RTTY

THE W6NRM RADIOTELEPRINTER TERMINAL UNIT, MARK III

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HORSE TRADES

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THE W6NRM RADIOTELEPRINTER TERMINAL UNIT, MARK III

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Redwood City, California

PART I—DESCRIPTION OF THE TERMINAL UNIT PROPER

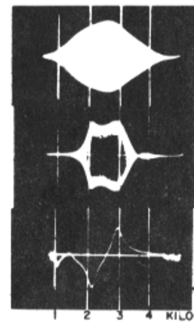
This is a new Terminal Unit for use in radioteletypewriter communication work. It is a compact self-contained unit that accepts audio tones from a communiation receiver tuned to a RTTY signal and translates them into the needed DC pulses for keying a teletypewriter machine. This is the receiving mode. For transmission, an unique system built into this "TU" permits the same machine to be used for transmitting using its self-contained keyboard. No special modifications to the machine need be done—in fact, any teleprinter with its selector magnet and keyboard in series as for landline connection can be plugged directly into this TU and then it is ready for radio teleprinter work. A simple diode shifter circuit is included in the TU design to permit generation of frequency-shift keyed (FSK) signal when it is hooked up to any of the usual VFO circuits as found in amateur transmitters. Furthermore provision is made for precise shift adjustment, relying on the responses of the calibrated mark and space filters contained in this TU. All in all, the result is an optimal terminal unit design that should be of much value to the RTTYer, whether old-timer or just starting the game. And there are a number of significant related features as will be disclosed as they turn up in this paper.

The main features of this TU are as follows . . .

1. Standard bandpass filter-limiter-discriminator system, having bandpass of 1700-3400 cps at its input, and discriminator tuned for 850 cps shift at 2125/2975 cps peaks.
2. Input impedance 5000 ohms and 4 ohms. The latter value matches the loudspeaker connection on any communications receiver. (600 ohms impedance possible, with the proper transformer)
3. Full limiting on audio inputs down to 2 microwatts. Normal operating level 10 milliwatts, so over 37 decibels of dynamic limiting is available.
4. Novel teleprinter loop circuit permits use of any standard keyboard-teleprinter without any particular modifications. Machine receives from and sends through this same loop circuit, and the TU takes care of all reception and transmission—as controlled by the station. 20 or 60 milliampere loop current available. One side of teleprinter line is grounded.
5. Simplified circuit for operating transmitter frequency shift diode, together with provision for self-calibration on shift, relying on indications from the calibrated discriminator.
6. An effective tuning indicator system for precise tuning-in of radio teleprinter signals as well as for setting transmitter shift, as mentioned above.
7. Automatic markhold circuit for holding teleprinter in case of no-signal (or just noise input). Circuit is controllable by station control for changeover between transmit and receive.
8. Total of seven tubes, of commonly available types, together with seven power-supply-type silicon diodes. Two neon lamp regulators. The entire TU is self-contained in a modernistic aluminum cabinet measuring 8½ x 7 x 5½ inches in size. Power consumption less than 50 watts, from 115 volts AC line.

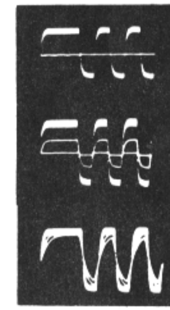
The Input Circuit—Bandpass Filter

The TU circuit is straightforward in overall design as indicated in the block and circuit diagrams shown in Figures 1 and 2. The system follows standard Frequency Modulation practice in that it utilizes a limiter-discriminator setup. It operates in the audio range of 2 to 3 kc — enabling this TU to be employed with any radio receiver that is capable of receiving the desired RTTY signal and providing the proper 2125 cps (Mark) and 2975 cps (Space) tones to key the teleprinter. Thus the receiving mode operates in a quite normal fashion.



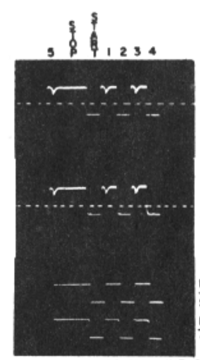
FILTER CHARACTERISTICS
W6NRM TERMINAL UNIT MK.III

FIGURE 3.



DISCRIMINATOR-LOWPASS FILTER-DC AMPLIFIER WAVEFORMS
W6NRM TERMINAL UNIT MK.III

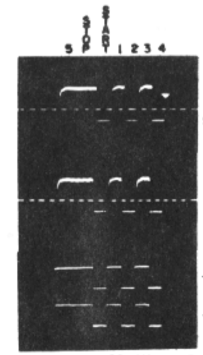
FIGURE 4.



20 MA. LINE CURRENT

SIGNAL KEYING WAVEFORMS
W6NRM TERMINAL UNIT MK. III

FIGURE 6.



60 MA. LINE CURRENT

SIGNAL KEYING WAVEFORMS
W6NRM TERMINAL UNIT MK. III

FIGURE 7.

The TU has a basic 4 ohm input which matches the loudspeaker connections as found on any communications receiver. This match is optimum and at the same time provides isolation of input from the rest of the TU circuits as far as DC voltages are concerned. Reason for this arrangement will become apparent later on, and furthermore to obtain signal coupling from receiver to TU only requires a few turns of link wire wound onto a toroid coil in the bandpass filter. However, incorporated in the TU is a 5000 ohm impedance, and this broadens the input circuit versatility as will now be seen.

