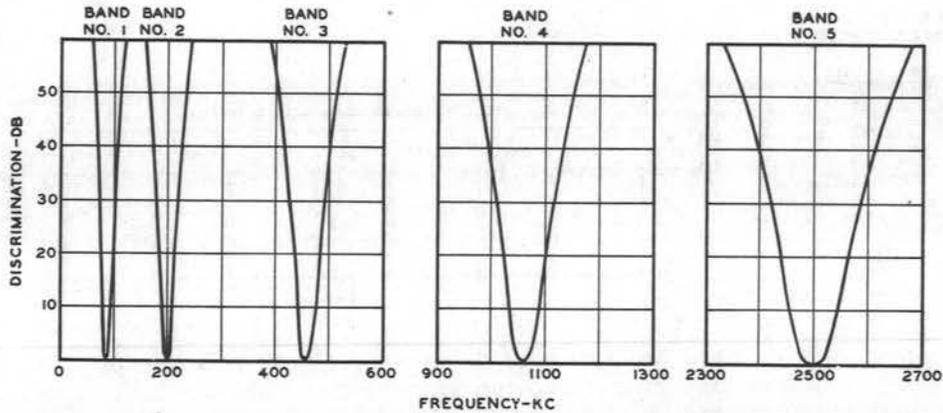


Fig. 25 - Typical Discrimination Characteristics of Variable Preselector at Mid-Frequency of Each Band

ranges from about 6 to 75 kc. Fig. 25 shows representative discrimination characteristics for each of the five bands at their approximate mid-frequencies.

2.61 The over-all gain of the preselector may also vary by a small amount as the frequency to which it is tuned, is changed. The variation may be greatest near the ends of the different bands. If calibrated at a mid-band frequency the deviations towards the ends may, in extreme cases, be as great as ± 2 db. In particular measurements using the preselector, where a high degree of accuracy is necessary, the 44A TMS should be calibrated at the frequency of measurement.

(K) Control Panel

2.62 The control panel is located on the upper portion of the sloping face of the console as shown in Fig. 3. The two position power switch may be set to accept power from the receptacle provided in the control panel itself or from the other receptacle in the lower part of the back of the console.

2.63 A fuse for the a-c supply is located on this panel. It is a 5 ampere fuse, Bussmann MTH5 or Littelfuse 312005. A spare fuse is provided in a receptacle similar to that used by the fuse in service.

2.64 The VARIABLE PRESELECTION IN, VARIABLE PRESELECTION OUT, DET IN and RCDR jacks appear on the control panel and are connected through cables to similar jacks located on the Variable Preselector and Detector.

(L) Bridging Transformer

2.65 A special bridging transformer, coded as the 216A repeating coil, has been developed for use with the 44A Transmission Measuring System. Bridged across a circuit it will permit measurements without materially affecting

transmission over the coaxial system introducing a loss of only .1 db. The low bridging loss is achieved by making the transformer have a high impedance on the line side and by making it physically small so that it may be connected to the coaxial line with a minimum of shunt capacitance. A picture of the transformer is given in Fig. 26. The line side terminates in a coaxial plug for insertion in a parallel jack in a coaxial jack field. The low impedance side, which is 75 ohms, terminates in a coaxial jack. From this jack, connection is made to the 44A TMS with an ordinary coaxial patch cord.

2.66 The loss through the transformer at 1000 kc when connected across a 75 ohm circuit, is 20 db + .15 db. At 60 kc and 3100 kc the

