TELEWRITER FREQUENCY SHIFT CONVERTER
MODEL K

PURPOSE: The Telewriter Converter Model K is used as a part of a radio receiving system for frequency shift signals and converts audio tones from the output of a receiver into DC pulses. These pulses may be used to operate a teleprinter or other devices requiring DC pulses.

DESCRIPTION: The Model K Converter accepts audio frequency-shift tones with a center frequency of 2550 cps and shifts from 100 to 1000 cps. The incoming signals are fed through a specially designed symmetrical limiter which is free of the usual DC level shift. The limiter removes any amplitude variations prior to discriminator. The limited signals are applied to a linear discriminator which utilizes high quality toroids. The linearity of the discriminator insures maximum rejection of both Gaussian noise and interference from other signals. It also allows operation with narrow shift signals and variations of shifts as well as drift of the center frequency. The output of the discriminator drives a low pass filter which removes the effects of beat notes due to interference and sharp impulse noise. The filtered DC pulses are approximately 100 volts peak-to-peak. These large pulses are clipped by a symmetrical clipper which uses only the center 4 volts of the pulses, providing exceptional "cleaning-up" of noisy signals. Under very poor conditions or for severely distorted signals, a panel control allows the clipped portion of the pulse to be moved up or down on the pulses to obtain the best signal. The correctly shaped pulses then operate a vacuum tube keyer which gives direct-magnet operation of the teleprinter loop from a self-contained loop supply. This assures freedom from local radio noise from the DC loop. There is a meter for measuring and adjusting the loop current to the desired value.

ADDITIONAL FEATURES OF THE MODEL K:

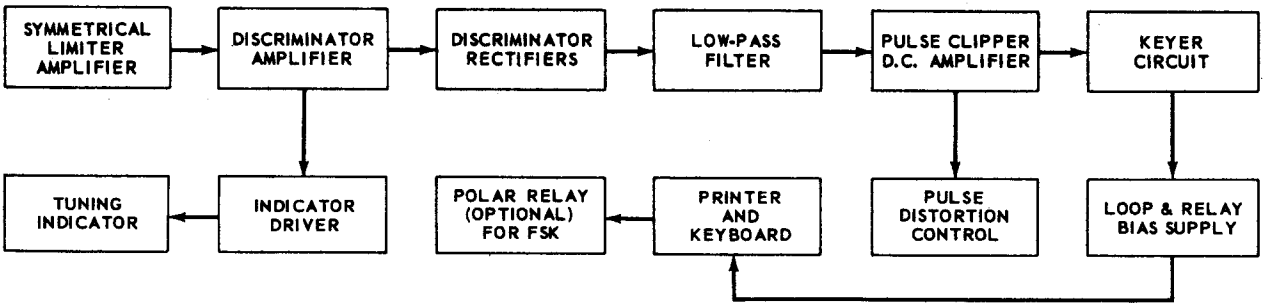
Extremely simple operation with no adjustments needed for normal operation.

An effective tuning indicator for rapid, easy tuning of FSK signals. The indicator also provides a quick method of adjusting transmitter frequency shift.

Standby switch for quieting printer while tuning. Rear connection for send-receive relay to allow use of local loop in conjunction with polar relay for transmitting FSK.

Optional built-in polar relay for clean FSK with local copy. Also optional FSK driver circuit available.

Circuit design optimized to provide efficient operation under high interference level from CW, phone and FSK signals.



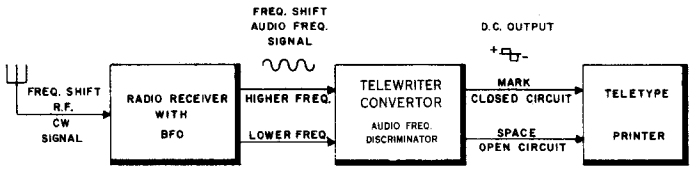
TECHNICAL DATA, Telewriter Model K

Input Impedance: 600 ohms
Input Level: -33 dbm to 30 dbm (ref 1 mw.)
Input Frequency Shift Limits: 100 to 1000 cps frequency shift
Output: Neutral DC pulses of 60 ma in 0 to 5000 ohm external load with one side grounded.
Keying Speed: 100 wpm max. (higher speeds on special order)
Metering: Panel meter; 0 to 100 ma.
Tuning Indicator: Dual electron indicator tube.
Controls:
  Front Panel:
    Power switch
    Shift reverse switch
    Receiver-standby switch
    Distortion correction control
    Tuning indicator adjustments
  Internal Adjustments:
    Loop current
    Balance control
    Bias current adjustment for OPTIONAL polar relay
Mounting: Standard WE 19" relay rack or optional cabinet