In the input circuit as shown in Figure 2 there is a plate-to-voice-coil loudspeaker transformer arranged to provide a high impedance connection. This is the 5000 ohm, as just mentioned before, and this setup is "bilateral" (two-way). Tone signals can be fed into this extra frontpanel mounted connection from a high impedance output on the receiver, or — if the 4-ohm TU input is being used — the same connection now feeds out an impedance-stepped-up tone signal through the same front panel jack to a pair of headphones for aural monitoring or to some special frequency-indicating instrument. Alternatively a 600 ohm connection could be provided by using the proper transformer (600 ohms to 4 ohm voice coil) in place of the 5000 ohm to 4 ohm transformer. Either transformer can be small and relatively cheap as low audio levels are involved —ordinarily not over a hundred milliwatts needed. 1 watt transformer size, as say from AC-DC broadcast receivers, would be adequate. If the 4-ohm input is to be used exclusively, the transformer is unnecessary and the TU connection then consists of a simple link wound onto the input toroid in the bandpass filter.

The bandpass filter consists of three 88 millihenry size toroids, two of which are used with three paper capacitors in a pi-configuration designed to provide the main passband between 1800 - 3400 cps, with the peaks at the Mark and Space frequencies. The third toroid is in a LC trap circuit installed to sharpen the cutoff on the high frequency side — as the pi-filter itself has a rather gradual cutoff slope on that side. The entire filter feeds into a 10,000 ohm load to yield a reasonably flat-topped response in the 2 - 3 kc range. This is sufficient to pass the standard 2125 cps (Mark) and 2975 cps (Space) tones, yet a measure of rejection is afforded against other signals below and above the pass-band of the complete filter. As the oscillogram of Figure 3 shows, more than 20 decibels attenuation is obtainable on frequencies outside the 1700-3400 cps range and thus the filter becomes an important and essential part of the complete radioteleprinter terminal unit. This is so because all communications receivers have more or less response in the lower audio ranges and interfering signals, such as CW and other adjacent channel RTTY, are apt to be found there which might affect reception from the desired RTTY channel. Same is quite true for the audio range above 3 kc. All in all, the bandpass filter combined with the receiver's selectivity provides a well defined 1 kc wide channel tuneable through the HF spectrum in search of RTTY signals.

This filter is built into a miniature box so it can be conveniently plugged into the TU. This permits adjustments and changes of filters for various responses or improvements or different frequency ranges. The discriminator unit is in another similarly-sized plugin box. Both units, opened up, are shown in one of the photographs.

The Limiter and Discriminator Portion

The next stages after the bandpass filter are the limiter and discriminator. As the teleprinter circut requires a definite on-off signal (on neutral keying basis) derived from the FM telegraph signal, some form of frequency sensitive detection is required to sense the frequency-shift-keying (FSK) and deliver the information to an appropriate teleprinter loop. This is the function of the discriminator.

First, however, as the discriminator is also sensitive to amplitude changes in its input, we must provide some means of limiting to guard against variations in audio level as may be caused by QSB or audio gain setting variations on the receiver. This is the function of the limiter circuit as indicated in Figure 2, compromising two stages of audio amplification. The first stage is a 12AX7 triode stage with a series resistor in its grid to permit continuous saturation by the signal from the bandpass filter yet without disturbing the latter due to diode clipping effect. The second stage is similarly designed and has a 6AQ5 power tube which now feeds through a small loudspeaker output transformer (5000 ohm to 4 ohm) into the discriminator LC circuits via links.

The limiter has an overall gain of 37 cibles to full saturation, when based on a normal input level of 10 milliwatts — a level that is barely audible through the loudspeaker. The RTTY signal can fade that much — 37 db — yet the discriminator will receive a constant audio power input — resulting in a constant rectified DC output on a single tone that may go as low as 2 microwatts in the TU input.

The 6AQ5 tube is employed to power the discriminator circuit, as the latter requires appreciable drive to provide sufficient output to subsequent circuits. The mark and space LC circuits each consists of a 88 millihenry size toroid coil resonated to the desired peak frequency by an appropriate capacitor. Two such simple LC circuits — one tuned to 2125 cps and other tuned to 2975 cps — are mounted, together with their rectifiers and loads, in a miniature plugin unit to facilitate installation in the TU yet permit changes or adjustments of LC circuits for other frequencies. The LC's are driven by means of low impedance links — consisting of few turns of wire around each toroid coil — and these links, in series, are driven by the 6AQ5 through its transformer. Again an optimum impedance match is had, with maximum power transfer from power audio stage to discriminator, and at the same time the latter's LC circuits are effectively isolated from the subsequent rectification and keying circuits as far as DC is concerned. This is important to avoid distortion on teleprinter signal waveforms as would be caused by capacity coupling into LC from limiter circuitry.