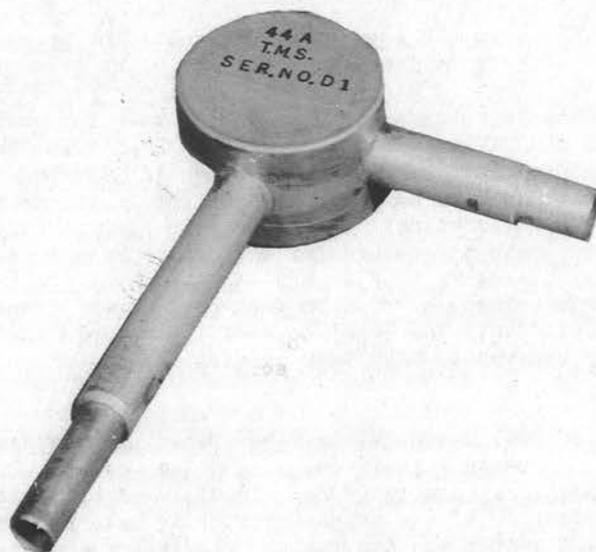


Fig. 26 - 216A Repeating Coil

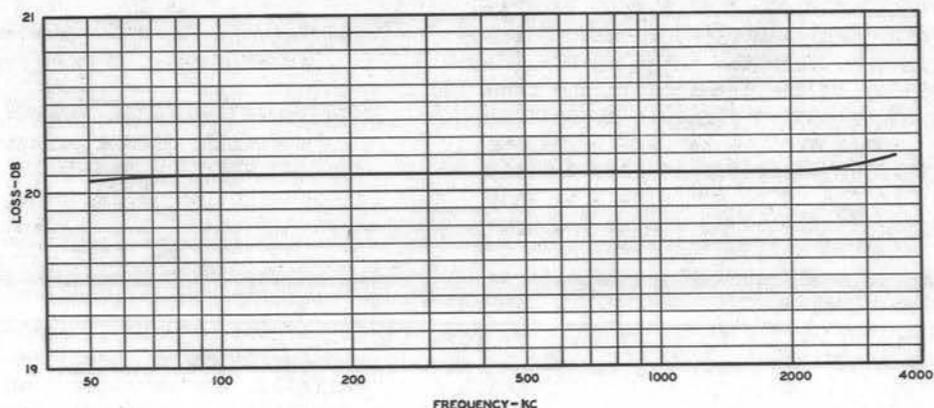


Fig. 27 - Typical Loss Frequency Characteristic of 216A Repeating Coil

deviation from the 1000 kc value maybe as great as .1 db. A typical loss frequency characteristic is given in Fig. 27.

2.67 In making measurements using the 216A repeating coil, allowance must be made for the loss which it introduces. For example, a power of -40 dbm on the line will be read as -40 dbm when the 44A TMS itself terminates the line and as -60 dbm when the transformer is used. Therefore, in the latter case, an allowance of 20 db must be made in order to obtain the true value, -40 dbm.

(M) Power Supply

2.68 Two main power units are supplied as part of the 44A TMS, J86223A giving 6.3 volts a-c for the heaters of the electron tubes on all panels and J86219A providing a 300-volt d-c plate and screen supply for all tubes. Each power unit is a regulated type maintaining its nominal voltage over a range in the a-c supply voltage of 105 to 125 volts. The J86223A power supply is described in Section A301.535 of Bell System Practices and the J86219A power supply in Section A301.312.

2.69 In addition to the above units, a non-regulated 6.3-volt transformer is provided for lighting the various signal lamps.

2.70 Receptacles are provided for the 115-volt a-c supply on the control panel and on the lower part of the back of the console. A ground wire is carried through the cord terminating in a clip which permits connection to any convenient grounded metallic framework such as a relay rack. This ground wire is connected to the framework of the console through a choke coil intended to isolate the high frequencies from this ground.

2.71 Power from the main panel switch passes to the regulated power supply units through three door switches, one being mounted

on each side of the console and one on the back. Removing a side results in power being automatically removed from the unit as a safety measure.

(N) Ventilating Fan

2.72 A fan is provided in the bottom of the test set to minimize the temperature rise within the console. With the fan operating the temperature will not rise more than 15°F. above the ambient room temperature.

3. CALIBRATION

(A) General

3.01 There are certain instabilities in the elements comprising the 44A TMS which will necessitate occasional calibration. These instabilities may have a short term effect such as those due to temperature changes or there may be long term aging effects. In general, they may be divided into two classes, those affecting the gain of the set and those affecting the frequencies of the heterodyne oscillators. The former will affect the power readings made with the test set, while the latter will affect chiefly the frequency scale of the first oscillator.