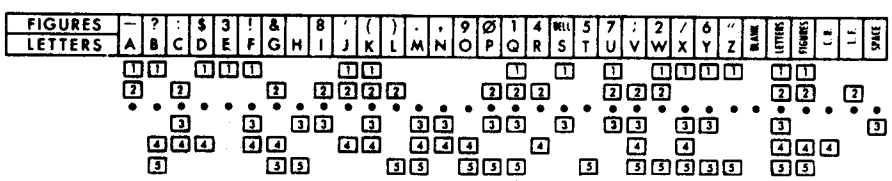
Chassis & Panel: Aluminum panel 19" wide, 4" high. Gray enamel finish. Screw holes 3" on centers. Steel chassis, cadmium plated, 16 3/4" wide, 3-3/4" high, 7-1/2" deep. Weight complete 10 lbs.
Cabinet: Steel, 19" wide, 4" high, 8" deep. One piece. Vents in rear and bottom. Rubber feet. Weight 7 lbs.
Power Requirements: 115 volts, 60 cps; 50 watts max.
Tube Complement:
  1-12AX7 Amplifier-limiter
  1-12AX7 Discriminator driver
  1-12AX7 Pulse clipper and DC amplifier
  1-6W6 Keyer tube
  1-12AX7 Tuning indicator driver
  1-6AF6 Electron tuning indicator
  1-6X4 Power supply rectifier
  1-Silicon diode loop supply rectifier
Prices:
  Model K for Rack Mounting . . $189.00
  Cabinet 14.50
  Polar Relay 24.50

BLOCK DIAGRAM
EQUIPMENT NEEDED TO RECEIVE RADIO TELETYPEWRITER
FSK OR AFSK SIGNALS

BLOCK DIAGRAM
FREQUENCY SHIFT METHOD RADIO TELETYPE COMMUNICATION



TELETYPE CODE
A TYPICAL CODING ARRANGEMENT



NUMBERS INDICATE MARKING CODE PULSES

ALLTRONICS - HOWARD CO
BOX 19, BOSTON 1, MASS.
RIchmond 2-0048

INSTALLATION

MECHANICAL:

Inspect the tubes to make sure they are properly seated in their sockets.

If the converter is to be operated in the cabinet, it is recommended that the chassis cover plates be removed to improve ventilation.

ELECTRICAL:

Connect the power cord to a source of 110-120 volts 50-60 cycles, alternating current.

Connect the shielded audio input cord to the 500-600 ohm speaker terminals in your receiver. If only 4-8 ohm audio output is available, an impedance matching transformer should be used.

If a polar relay is to be used for keying the transmitter, it should be inserted in the octal socket provided for this purpose within the converter chassis, provided it is a Sigma type having the same base connections as the type we supply.

If an external polar relay for keying the transmitter is to be used, the jumpers in the male octal plug which we supply, should be changed in accordance with the wiring diagram shown in Figure #2, so as to provide loop and bias connections at the 6 pin socket located on the rear of the converter chassis.

DESCRIPTION OF CONTROLS

POWER SWITCH:

The primary power switch is located on the front panel. The tuning eye provides a "pilot light" as it will be glowing brightly when the unit is on.

DISTORTION CONTROL:

A knob in the center of the panel adjusts the Distortion Control, and is used to vary the clipping level of the pulse clipping circuit. This change varies the weight of the marks and spaces allowing for correction of pulse bias due to noise, interference, propagation conditions or faulty sending equipment. It is also useful in copying through strong interference. Its normal setting is with the index at the top, or center of its range. After using for poor signals, be sure to return this control to center.

EYE ADJUSTMENTS:

The Eye Adjustments allow the tuning eye to be set for just closed on mark and space signals. Since this type indicator is very sensitive, an occasional adjustment may be nwcessary due to changes in line voltage or aging of components. These controls are normally not changed after initial adjustment. To set up, obtain a steady audio tone from receiver and tune for maximum closing of one side of eye. Adjust the control for that side of eye for the shadow to be just closed. Then retune receiver for other side of eye closed and make a similar adjustment for that side.

REVERSE-NORMAL SWITCH:

The Reverse-Normal switch is used to receive FSK signals which have the normal space low, mark-high relationship reversed. When using the converter in conjunction with a particular receiver, the receiver BFO should be set on the proper side of center so that normal signals print with this switch in NORMAL position.

SEND-RECEIVE SWITCH:

A Send-Receive switch is provided which grounds the grid of the keyer tube so that it draws full loop current. This allows a keyboard in the local loop to be used to operate the printer. If a polar relay is used in the loop circuit, it will repeat the keyboard signals so as to operate the transmitter FSK circuit, hence the "SEND" notation. A plug at the rear has contacts in parallel with this switch to allow remote operation from the transmitter send-receive relay if desired. The Send-Receive switch is also useful for quieting printer from running wild during tuning due to noise and random signals. The switch is thrown to SEND until the tuning indicator shows correct tuning at which time it is thrown to RECEIVE to print.

PRINTER JACKS:

Two closed circuit jacks are provided on the front panel for convenient connection of printer and keyboard or local printer loop circuit. These jacks are in series so either one may be used. When operating without the internal relay, plug connections on the rear chassis also provide loop connections. The 0-100 ma panel meter monitors the printer loop current which is adjustable by means of an internal slide-resistor.

OPERATING INSTRUCTIONS

PRELIMINARY:

Turn on the Model K and the radio receiver and allow to warm up. The Reverse-Normal switch should be in NORMAL position and the Send-Receive switch in SEND position. The first operation will be to find the proper BFO setting for the receiver. Tune in a steady carrier with BFO on and adjust the tuning eye as described in previous section. Now set the receiver selectivity, if adjustable, to as narrow as available above 1.2 kc. The 3 kc bandwidth used for SSB does very nicely. If the receiver bandwidth is greater than this, an audio bandpass filter is recommended ahead of the converter. Also, the crystal filter is useful when used with a broad setting. Some experimenting with the crystal filter will probably be necessary for best results. Now tune in a strong FSK signal such as NSS, news or weather station. Turn the BFO off and AVC on and tune for maximum S-meter reading. The object here is to get the two mark-space signals in the center of the receiver pass band. See Figure 5. Now turn on BFO. Adjust BFo for equal closing of each side of eye. This indication should be quite distinct. It is possible to get a similar indication from sub-harmonics of the 2125 and 2975 cps tones but these will be easily recognized with a little experimenting. If the eye shadows do not completely close, then you have a station with a narrow shift. It should be easy to find a station with full 850 cps shift for this initial testing.