The outputs from the two separately tuned LC's feed into silicon rectifier diodes, type 1N1695, and the rectified currents are fed into RC loads. The latter are made quite low in impedance to "swamp down" the discriminator LC's to broaden their respective peaks. We now obtain the familiar "S" shaped output swing versus frequency, and the swing between peaks is quite linear, as indicated in the lower oscillogram of Figure 3. Normally the peaks will be set on the exact frequencies of the incoming 850-cps-shift RTTY signal and under this condition the discriminator output swing is 150 volts between the peaks. The output is "single-ended", obtained by grounding one rectifier output and feeding the other rectifier output into the lowpass filter-DC amplifier stages. Shown in Figure 2 is a DPDT switch that permits input signal FSK sense reversal should the occasional signal be "upside down." All it does is to transpose the rectifier outputs between ground and input to the subsequent circuits.

The LC peaks are calibrated to the exact desired mark and space frequencies and in themselves form an accurate and convenient means of setting one's transmitter frequency shift. This will be referred to later on.

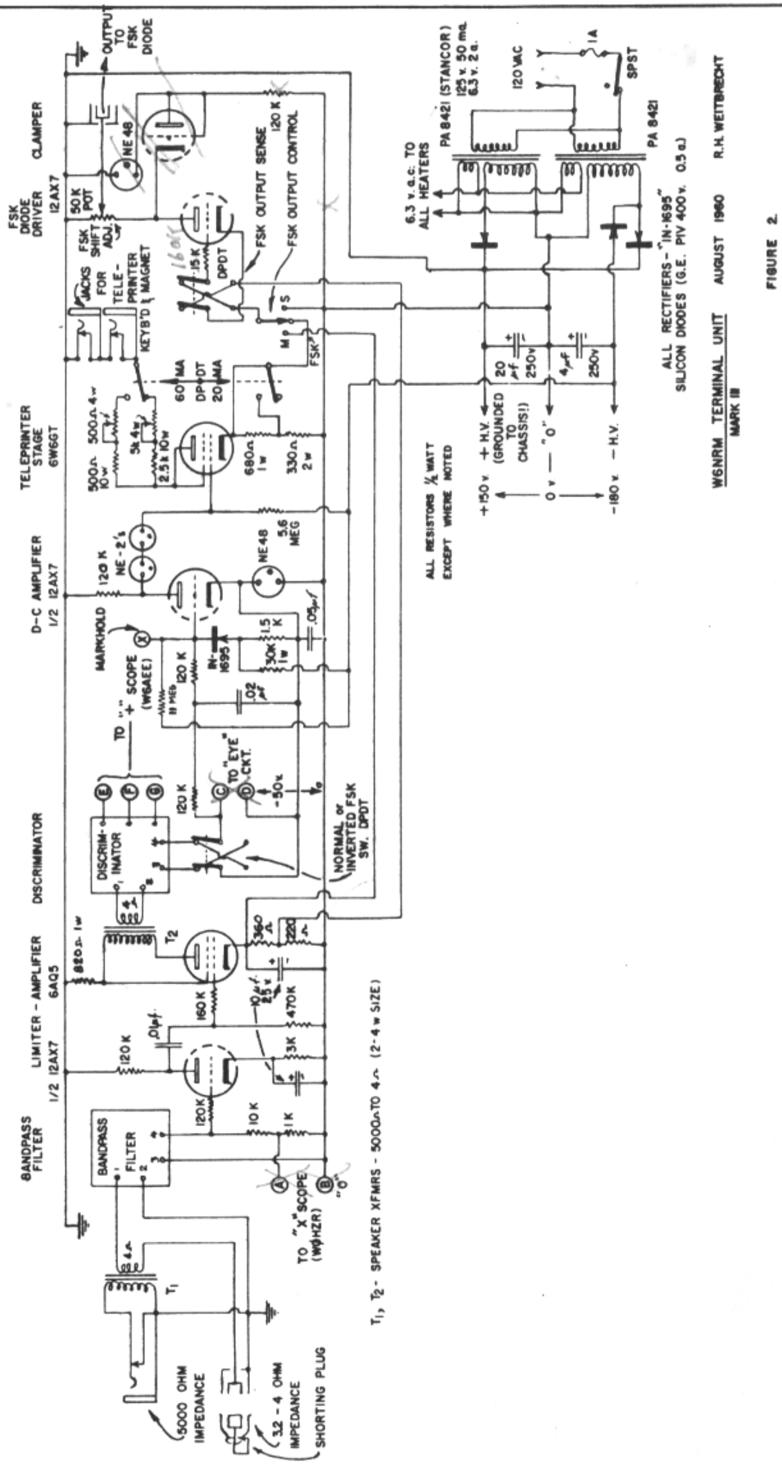
It will be noticed in the circuit diagram that the discriminator RC loads have different R and C values on mark and space channels. This is because the LC circuits have different bandwidths (assuming equal loads) at the two frequencies — hence the necessity for loading down one LC (the mark side) more than the latter. The time constant RxC remains the same, however, for both loads, thus preserving the detected waveform symmetry between mark and space transitions. The overall result is symmetry in the discriminator response versus input frequency enabling it to work well on RTTY signals having shifts appreciably different from 850 cps. As a matter of fact — on a good signal this discriminator will take shifts as low as 200 cps yet be able to print it all. Indeed this makes the TU tolerant of drift or mistuning on a normal 850 cps shift signal.