3.02 To guard against these effects it is recommended that the sensitivity and the frequency scale be checked in all cases where the power is turned on after the set is cold. A warmup period of at least thirty minutes should be allowed. Where stability is not important measurements may be made after a shorter warmup period.

(B) Adjustment of Film Scale on Variable Frequency Oscillator

3.03 In adjusting the scale of the variable frequency oscillator, the 3560 kc signal, produced by the crystal controlled oscillator

feeding the second modulator, is used as a standard. A small amount of this 3560 kc signal is taken off through the 3560 KC CHECK jack and inserted in the detector input at DET IN. This will register on the detector in the same manner as any other input signal. By setting the frequency scale at 3560 kc and adjusting the FREQ ADJ trimmer capacitor to give a maximum meter reading the film scale will be made to read correctly at that frequency. The precision of the original calibration will have to be relied upon to avoid excessive departures at the lower frequencies.

3.04 Apparatus Required:

- 1 - P2AW Cord

3.05 Procedure:

- (1) The 44A TMS shall have been operating for at least a half hour before making this adjustment.
- (2) Connect from 3560 KC CHECK to DET IN.
- (3) Push the BAND WIDTH switch to 4000 CYCLES.
- (4) Set SENSITIVITY 1 at -40 dbm.
- (5) Set the FREQ scale to 3560 kc and then tune by means of the FREQ knob to give a maximum deflection on the meter. If the meter goes off scale, restore it by adjustment of SENSITIVITY 1.
- (6) Push the BAND WIDTH switch to 600 cycles and repeat (5).
- (7) Set the FREQ scale to exactly 3560 kc and adjust the FREQ ADJ control to give a maximum deflection on the meter.

(C) Adjustment of Film Scale on Variable Frequency Oscillator to Pilot Frequencies

3.06 A more precise adjustment of the frequency scale may be obtained by using the pilot frequencies of the L1 system as standards. Not only do the pilots have a greater absolute accuracy but they are located in the working frequency range. The following procedure assumes the use of the 2064 kc pilot as a standard. A similar procedure would be followed for any of the other pilots.

3.07 Apparatus Required:

- 1 - P2AW Cord
- 1 - 216A Repeating Coil

3.08 Procedure:

- (1) Adjust the film scale at 3560 kc in accordance with Paragraph 3.05.
- (2) Insert the 216A repeating coil across a coaxial line at a repeater output and connect the low impedance side to DET IN by means of the P2AW cord.
- (3) Set the FREQ scale to 2064 kc and the SENSITIVITY 1 control to -40 dbm.
- (4) Adjust the FREQ scale slowly over a narrow range until the 2064 kc pilot registers on the meter keeping the reading on scale by adjustment of the SENSITIVITY 1 control. The nearest speech channel frequencies of the L1 system are 2044 kc and 2072 kc.
- (5) Set the FREQ scale to 2064 kc and adjust the FREQ ADJ capacitor to give a maximum deflection on the meter.

(D) Calibration of Detector Sensitivity

3.09 The response of the detector is very uniform over the frequency range from 50 to 3500 kc. The total spread over this range should not exceed .2 db. The sensitivity of the detector is adjusted by means of the SENS CAL control. A known power input is applied to DET IN and with the SENSITIVITY 1 dial set at that power value, the SENS CAL control is adjusted to give a 0 db reading on the meter. A calibrating frequency of 1000 kc is specified. However, the adjustment may be made at any frequency at which a very high degree of accuracy is required.

3.10 Apparatus Required:

- 1 - P2AW Cord
- 1 - 53A Mobile Oscillator or equivalent

3.11 Procedure:

- (1) The 44A TMS should have been in operation for at least thirty minutes before calibrating.
- (2) Set the frequency of the 53A Mobile Oscillator to 1000 kc and adjust the output to 0 dbm into the 75-ohm thermocouple unit.
- (3) Reduce the output of the 53A Mobile Oscillator to -60 dbm by adjusting the loss of the attenuator on that unit to 60 db.
- (4) Connect the -60 dbm output to DET IN on the 44A TMS.