When BFO is set for best eye indication, check loop current meter for proper printer current. Then throw Send-Receive switch to RECEIVE. Printer should now copy message being received. If no copy is obtained, throw Reverse switch to REVERSE. If signal still does not print, the station may be high-speed CW-FSK or high-speed RTTY. In this case, tune for another station. When correct printing is obtained, mark the BFO setting on your receiver so that you can reset to this point again. Then tune BFO on other side of zero-beat until eye again indicates proper tuning. It should now be necessary to throw Reverse switch to opposite position to get copy. Mark this setting of BFO, also. By tuning in amateur RTTY signals, the correct setting for the BFO to obtain copy with switch in NORMAL POSITION can be easily found. For best results, always set the BFO to the correct mark and tune in signals with receiver dial.

For some receivers, the BFO may have a limited range and the 2975 cps tone cannot be obtained from the pitch adjustment. It may be necessary to adjust internal BFO trimmer to obtain this tone.

After the above procedure has been followed, the converter is ready for use. Tune in signals with receiver dial until eye shows correct pattern. Examples of tuning are shown in Figure 6. After a little experience, it will be found that tuning can be done very quickly and easily. The eye can be observed during operation and any drift of receiver or transmitter easily noticed and receiver dial can be touched up to correct. The linear discriminator will tolerate a reasonable amount of drift before misprinting occurs so tuning is not critical under normal conditions.

TUNING WIDE SHIFT SIGNALS:

The Distortion control should be at center position, Reverse switch at NORMAL and Send-Receive switch at SEND. This quiets printer so that it does not

run wild on CW and noise. Tune for the desired signal using the receiver dial, making sure that BFO is set properly as described above. The eye will alternately open and close as an FSK signal is tuned in. If the signal being tuned has standard 850 cps shift, a point will be found where both sides of eye are exactly closed during keying. The Send-Receive switch is then thrown to RECEIVE. The printer will then copy. If the incoming signal is resting on "mark" it can be tuned by adjusting for the Mark side of eye closed.

Weak, fading or noisy signals may misprint. Many such signals can be improved by adjusting the distortion control until the copy improves. If a DC oscilloscope is available, the best adjustment can be seen from observing the detected pulses. (Fig. 4). Some practice and experience will quickly show the best method of adjustment for a particular receiving set up.

TUNING NARROW SHIFT SIGNALS:

Narrow shift signals will fail to close the eye on both sides simultaneously. Tune for approximately equal closing on each side. In order to insure that the smaller pulses resulting from narrow shift signals will be centered symmetrically about the clipping level, the distortion control may be adjusted for best copy on narrow shift.

SETTING TRANSMITTER SHIFT:

The accurate discriminator transformer used in the Model K allows it to be used for quickly setting the transmitter shift. With the receiver operating and the VFO only on, tune the VFO dial for the mark side of eye exactly closed. Then open keyboard circuit by pressing break key and adjust the shift pot for the space side exactly closed. The transmitter will now be set on the same frequency as the receiver. These instructions apply to most FSK circuits. However, some units, especially those using heterodyne systems may require setting mark and space in opposite order. This can be easily determined by experiment.

USE OF LOCAL LOOP FOR FSK:

A direct method of copying your own signal while transmitting is to reduce receiver sensitivity and print the signal coming through the receiver. The keyboard is connected directly to the FSK circuit and is separated from printer, [redacted] This method has a number of disadvantages and some method of direct copy is usually preferred. The optional internal polar relay, or an external polar relay may be used to repeat the keyboard signals to the FSK circuit. The keyboard, printer and polar relay line coil are in series and the built-in loop supply is used to supply loop current. The keyer grid is grounded to cause it to draw current continuously by means of the Send switch or by contacts on the transmit-receive relay. If the optional internal relay is used, the output socket on rear chassis is connected to the FSK as indicated in Figure 2c and to the transmit-receive relay. If an external relay is used, a dummy plug is inserted in the internal relay socket and the bias coil and line coil connected to the output socket as shown in Figure 2b. The bias current is set as described in the INSTALLATION section. Since the printer loop is brought out to the relay line coil for this arrangement, a set of short-circuit jacks may be installed for the local loop if desired. If the converter loop circuit is not used for operating, a polar relay dummy plug [redacted] inserted in [redacted] the relay socket [redacted] as shown in Figure 2a.

DESCRIPTION OF OPERATION

Fig. 1.

LIMITER:

The limiter-amplifier stage consists of a dual-triode amplifier V1 whose first stage is supplied with fixed bias from a voltage divider network and driven from a transformer T1 to prevent a shift in operating point under heavy limiting conditions. The second stage is capacity coupled and insures complete limiting even under low signal conditions.