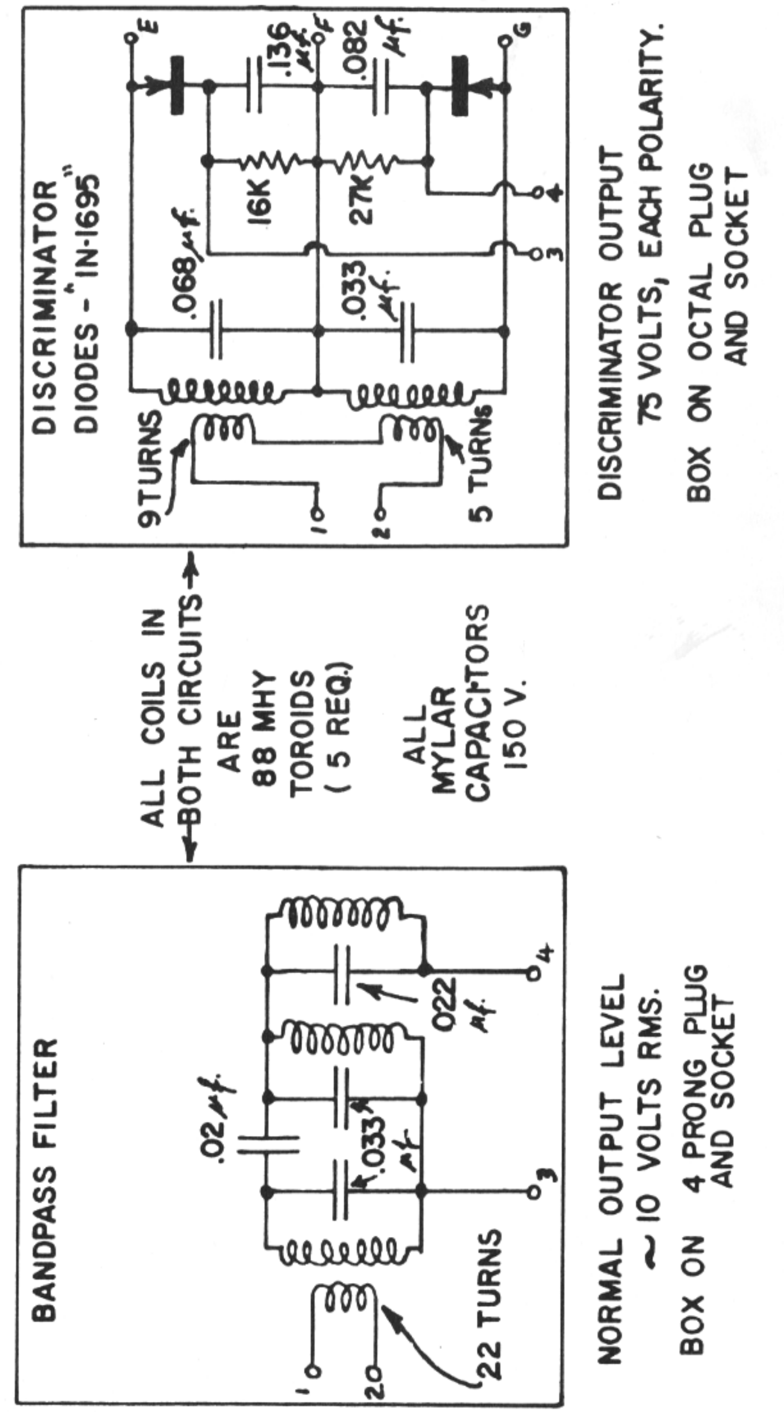
The link turns have been adjusted to equalize the mark and space discriminator voltage outputs. This is very important because of need for symmetrical keying (zero distortion) envelope as well as for satisfactory noise balance. Variation on link turns makes for rough adjustment, and paralleling of appropriate resistor across one load provides a fine means of balance. Adjustment is easily made using injected 2125 cps and 2975 cps tones (one at a time) and making their responses equal — 75 volts negative on mark, 75 volts positive on space.

The Lowpass Filter and D-C Restoration

The detected voltage swings (—75 volts on mark, +75 volts on space) feeds through a low pass filter consisting of a pair of 120 K resistors and a .02 mfd capacitor. This rudimentary filter cleans up noise spikes or similar disturbances yet passes the low frequency telegraph signal. In this connection it may be remarked that the discriminator loads have appreciable time constants, and so together with the low pass filter constant, the overall time constant is approximately 3 milliseconds. Also, the filter serves as an isolating device to permit the markhold circuits to take control without disturbing the discriminator itself.

Figure 4 shows waveforms as observed at various points along the low pass filter. The signal "Y" was injected and detected like a RTTY signal, and its precisely generated 22-millisecond mark and space alternate reversals are easily observed. The "clipping point" shown refers to the zero-axis of the waveform — the point where the discriminator output is zero — and indicates overall