- (5) Set the SENSITIVITY 1 dial to -60 dbm and set the BAND WIDTH switch at the position at which measurements are to be made, either 4000 CYCLES or 600 CYCLES.
- (6) Set the FREQ scale at about 1000 kc and adjust to give a maximum deflection on the DB meter. Leave the FREQ scale set at the mid-point of the range over which the response is flat.
- (7) Adjust the SENS CAL control to give a 0 reading on the DB meter.
- (8) Set the SENSITIVITY 1 dial to -50 dbm and observe the meter which should read -10. Adjust R530, if necessary to obtain a -10 reading. It is necessary to remove the front door of the console to make this adjustment.
- (9) If an adjustment was required in R530 set the SENSITIVITY 1 dial to -60 dbm and repeat (7).
- (5) Connect from VARIABLE PRESELECTOR OUT to DET IN with a 341A plug.
- (6) Set the SENSITIVITY 1 dial to -60 dbm and the BAND WIDTH switch to 4000 CYCLES.
- (7) Set the BAND switch on the Variable Pre-selector to 50-117 KC and the TUNE dial to 85 kc.
- (8) With the SENSITIVITY 2 dial set at -60 DBM, adjust the FREQ and TUNE dials to give a maximum meter deflection.
- (9) Adjust the screwdriver control, P1, on the back of the Variable Preselector panel to give a 0 deflection on the meter. It will be necessary to remove the back door of the console to make P1 accessible.
- (10) Repeat steps (3) to (9) for each of the other four frequency ranges under the following conditions:

(E) Calibration of Variable Preselector

3.12 Since the Variable Preselector has five different frequency ranges or bands, it will be necessary to calibrate them separately. The response over each range is sufficiently flat that a mid-range calibration should be satisfactory for most measurements. Deviations toward the ends of each range may be as great as +2 db in extreme cases. Where a high degree of accuracy is required at a particular frequency the calibrating procedure should be modified to call for that frequency.

3.13 Apparatus Required:

- 1 - P2AW Cord
- 1 - 341A Plug
- 1 - 53A Mobile Oscillator

3.14 Procedure:

- (1) The 44A TMS should have been in operation for at least thirty minutes.
- (2) This calibration should be preceded by a calibration of the Detector with the BAND WIDTH switch at 4000 CYCLES.
- (3) Set the frequency of the 53A Mobile Oscillator to 85 kc and adjust the output to 0 dbm into the 75-ohm thermocouple unit.
- (4) Reduce the output of the 53A Mobile Oscillator to -60 dbm by adjusting the loss of the attenuator on that unit to 60 db. Connect the -60 dbm output to VARIABLE PRESELECTOR IN on the 44A TMS.

Band No.	Test Freq.	Band Switch	TUNE and FREQ Knobs	Adjust Pot. on Panel
2	196 kc	117-274 kc	196 kc	P2
3	457 kc	274-640 kc	457 kc	P3
4	1070 kc	640-1500 kc	1070 kc	P4
5	2500 kc	1500-3500 kc	2500 kc	P5

4. OPERATION

(A) General

4.01 The 44A Transmission Measuring System will be used principally in measuring the power of single frequency signals or noise on L1 Carrier Telephone Systems. Where the coaxial line may be interrupted the measuring system should be connected to terminate it. Where the line may not be interrupted a bridging connection should be made through the 216A repeating coil and a correction made for the loss of the latter.

4.02 The Detector alone will measure down to values of -70 dbm on a terminated circuit and -50 dbm using the bridging transformer. When measuring with the 4000-cycle band width, at a repeater output, a measurement will be subject to interference if there is any appreciable amount of energy in the frequency range immediately adjacent. This will be the case on an L1 system except around the pilot frequencies. With the alternative 600-cycle band, however, it should be possible, on most channels, to pick out signals down to -65 to -70 dbm. The limit of measurement will be established in such cases by line noise or by modulation, in the 44A TMS itself, between the

various talkers, carrier leaks, pilot channels and signaling tones which are present on the line. Obviously it will not be the same on all channels and at all times.