DISCRIMINATOR DRIVER:

The signals from the preceding stage are fed to two tuned circuits by an isolating resistance network. This network is in the form of a potentiometer and is adjustable to provide balancing of the signal to the two tuned circuits. The tuned circuits use toroidal inductors and the Q's of these circuits have been adjusted to provide linear discriminator frequency-voltage characteristics.

DISCRIMINATOR RECTIFIERS:

The mark and space signals are amplified by V2 and coupled to the rectifier circuit by two isolating transformers, T2 and T3. A voltage-doubler rectifier circuit across the output of each transformer followed by a load resistor and filter capacitor provides a DC voltage proportional to the instantaneous frequency of the input signal. A differential connection of the two rectifier circuits causes the DC output voltage to be of opposite polarity for mark and space.

PULSE CLIPPER AND DISTORTION CONTROL:

Due to a train of FSK mark-space pulses at the input of the converter, a series of DC pulses appears across the discriminator load resistors R9 and R10. These pulse will not be clean but will contain audio tone components and beat-frequency components due to the audio tones mixing with noise and interference. These contaminated pulses are filtered by means of a low pass filter consisting of R11, R12 and C10, having a roll-off at approximately 100 cps. This filter effectively removes the audio tones and greatly attenuates beat notes above the FSK dot rate. The peak-to-peak voltage applied to the low pass filter is in the order of 85 volts.

A dual clipper and DC amplifier V3 slices out a five volt section of the filtered pulses which removes the remaining distortion and beat frequencies riding on top of the pulses. One section of V3 is diode connected and clips the negative going portion of the pulses. This prevents a shift in DC operating point due to the charge on the low pass filter. Grid limiting in the other half of V3 clips the positive going half of the pulses. The voltage levels at which clipping occurs is set by fixed bias networks.

In passing through the low pass filter, the pulses are partially integrated, giving them a trapezoidal shape. Thus the ratio of a mark to space pulse width after clipping will depend upon the centering of the five volt slicing interval on these trapezoidal shaped pulses. A variable potentiometer, the distortion control, allows this point to be adjusted from the front panel.

Under normal good-signal conditions, this control is centered and the slicing interval is in the exact center of the pulses. However, under poor conditions or distortion of signals due to multipath or other propagation anomalies, this control can be varied to increase the weight of either mark or space and reduce the errors due to this distortion.

The dc amplifier section of V3 is driven from cutoff to full conduction by the signal pulses and produces clean pulse in its plate circuit of about 200 volts peak-to-peak.

KEYER CIRCUIT:

The output pulses from V3 are capacity coupled to the grid of a triode-connected power pentode V4. The grid of this tube is returned to B_+ through a high resistance causing the grid to be normally clamped at 0 volts. The time constant of this resistance and the coupling capacitor is sufficient to pass the longest space (negative going) pulses used in lowest speed Baudot code. Thus the negative-going pulses from V3 drive V4 to cutoff and the positive-going pulses drive V4 to full conduction. If the signal remains on space, the capacitor discharges and V4 returns to full conduction. This prevents printer from running open.

LOOP SUPPLY:

A built-in 120 volt dc power supply is used to furnish loop current for operation of the printer and is used for the plate supply of the keyer Tube V4. Since this supply is independent of the plate supply for the rest of the circuit it may be floated with respect to ground. Thus the printer loop may be operated at ground potential. A fixed resistor is provided to set loop current to desired value as shown by meter on the front panel. A separate fixed resistor is used to allow the loop supply to supply bias current to a polar relay for FSK use.

TUNING INDICATOR:

V6 is a dual-electron eye tube which is driven from the indicator driver tube V5. A full-wave diode detector from the plate of each section of the discriminator driver V2 causes the eye to close when a signal is present on each respective plate. Front panel eye adjustments allow the eye to be set so that the mark side is just closed when a 2125 cps signal is present and the space side just closed for a 2975 cps signal present. When an 850 cps FSK signal is tuned in properly, each section will be opening and closing alternately and due to the persistence of vision will appear closed on both sides.

POLAR RELAY CIRCUIT:

An octal socket is provided for a miniature polar relay which is optional. When the relay is installed, an output plug allows the contacts of the relay to be used to operate a FSK circuit in a transmitter when a keyboard is in series with the printer loop and the converter is in SEND mode. If the internal relay is not used, a dummy plug is installed in the octal socket and bias current is available at the output plug for using an external polar relay in a similar manner.

FSK CIRCUIT:

A simple FSK circuit which will give excellent results with most VFO circuits is shown in Figure 3. A shift-adjusting potentiometer may be mounted in any convenient location and is fed by means of a high resistance from a source of regulated voltage. The voltage at the top of the pot should be about 50 volts. The keyboard or polar relay contacts, short out this voltage in "mark" condition. The VFO is shifted by means of a 45 mmf trimmer attached to the cathode of the tube. This capacitor is switched in and out by a pair of germanium point-contact diodes such as 1N69's. A low-pass filter softens the keying pulses to prevent clicks. These parts can be mounted in a small can or mini-box mounted as close as possible to the VFO. The lead to the pot should be shielded to prevent hum pickup.

To adjust the FSK circuit, set transmitter on lowest frequency to be used. Set shift pot near top of its range and set shift to 850 cps using the 45 mmf trimmer to adjust, using an insulated tool. If full shift cannot be obtained, raise the voltage at the pot until sufficient shift is obtained. Once this trimmer is set, all other changes are made with shift pot. It will be necessary to change the shift pot adjustment when going to higher frequency bands where frequency multiplication is used. Usually, small frequency changes in one band do not require readjustment.