W6NRM TERMINAL UNIT MARK III
AUGUST 1960
R.H. WEITBRECHT
FIGURE 2
BANDPASS FILTER
1/2 LIMITER - AMPLIFIER 12AX7
6AQ5
DISCRIMINATOR
1/2 D-C AMPLIFIER 12AX7
TELEPRINTER STAGE 6W6GT
FSK DIODE DRIVER 12AX7
CLAMPER
OUTPUT TO FSK DIODE
5000 OHM IMPEDANCE
3.2 - 4 OHM IMPEDANCE
SHORTING PLUG
T1, T2 - SPEAKER XFMRS - 5000Ω TO 4Ω (2-4 w SIZE)
TO "X" SCOPE (W0HZR)
TO "Y" + SCOPE (W6AEE)
TO "EYE" CKT.
MARKHOLD
NORMAL or INVERTED FSK SW. DPDT
JACKS FOR TELE-PRINTER KEYB'D & MAGNET
FSK SHIFT ADJ.
FSK OUTPUT SENSE
FSK OUTPUT CONTROL
ALL RESISTORS ½ WATT EXCEPT WHERE NOTED
+150 v. + H.V. (GROUNDED TO CHASSIS!)
0 v. — "0"
-180 v. - H.V.
6.3 v. a.c. TO ALL HEATERS
PA 8421 (STANCOR) 125 v. 50 ma. 6.3 v. 2 a.
120 VAC
SPST
PA 8421
ALL RECTIFIERS - "IN-1695" SILICON DIODES (G.E. PIV 400 v. 0.5 a.)


DISCRIMINATOR DIODES - "IN-1695"
9 TURNS
5 TURNS
.068 µf.
.033 µf.
16K
27K
.136 µf.
.082 µf.
DISCRIMINATOR OUTPUT 75 VOLTS, EACH POLARITY.
BOX ON OCTAL PLUG AND SOCKET
ALL COILS IN BOTH CIRCUITS ARE 88 MHY TOROIDS (5 REQ.)
ALL MYLAR CAPACITORS 150 V.
BANDPASS FILTER
22 TURNS
.02 µf.
.033 µf.
.022 µf.
NORMAL OUTPUT LEVEL ~ 10 VOLTS RMS.
BOX ON 4 PRONG PLUG AND SOCKET

appearance of waveform symmetry into the keying stages.

The top oscillogram shows the waveform direct off the discriminator. The thickened traces at the top and bottom of the waveform are due to incomplete filtering of the tone frequencies involved by the rectifier's RC loads. The middle oscillogram is a composite of three traces — the first being right off the discriminator. the second being from the junction between the 120 K resistors with capacitor connected forming the low pass filter; and the third is at the output of the filter into the DC amplifier. Referring to the second trace — the 02 mfd capacitor has cleaned up the incomplete tone filtering and added some time constant to the result. As for the third trace, it is a clipped waveform — both tops and bottoms have been severely clipped so that only transistions occuring in the very middle of the signal waveform — the zero axis — can pass on to the next stage for DC amplification, Thus the significance of the "clipping point" becomes clear, and it assures delivery of a clean balanced square wave to the DC amplifier in spite of overall distortion to the waveform caused by the limited frequency range in the low pass filter. Now we will discuss the effects of the low pass filter.

The lower oscillogram is again a composite of four traces to illustrate the effects of changes in lowpass time constants. It is noticed that as one increases the capacitor size, the detected waveform is increasingly degraded. Noticing particularly the top and bottom levels of these 22-millisecond transitions, we see that we may have trouble due to excessive time-constant in this section as we receive RTTY signals having all sorts of information — not just 22-millisecond alternate transitions. In other words, each 22 millisecond reversal as portrayed on the traces must approach its maximum value as closely as possible before the next transition. 22 milliseconds is the shortest time between any possible reversals when operating on a single-channel 5-unit RTTY basis, at 60 wpm speed, and hence this leads to the decision to use a small time-constant in this low-pass filter section. (.02 mfd).

The output from the filter is clipped in both directions by two diodes working together. The positive excursion is clipped by the diode action in the DC amplifier's grid-cathode, while the negative excursion is clipped by a silicon diode biased 5 volts negatively with respect to the cathode. In effect only the moddle 5 volts around the zero axis of the 150 volt discriminator swing is detected and passed on to the DC amplifier. This is termed "zero-axis crossing detection" and assures that the mark-space transitions will be kept on a symmetrical manner with respect to the low pass filter output waveform — thus passing the teleprinter signal with a minimum of bias or distortion. Incidentally the wide difference from the 150 volt discriminator swing to the 5 volt swing at the DC amplifier enables the system to work well on RTTY signals having appreciably different shifts than 850 cps. There is *no* "voltage attenuation" through the low pass filter, as careful study of this circuit will show.

In regard to the negative clipping diode mentioned above — it is possible to use a Zener diode at 5 volts in place of the diode with its biasing network. This would be more expensive and does not markedly improve the performance of the system.

The DC Amplifier

This section, using a triode in the 12AX7 envelope, accepts the 5 volt transitions from the low pass filter and amplifies them to provide the 150 volt DC swings for keying the "Teleprinter Stage." Actually only about 3 volts is needed for cutoff in this triode stage — the 5 volts is just to assure complete cutoff on negative excursions from the discriminator.

The amplifier's cathode is held negatively some 50 volts with respect to the "0" line as shown in the Figure 2 circuit diagram. This is accomplished using a NE-48 neon lamp regulator. The "ground" or "D" of the discriminator output goes directly to cathode of this DC amplifier; likewise the "ground" of the low pass filter (the ground end of the .02 mfd capacitor). The reasons for this 50 volt offset are twofold — (1) to provide for more plate voltage swing from the DC amplifier to cause effective drive on the teleprinter stage; and (2) to provide an optimum biasing point for the indicator circuit.