4.03 The Variable Preselector, adjusted to a gain of 40 db, will extend the range of measurement to -110 dbm when terminating a circuit and -90 dbm for bridged measurements. Moreover it provides additional selectivity to exclude other frequencies which may be present on the circuit under measurement. The band width of the preselector may be 60 kc or more at the higher frequencies, ranging down to less than 10 kc at the lower frequencies. Typical characteristics are given in Fig. 25. In picking out signals on particular channels of a working L1 system the range will be limited, as in the case of the Detector alone, by noise or modulation, but may be slightly greater because of the additional selectivity.

4.04 If in the course of a test using the Variable Preselector, the measurement indicates a power value exceeding -60 dbm, the test should be made using the Detector alone.

4.05 The procedures which follow assume that the 44A TMS has been permitted to stabilize for at least thirty minutes and calibrated in accordance with Section 3 CALIBRATION.

(B) Measurements Using Detector Alone

4.06 Apparatus Required:

- 1 - P2AW Cord
- 1 - 216A Repeating Coil

4.07 Procedure:

- (1) (a) For terminated measurements connect the circuit under measurement to DET IN. Under this condition the maximum sensitivity of the detector is -70 dbm.

(b) For bridged measurements connect the bridging transformer to a parallel jack of the circuit under measurement and connect from the low impedance side of the transformer to DET IN. Under this condition the maximum sensitivity of the detector is -50 dbm.
- (2) Set the BANDWIDTH switch to 4000 CYCLES. If there are speech or carrier leak signals on the line within 4 kc of the frequency of measurement, set the switch at 600 CYCLES.

(3) Set the FREQ dial to the frequency measurement and adjust to give a maximum response on the DB meter, keeping the reading on the meter scale by means of the SENSITIVITY 1 dial.

- (4) (a) For terminated measurements the sum of the SENSITIVITY 1 dial reading and the meter reading gives the power value in minus dbm.

(b) For bridged measurements the power value will be the same as determined in (a), increased by 20 db to account for the loss in the bridging transformer.

EXAMPLE: Sensitivity 1 dial reads -30 and meter reads -6
Power value = $-30 - 6 + 20 = -16$ dbm

(C) Measurements Using Variable Preselector and Detector

4.08 Apparatus Required:

- 1 - P2AW Cord
- 1 - 341A Plug
- 1 - 216A Repeating Coil

4.09 Procedure:

- (1) Connect VARIABLE PRESELECTOR OUT to DET IN using the 341A Plug.
- (2) (a) For terminated measurements connect the circuit under test to VARIABLE PRESELECTOR IN. Under this condition the maximum sensitivity of the measurement is -110 dbm.

(b) For bridged measurements connect the bridging transformer to a parallel jack of the circuit under measurement and connect from the low impedance side to VARIABLE PRESELECTOR IN. Under this condition the maximum sensitivity is -90 dbm.
- (3) Set the BAND WIDTH switch to 4000 CYCLES and the SENSITIVITY 1 dial to -60 dbm. If there are speech or carrier leak signals on the line within 4 kc of the frequency of measurement, set the switch at 600 CYCLES.
- (4) Set the BAND switch and the TUNE dial on the Variable Preselector and the FREQ scale of the Detector to correspond with the frequency under measurement. Adjust the FREQ and TUNE dials to give a maximum deflection on the DB meter keeping the reading on the meter scale by adjustment of the SENSITIVITY 2 dial.

- (5) (a) For terminated measurements the sum of the SENSITIVITY 2 dial reading and the meter reading gives the power value in minus dbm.
- (b) For bridged measurements the power value will be the same as determined in (a) increased by 20 db to account for the loss in the bridging transformer.

EXAMPLE: Sensitivity 2 dial reads -80
and meter reads -7.5
Power = $-80 - 7.5 + 20 = -67.5$ dbm

5. MAINTENANCE

(A) General

5.01 The console type of construction used in the 44A TMS is arranged with front, back and side covers which are readily demountable. This makes all parts of the system accessible for maintenance purposes. Under the back and side covers are placed door switches which automatically shut off the power supply, as a safety measure, when the cover is removed. To facilitate maintenance operations with the covers off, power may be restored by manual operation of the switches.