MAINTENANCE

GENERAL:

The Model K Converter has had all internal adjustments set at the factory. Very little maintenance is required. Replacement of tubes may require readjustment of the balance control located on the printed circuit board. A simple procedure is as follows:

1. Set Distortion control to center position.
2. Send-Receive switch on RECEIVE.
3. Short receiver antenna to ground so that no signal is received and adjust gain and volume controls to get a high-level thermal noise signal.
4. Adjust the balance control located in center of printed circuit board to the point where the noise causes the Loop Current meter to fluctuate. If this occurs over a range of adjustment, center the adjustment between the points where the meter stands still.

TROUBLE SHOOTING:

Table I lists the tube voltages as measured with a VTVM. In case of trouble, a check of these voltages will usually show up the defective area. In general, check for obvious difficulties such as printer unplugged, receiver output open, tube heater open, etc. In case that no obvious cause is apparent, the suggestions in Table II may help.

TROUBLE-SHOOTING CHART

TABLE I

SYMPTOMS	POSSIBLE CAUSE	REMEDY
Eye operates, printer current steady	Send-RCV switch on SEND	throw to RCV
	Send-RCV relay closed	open relay
	C12 shorted C10 shorted	replace
	Distortion control misadjusted	center control
Eye operates, no loop current	X9 defective	replace (check R28, C18 also)
	C18 shorted	replace (check X9,R28)
	6W6 defective	replace
	R21 open or slider loose	replace or repair
	Printer jack defective	replace
	meter open	replace
	break in printer loop	check printer coils, external loop wiring
Eye operates, printer makes excessive errors	Check voltage across center terminals of S1 for "mark" and "space" tones	If not approx. +40 and -40 volts, then check C-6,7,8,9; X-1,2,3,4; R-9,10; replace as required
	If above voltages correct, check V3 circuit	Replace any defective parts
Eye works on one side only, printer makes excessive errors	D1 open on one side	Order replacement
	T1 or T2 defective	Order replacement
	R7 defective V2 defective	Replace
Eye does not work properly, printer works satisfactorily	Check V5, V6, C13, C14, other parts in eye circuit	Replace defective parts
	Recheck eye adjustments	
Eye out, no loop current	Fuse open	Replace (check for short in power supply or fil. lines)
	V7 defective	
	CH1 open C17	Replace