The output from the amplifier feeds through a pair of NE2 neon lamps which act as "voltage steps" to transfer the plate swing down 100 volts so the teleprinter stage's grid (the 6W6GT) may be driven negatively with respect to the "0" line. When the DC amplifier is cut off, the plate voltage rises to near +150 volts with respect to the 0-line, thus causing +50 volts to appear on the teleprinter stage's grid. Actually due to diode action in the latter stage, the DC voltage is less than that but nevertheless assures complete conduction in the teleprinter loop circuit for the *MARK* condition.

And when the DC amplifier is conducting, plate voltage is quite low, and some 100 volts negative potential appears on the teleprinter stage's grid — thus cutting it off a *SPACE* condition to the teleprinter loop circuit.

In the above described way the drive to the teleprinter stage is effectively provided, is rigidly controlled by the zero-axis crossing detection system. Due to the 5-volt input swing at the DC amplifier input as compared to the 150 volt swing available from the discriminator (no voltage attenuation — just clipping), the whole system functions just almost like a flip flop stage, giving sharp and precise transitions. This is a point to illustrate the need for proper handling of signal from a single-ended connected discriminator-DC amplifier setup. We do not need "push-pull circuitry."

The NE2 lamps, in their role as voltage steps, must be kept ignited (glowing) all the time. A 2.4 megohm resistor, fed by —180 volts from the power supply, provides this keep-alive.

One more detail — about the DC amplifier. Suppose there is no signal input into the TU — as when the receiver is muted and no audio output is available. There will be no output from the discriminator and the DC amplifier's grid will be at zero bias. This stage will now conduct and apply a cutoff bias to the teleprinter stage, resulting in a Space condition (no current) in the teleprinter loop. The teleprinter machine will run "open," and this is not desired. Hence we provide a slight amount of bias to the DC amplifier using the 11 megohm resistor fed by —180 volts so the grid is now held in a just cut-off condition. This does not affect the zero-axis symmetry and yet when a RTTY signal comes into the TU, the 150 volt mark-space swings from the discriminator effectively takes control on the DC amplifier.

The Teleprinter Stage and the Teleprinter Loop

Now we have arrived at the "heart" of this TU design — the Teleprinter Loop. As generally defined by the telegraph engineers, a "loop" means a two-wire circuit, complete with power source and series current adjusting resistance, that includes one or more teleprinters and means are provided so that this same machine (or machines) may receive from or send into this circuit.

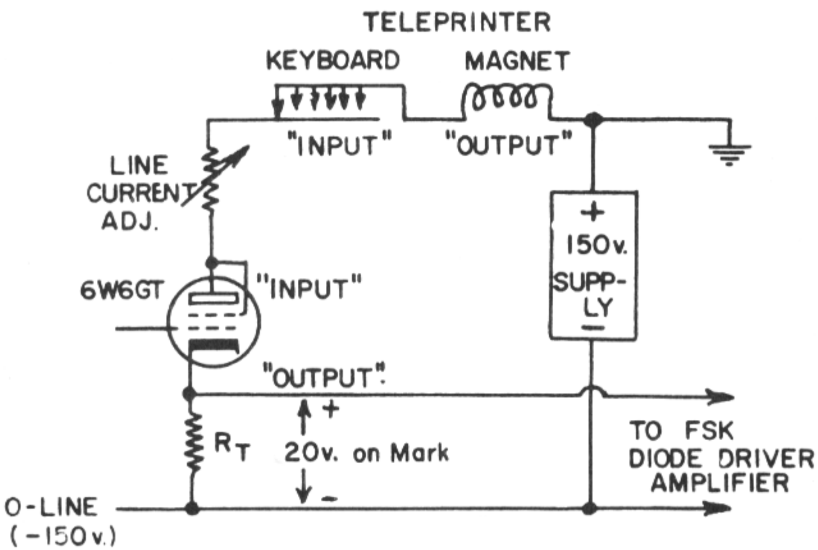
This loop, in order to have two stations, requires two teleprinters, complete with keyboards (sending devices), and these machines then can be physically separated over miles of two-wire connection. In this way, two people can "converse" with each other as simply as typing out messages on either keyboard and reading the result as it emerges from both teleprinters. The operator doing the keyboard work obtains "local copy" for monitoring purposes — to see that the message he is sending is correctly reproduced. And if the two wire circuit to the other station is good, the distant teleprinter prints out the message. And the distant operator can "break in" and acknowledge receipt.

We would like to approach this ideal situation or duplex working in our amateur RTTY operations. This can be and has been done successfully. However for this paper we will restrict ourselves to consideration of how we should best connect our teleprinter(s) with keyboard(s) to our normal "one-way-at-a-time" amateur RTTY circuit.

Each machine has a printer unit for receiving messages in typewritten form on a paper — and — a sending unit in the form of a keyboard. In landline teleprinter work, these two units are normally connected in series and are connected into a "loop." In this way the machine readily receives from and sends into this loop circuit — resulting in "local copy." The loop merely supplies a current, and this current can be interrupted either by the distant sender or by the keyboard right here. The loop may as well include additional machines such as tape cutters (called reperforators or "reperfs") and tape senders (called tape distributors or TD's) for added versatility and automaton in RTTY station operations. We want as many of these features as possible in our TU design considering the usual manner of our amateur RTTY communications — "one way at a time" during a RTTY QSO.