Caution: The voltages which exist in some parts of the circuit of the 44A Transmission Measuring System, particularly in the power supply, are considered dangerous. Maintenance work on the System should be done by experienced personnel and only after all necessary precautions have been taken. Contacts with all electrical terminals should be avoided. Test picks should not be permitted to touch two metal parts at the same time or destructive and dangerous short circuits may occur. The door switches, when open, disconnect only one side of the power supply. If the power supply is improperly poled, it will be possible to have some a-c terminals alive.

5.02 Should occasion require it, the Detector and Variable Preselector of the 44A TMS may be lifted out of the console for bench servicing. To make this possible, all wiring to these panels is connected through plugs which may be easily disconnected.

(B) Plate Voltage Supply

5.03 A plate and screen supply of 300 volts is supplied to all panels of the 44A TMS from the J86219 Regulated Rectifier. This is

located in the lower part of the console, facing the front. A voltmeter and a potentiometer located on the face panel of the rectifier permit an adjustment of the voltage to the proper operating value of 300 volts. Instructions in the maintenance of this rectifier are given in Section A301.312 of Bell System Practices.

(C) Heater Supply Voltage

5.04 Power for the heaters of the different parts of the circuit is supplied by the J86223 Regulated Rectifier. This is also located at the bottom of the console behind the J86219 Rectifier. The voltage is adjustable by means of a control located on the panel but a separate a-c voltmeter is required. Maintenance procedures for this power supply are covered in Section A301.535 of Bell System Practices.

(D) Tube Tests

5.05 Electron Tubes should be removed from the 44A TMS and checked in the KS-5727, L1 Test Set when there are any indications that they may be contributing to faulty operation. Care should be taken at such a time to shut off the power before removing the tubes to avoid damage to the 403B varistors.

5.06 If a tube is changed at any time, the calibration of the test set should be checked. In the case of a replacement of V601, the variable oscillator tube, the film scale should be readjusted to take account of any small change in the tube capacitance.

(E) Check of Oscillator Voltages in Modulators

5.07 Proper operation of the first and second modulators requires a voltage from the oscillator high enough to make the conversion efficiency independent of voltage changes. This voltage should be at least .7 volt r.m.s. in the case of MOD 1 and 1.0 volt r.m.s. in the case of MOD 2. In the case of MOD 1, the limit applies at any point in the frequency range of the variable oscillator.

5.08 These voltages may be checked by a vacuum tube voltmeter such as Measurements Corporation, Model 62, connected across terminals 3 and 7 of the modulator.

(F) Gain Changes

5.09 The SENS CAL potentiometer will ordinarily have a gain margin large enough to take care of any normal changes due to aging of tubes, modulators, etc. In the case of excessive or sudden changes suspected tubes should be checked and replaced if they fail to meet normal requirements.

5.10 Proper functioning of the 403B varistors requires that the two silicon crystals which make it up have a low resistance in one direction and a very high resistance in the other direction. Should the larger resistance of either fall off considerably, the conversion efficiency of the unit as a modulator will be seriously affected. This will show up as a decrease in the sensitivity of the detector unit.

5.11 There is no easy way provided at this time for checking these varistors in the field. If they are suspected of causing trouble they should be replaced.

5.12 The 400A varistors used in the rectifier circuit of the DET MON panel are in the same category. However, they are less likely to give trouble and therefore have been soldered in place rather than mounted on a plug.

(G) Adjustment of Compensating Coil in Detector

5.13 In the plate circuit of the first stage of the detector unit (V201) there is a small inductance coil (L201) which functions to make the gain of that stage uniform over the range from 50 kc to 3500 kc. This inductance is adjusted in the factory and should not require further adjustment in the field.

5.14 Should it be necessary to check this gain uniformity it may be done by calibrating the detector in the usual manner using -30 dbm at 1000 kc and then checking the response at 3000 kc. These points should not differ by more than .1 db. If the difference is greater than this amount, L201 may be adjusted to bring the difference within limits.