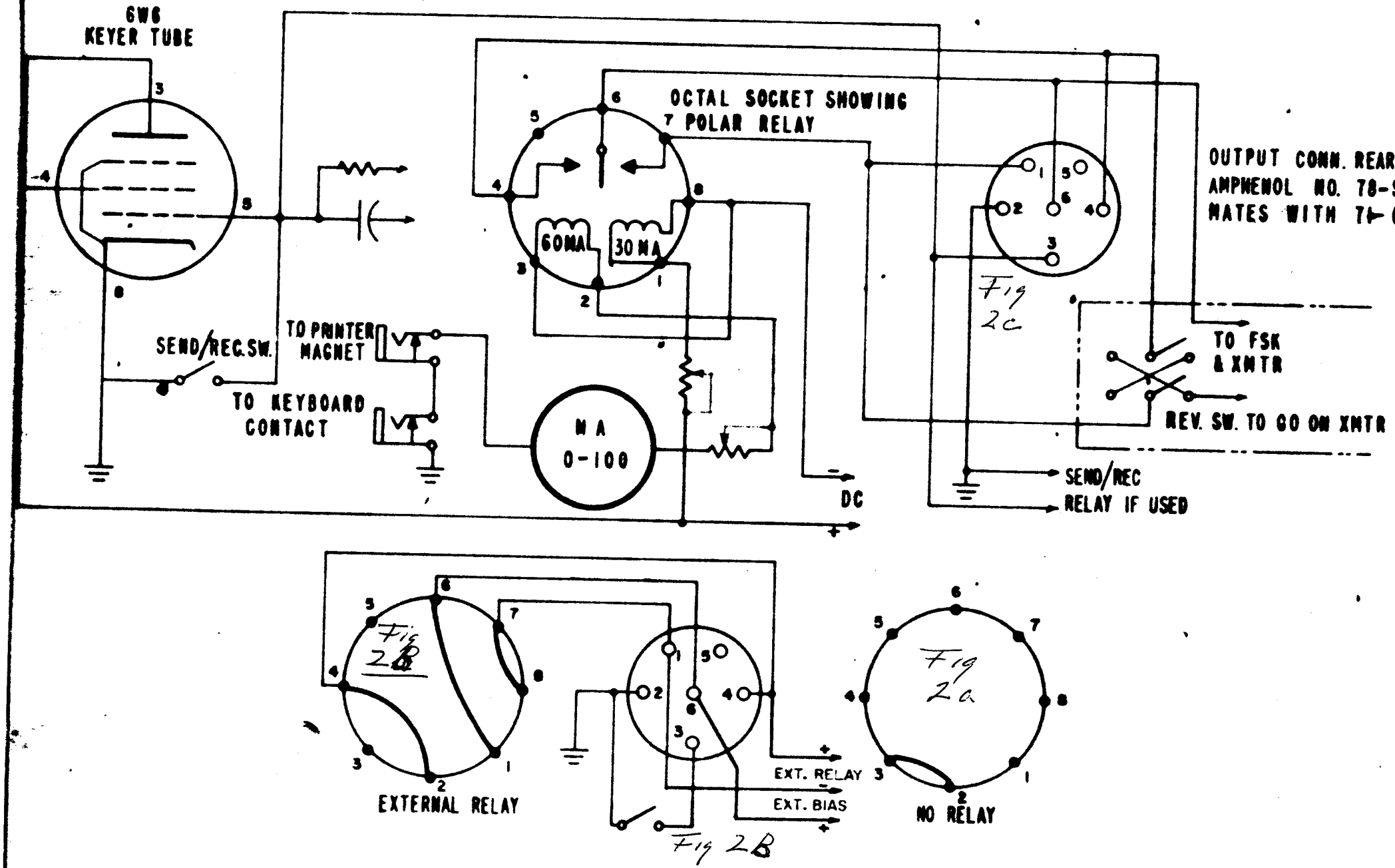


FIG. 2 ALTERNATE JUMPER PLUGS TO BE USED IN PLACE OF POLAR RELAY

ALIGNMENT INSTRUCTIONS

1. BALANCE POTENTIOMETER ADJUSTMENT:

   a. Remove Clipper tube V3 from its socket.
   b. Connect Audio Signal Generator to input socket.
   c. Connect Vacuum Tube Voltmeter to diode load, by making connections to the polarity reversing switch terminals.
   d. Set Signal Gen to 2125 cycles and note reading on V.T.V.M.
   e. Set Signal Gen. to 2975 cycles and note reading on V.T.V.M. (Polarity reverses from Mark to Space)
   f. Adjust Balance Potentiometer until equal readings are obtained for Mark and Space.

2. DISTORTION CONTROL ADJUSTMENT:

   a. Replace V3 and disconnect audio signal generator from input receptacle.
   b. Remove V.T.V.M. from diode load connections.
   c. Connect grounded cable from V.T.V.M. to pin #8 of V3 and the ungrounded cable to pin #7 of V3.
      This can be easily done by making connections with clips to appropriate resistor leads on the top side of the circuit board.
   d. Adjust Distortion Control potentiometer until V.T.V.M. reads exactly .2 volts. Set the Control knob so that the arrow points straight up.
      This knob is held in position by a collet which is tightened by a nut under the snap button.

Scope Controls: Sweep Speed-Low; Sync.-Int.