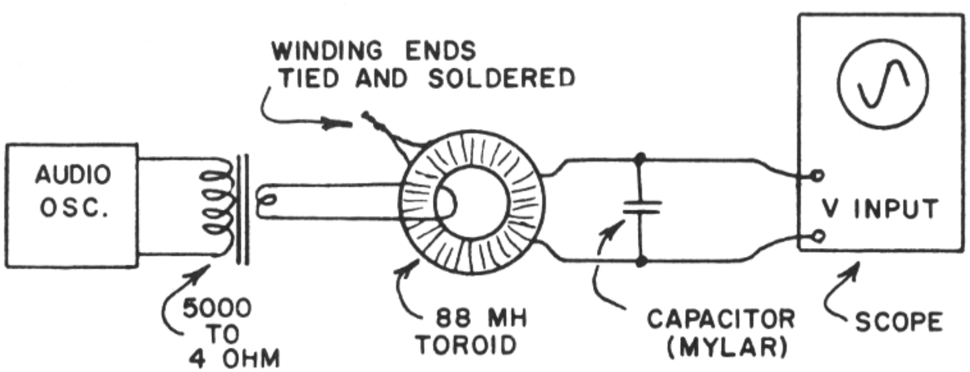
Accordingly the TU was designed with particular attention paid to the Teleprinter Loop circuit. We desire to have a powered loop all ready to accept one or more teleprinters, complete with sending devices (keyboard or TD's). This loop should have simple provision for working into a radio transmitter as well as for working off a radio receiver. The loop should and must handle the information pulses with minimum bias or distortion, even if additional machnes be included.

In the receiving mode, the Teleprinter Stage circuit has a 6W6GT keyer tube which is controlled by the received signal through the earlier limiter-discriminator-DC amplifier stages. The 6W6GT merely acts as a



TELEPRINTER LOOP

FIG. 5



TUNEUP PROCEDURE
FIGURE 9.

switch — to interrupt (key) the Teleprinter Loop with information pulses, thus causing all machines in the circuit to translate into letters, words, and entire messages, or to cut tapes, etc. For instance a Model 15 page printer will record the message and at the same time a Model 14 reperforator, in series in the loop, will cut a tape to be held for later retransmittal. Now we should pause and consider the power supply for this loop circuit and the entire TU as well.

The TU Power Supply

This loop circuit must be energized in some manner so signal pulses may flow into it. We therefore add a power source in the form of a transformer operated 150 volt DC supply having sufficient current for the loop — whether 20 or 60 milliamperes. The TU loop — the "Teleprinter Loop" — has the simple form shown in Figure 5.. We see that the 6W6GT acts as a switch to "key" the loop during reception. The series resistor in the keyer's plate circuit arjusts the loop current to 20 or 60 milliamperes as needed.

The B plus of the power supply is *grounded,* thus making at least one side of the 2-wire line to the machine(s) grounded and cold. This as we shall see not only keeps the loop line as near ground as possible but also simplifies the entire TU design.

The same loop power supply also powers the entire TU. This power supply consists of at least one transformer and some silicon diodes, feeding into two capacitors. The transformer used should be of 250 volt, CT, size, delivering at least 100 milliamperes current, together with a 6 volt winding with sufficient ampereage to power all the heaters in this seven-tube TU.

However such transformers do not seem to be available on the market. So Figure 2 indicates the use of two Stancor PA-8421 transformers — each having a 125 volt 50 ma. secondary and a 6 volt 2 amp. winding, and we arrange both for full wave rectification to obtain our needed +150 volts at 100 milliamperes, half wave rectification to obtain a few milliamperes at −180 volts, and also to provide for the filaments of the tubes in the TU. In this way we obtain the power source for the entire system. A total of three 1N1695 silicon diodes, each having a PIV of 400 volts and current capacity 500 ma. are used in this supply. Incidentally more of these inexpensive diodes are employed elsewhere in the TU — in the discriminator, DC amplifier, and markhold circuits. There are many similar silicon diode types on the market, and they should work out just as well as these 1N1695's at the specified ratings.

As indicated before, the "B plus" is grounded. That means our B minus is now hot at −150 volts, when referred to the chassis of the TU. This B minus is the "0-line" in Figure 2, as it would appear supposing the circuit was visualized as operating normally with grounded B-minus. This terminology is purely for convenience in describing this TU with its unique circuits.

The −180 volts mentioned above is referred to the "0-line," and this source supplies a few milliamperes to the NE-2 keep alive circuit, the DC amplifier neon voltage regulator, the indicator circuit, and the mark hold circuit. Of course, referred to chassis ground, this potential becomes some 330 volts negatitve.

No compromises were required in the overall TU design to accomodate the ground B plus. For that matter, we could have grounded B minus as in normal practice in vacuum tube amplifier design. Grounding B plus offers us two circuit advantages — (1) the printer line is "cold" on one side, and (2) simplification of the transmitter FSK driving circuit.

The grounding of B plus necessitates that care be taken not to "mess up" with the TU's signal input circuit. Considering an audio amplifier, it is evident that grounding B plus in such a circuit is apt to introduce hum into its input due to power supply ripple feeding into the amplifier's input — in parallel with the signal. And power supply transients or surges could cause annoying thumps in the output. We might even have regeneration and "motorboating" as a result.