(H) Terminating Capacitances on 221W Filter

5.15 To meet the requirements for flat transmission over a band of several thousand cycles, the wide band 40 kc filter, coded 221W, is terminated on each end by a 5100 ohm resistor and a capacitance of 75 mmf. This capacitance is set at the factory to an accuracy of ± 1 mmf and should require no further attention. C801 and C805 are adjustable for this purpose. Should the capacitance setting be disturbed for any reason a readjustment will require a capacitance bridge capable of making measurements to this degree of accuracy.

(I) Noise

5.16 Noise generated within the 44A TMS will ordinarily be low enough to have no significant effect on the accuracy of measurements. Should noise occur due to some defective component it may make itself evident in two

ways: first, where the noise is very large it may cause a meter deflection with no signal input and second, where it is a lesser amount and there is a single frequency signal input it may result in unsteadiness in the meter reading.

5.17 With the Detector alone in use and the BAND switch at 4000 CYCLES the noise will normally be at least 25 db below signals registered at the -10 point on the DB meter. It will obviously have to be considerably above normal to register on the meter. Unsteadiness in a meter reading begins to be apparent when the noise is about 15 db below the signal. At 10 db below it will be quite evident and will cause an error of about .2 db. Margins will be considerably greater with the BAND switch at 600 CYCLES.

5.18 The most likely sources of noise in the Detector are V301 and V401. If suspected they should be replaced. It should also be noted that excessive losses in the modulators, which can be made up by the SENS CAL control, will also tend to increase the noise.

5.19 With the Variable Preselector in the circuit the normal noise will be considerably higher than in the case of the Detector alone. It is also a function of the band which is being used, the margin being greater at the higher frequency bands. In Band No. 5, 1500 kc to 3500 kc, noise should be at least 15 db below signals registered at the -10 point on the DB meter. In Band No. 1, 50 kc to 117 kc the noise will be at least 10 db below. At other bands the margin will be somewhere between these two values. As in the case of the Detector alone, noise will be less with the BAND SWITCH at 600 CYCLES.

5.20 Excessive noise in the 44A TMS with the Variable Preselector in the circuit will usually be due to V1 or V2, which are 9003 type electron tubes. It may be necessary at times to select tubes for these sockets to obtain the noise margins given above.

(J) Replacement of Film Scale

5.21 It may be necessary at times to replace the film scale of the 44A TMS. A negative copy of the original scale is retained by the Western Electric Company and positive copies may be ordered as required. The installation of a new scale will require the removal of the detector unit from the console.

5.22 Procedure:

- (1) Remove the power plug and other connections from the detector unit.
- (2) Remove the panel mounting screws and lift the detector unit out of the console.

- (3) Remove the knob which turns the film scale and the screws which hold the VAR OSC unit to the main panel. Unsolder the wires running to the MOD 1 unit from the VAR OSC unit.
- (4) Lift the VAR OSC unit out of the detector unit and set down on the bench with the gear mechanism on top and the knob facing the observer.
- (5) Run the film to the low frequency end of the scale until it goes up against the stop, then run it slowly in the reverse direction until the arrow on the film scale lines up with the marker notch on the sprocket.
- (6) Disengage the film by removing the spring clip which holds it on the spool.
- (7) Loosen the idler pulley which holds the film engaged against the sprocket.
- (8) Disengage the film from the sprocket and unwind the film from the other spool, winding it up on a separate spool.
- (9) Thread the low frequency end of the new film scale around the sprocket wheel and line up the arrow with the marker notch. Be sure that the proper side of the film is facing the observer.
- (10) Lock the idler pulley in position holding the film against the sprocket.
- (11) Turn the dial mechanism so that it is against the stop at the low frequency end.
- (12) Cut the film at a distance of 15 inches from where the film leaves the sprocket. Wind this end up on the spool after clamping the end with the spring clamp. The clamp should cover only one layer of film.
- (13) Turn the mechanism over its full range of travel to the stop at the high frequency end. This will wind up the film on the spool to which the low frequency end was attached.
- (14) Cut off the film at the high frequency end, at a point 15" from where it leaves the sprocket wheel.
- (15) Turn the spool to which the high frequency end is to be attached, in a clockwise direction until the spring mechanism is fully wound. Attach the film by means of the spring clip and allow the spool to unwind until the film is tight.