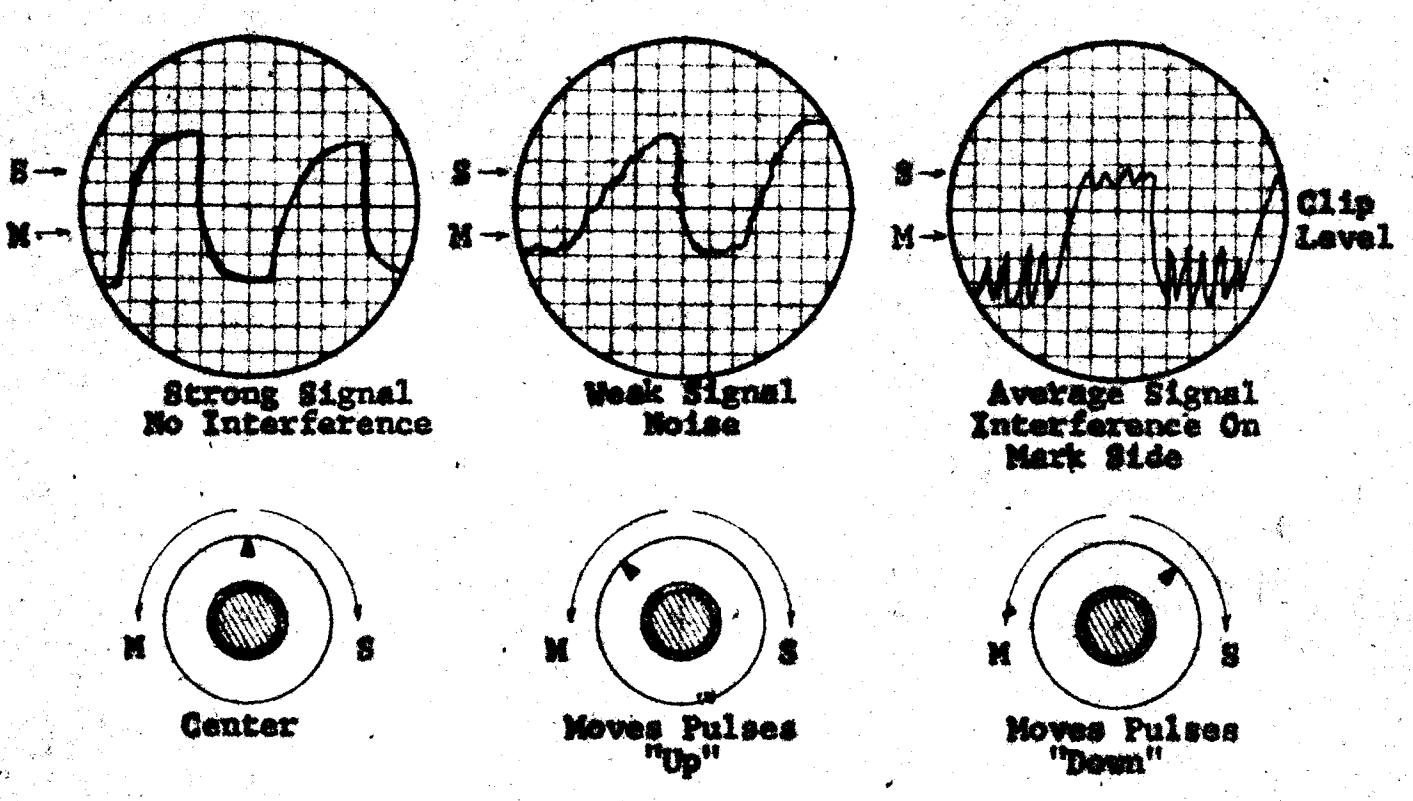
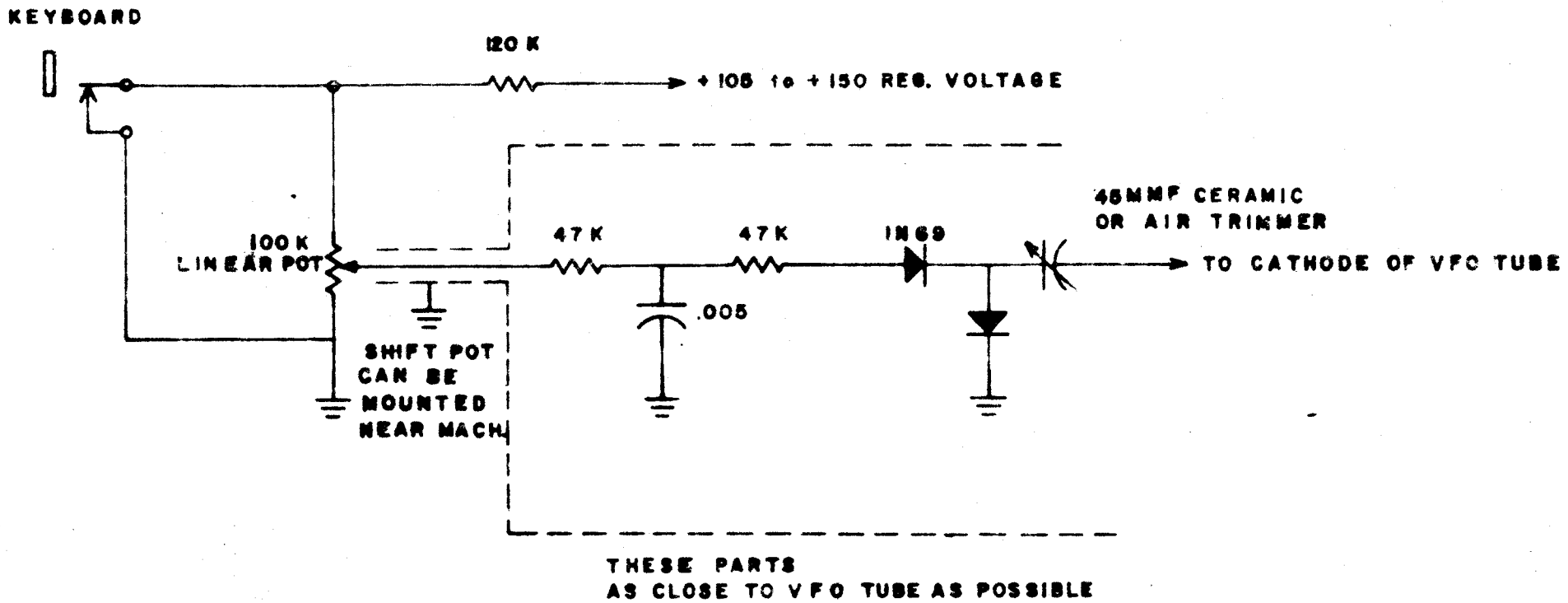