To allow adequate slack this should require about three turns of the spool. The spring clip should cover only a single layer of the film scale.

- (16) Replace the VAR OSC unit on the panel, restoring the knob and panel screws and reconnecting the wiring to the MOD 1 panel.
- (17) Restore the detector unit to the console and connect the power plug and other cables disconnected in (1).

(K) Cleaning of Film Scale

5.23 The film scale will, in the course of time, pick up a certain amount of dust and dirt. Most of this can be removed, without taking the film out of the oscillator, by cleaning as described herein.

- (1) Disconnect the power cable and other connectors from the detector unit.
- (2) Remove the panel mounting screws. Lift the detector unit out of the console and set it on a bench with the operating face in a vertical position.
- (3) Turn the FREQ control until it is up against the stop at the low frequency end of the scale.
- (4) Roll a 6" x 6" piece of KS-2423 cloth into a tube and fold it in the middle to form a U shaped pad. Looking down from the top of the detector insert the ends of this pad over the film scale and with the fingers press the pad lightly against each side.
- (5) With the fingers holding the pad turn the FREQ control to the stop at the high frequency end of the film scale, stopping where necessary to refold the cloth so as to expose a clean surface.
- (6) Repeat in the reverse direction, if necessary to obtain a clean scale.

(L) Lubrication

5.24 A number of points on the film scale mechanism and the tuning condenser will require occasional lubrication. KS-7470 oil should be applied as indicated, preferably with the small oiler designated as the 48GA tool. Teresso No. 43, made by the Standard Oil Co. of New Jersey, is an acceptable alternative.

The oiler with the oils recommended will be found to work best when kept at least three quarters full.

<u>Film Scale Mechanism</u>	<u>Quantity</u>	<u>Normal Interval in Months</u>
Storage Spool Spindles (each end)	2 drops	12
Idler Roller (each end)	2 drops	12
Guide Roller (each end)	2 drops	3
Idler Gear Stud	2 drops	3
<u>Tuning Condenser</u>		
Worm Shaft Sleeve Bearings	2 drops	3
Worm Wheel	8 drops	3

(M) Replacement of Dial and Signal Lamps

5.25 Dial and signal lamps on the 144A TMS will have to be replaced when burned out. There are five lamps used with the frequency scales on the Variable Preselector and three with the Detector. Two of the latter are associated with the FINE and COARSE scales of the FREQ capacitor and the third is associated with the MON jack.

5.26 The lamps in the Variable Preselector are No. 46 type G.E. There is a separate lamp for each of the five frequency scales. To replace the lamps, remove the back door and the left side panel of the console, disconnect the power plug and connecting cables from the preselector and remove the back cover of the Preselector. The five lamps are mounted on a single bracket, which must be dismantled to make the lamps accessible.

5.27 The lamp on the COARSE dial is a No. 47 type G.E. It is mounted on the back of a small plate on the front panel. The plate covers a hole just above the dial and the lamp projects through the hole to a position behind the dial. To change the lamp, remove the two screws which hold the plate on the panel and lift out the assembly.

5.28 The lamp on the film scale is a No. 63 type G.E. It is mounted on the bracket which supports the frosted glass window behind the film. To replace this lamp it is necessary to remove the Detector chassis from the console. Disconnect the power plug and connecting cables, remove the panel mounting screws, lift the Detector out and place it on a bench. The lamp may be reached from the top of the chassis. Replace the defective lamp and remount the Detector in the console.

5.29 The lamp associated with the MON jack is a standard switchboard lamp, type E1. This lamp may be removed through the front panel by removing the glass cap which covers it.

6. DRAWINGS AND SPECIFICATIONS

(A) Drawings (Not attached)

SD-59267-01 Application Schematic
 SD-59266-01 Detector Circuit
 SD-59306-01 Variable Preselector Circuit
 SD-80970-01 Circuit of 300 Volt Regulated Power Supply
 SD-81001-01 Circuit of 6.3 Volt Regulated Heater Supply

(B) Specification

J64014A 144A Transmission Measuring System
 (Section AA268.527)