FIG.4 D.C..OSCILLOSCOPE PATTERNS FOR VARIOUS SIGNALS



SUGGESTED CIRCUIT FOR FSK UNIT TO GO IN TRANSMATTER

Fig 3

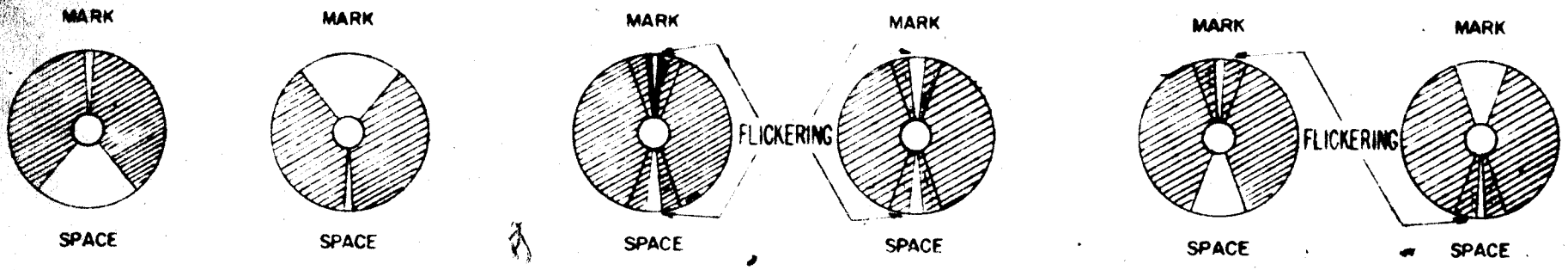


FIG. 6 EXAMPLES OF TUNING EYE ACTION

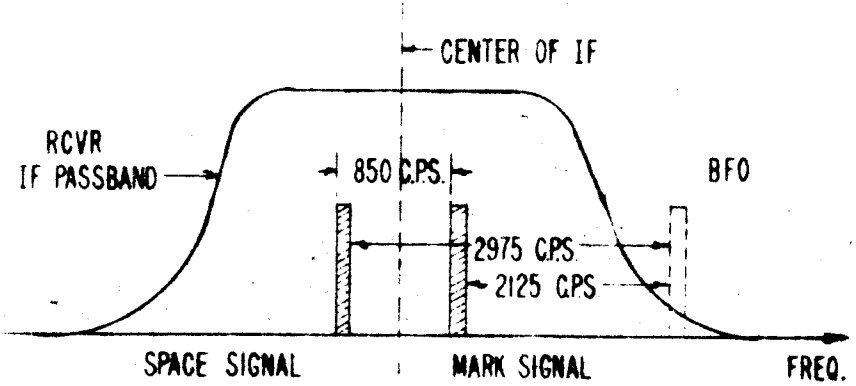
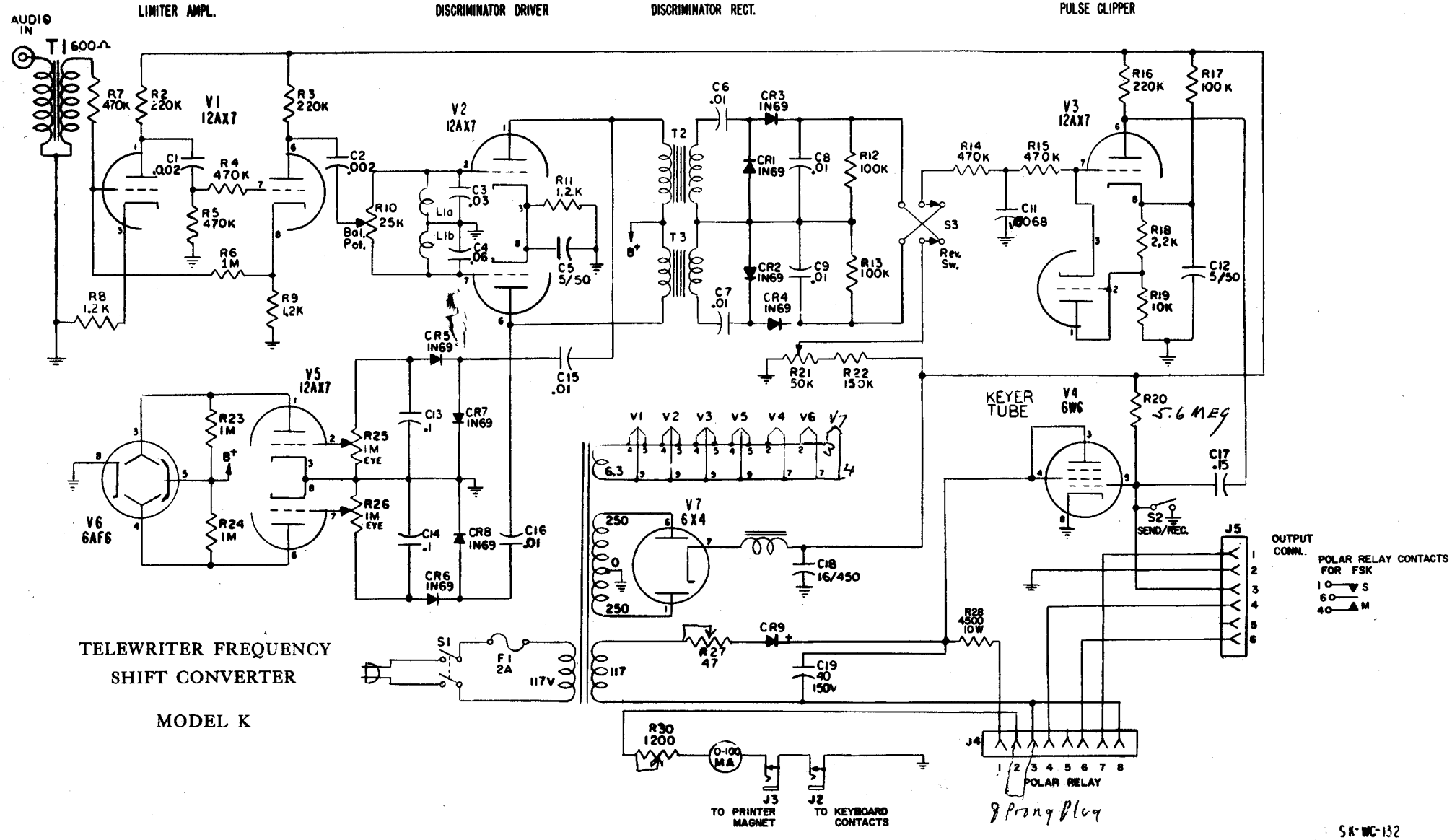


FIG. 5 PROPER RELATION OF FSK SIGNAL, BFO & REC. SELECTIVITY CURVE



TELEWRITER FREQUENCY SHIFT CONVERTER

MODEL K

SK-WC-132