Accordingly in this TU we use a link coupling between receiver and the input toroid coil in the bandpass filter — and we achieve two goals at a bold stroke; namely, optimum signal coupling into TU and effective isolation of signal input from the TU's neutral or "0-line." A few turns of insulated wire, easily threaded onto the toroid, serves as an efficient inductive link between the 4-ohm receiver connection and the rest of the TU. There are no interaction troubles of any kind, and the TU behaves as normally as a common audio amplifier.

The Teleprinter Loop (Cont'd.)

Having settled the power supply question, we turn to the loop design. As we want 20 milliamperes current for operating holding magnet printers (such as Model 26's, Model 15HM's, etc.) or 60 milliamperes for operating pulling magnet printers (the majority of Model 15's as well as Model 14 reperfs) we should design the loop circuit with a switching system and adjustable line resistances to permit setting to exactly 20 or 60 milliamperes as needed.

As Figure 5 shows the essentials, the main circuit is in Figure 2 and thus comprises the Teleprinter Loop. A DPDT switch is employed not only to select the series resistance for either current but also adjusts the cathode resistance, called "R_t" so a constant 20 volt drop is obtained during loop current on Mark. Now we will define this loop circuit more explicitly. It has at least "two inputs and two outputs"—all in series, along with its power source.

The inputs are:

(a) the 6W6GT keyer for switching the received signal into the loop.

(b) The keyboard for keying information into the loop.

The outputs are:

(a) the typing unit-page printer magnet for taking information from the loop.

(b) an output circuit for taking information from the loop to send out through the radio transmitter as a FSK RTTY signal.

We see that we could add more inputs and outputs in forms of TD's, reperfs, etc, in series in this Teleprinter Loop, and thus we not only obtain local copy but also extend our RTTY equipment to automatic versatility.

Numerous tests and evaluation runs have proved this TU's teleprinter loop to be accurate and free from distortion due to adding a reasonable number of machines into the loop. At least one page printer, one repref, and one TD, plus all incident keyboards, can be included in this loop without adverse results.

Shown in Figure 5 is the above mentioned resistor "R_t," in the cathode circuit of the 6W6GT keyer. The keyed loop current flowing through this resistor develops a voltage waveform which is a fair sample of the teleprinter information pulses in the loop. The waveform is somewhat distorted due to the machines (magnets and keyboards) in the loop. The printer magnets tend to have inductive lags and surges, while the keyboard contacts tend to introduce effects due to their paralleld spark suppressing capacitors. It is to be noted that the machines are employed in their landline form and we should not alter their circuits for radio circuit operation.

Oscillograms in Figures 6 and 7 show waveforms as developed across R_t (Fig. 5) by 20 and 60 ma. loop currents flowing under two modes; Input signal from 6W6GT keyer and input signal from Keyboard in loop. The top oscillogram in either figure shows the "Y" signal developed across R_t as switched into the loop by the 6W6GT keyer. The bottoms of the waveforms — corresponding to Space or zero-current conditions — are clean and sharp, while the tops — the Mark conditions (full current) — are somewhat affected by the characteristics of the printer magnets. The 60 ma. loop has a gradual buildup on the mark side as the magnet becomes energized and it pulls up on its armature. The 20 ma. loop has a bump due to the selector mechanism pushing the armature to its holding-magnet.

Using keyboards (with 6W6GT keyer locked on) we obtain similar waveform on either currents. The 60 ma. line waveform appears identical — whether switched by the keyboard or by the TU (6W6GT). The 20 ma. line waveform has a small difference between the two keyed modes — this is caused by the charging-up time-constant in the keyboard's spark suppressing filter. The bottom oscillograms show the waveforms as delivered by the TU at its FSK output — all ready for impression on the transmitter's FSK circuit. These waveforms are essentially square wave and on-the-air checks on this signal, using a separate RTTY receiver, TU, and machine, show quite satisfactory teleprinter range — indicating minimum bias and distortion effects. In fact this electronic Teleprinter Loop design delivers an excellent signal — superior to most any polar relay keyed amateur RTTY signal. Further evaluation tests are in progress and definitive data will be published later.

The FSK Diode Driver Circuit

The aforementioned Y-signal oscillograms (top and middle) show dotted lines defining clipping levels which are placed at proper points on the waveforms. A subsequent DC amplifier, suitably biased, operates to detect transitions below and above this clipping level in a similar way to the "zero-axis crossing detection" — and amplifies the result to provide direct "FSK Driver Output" in its plate circuit.

The amplifier is a triode unit (12AX7) and — like the DC amplifier after the discriminator — has a small grid swing between conduction and cutoff. The swing across R_t due to keyed loop current is 20 volts and the clipping level is set about 7 volts above the 0-line. Hence the amplifier responds to transitions above and below around this clipping level.

Now we will mention an important feature of this amplifier circuit. A double pole double throw panel switch selects "outgoing FSK sense" simply by operating the amplifier in a grounded cathode or in a grounded grid mode. As the driving source, R_t, is relatively low in resistance, this permits use of this simple circuit for quickly providing correct shift sense to the particular transmitter exciter. This is a necessity for owners of Hallicrafters HT-32's and such transmitters whose heterodyning systems are reversed on some of the bands.

This biasing point or clipping level is established by feeding +7 volts (referred to 0-line) into the DC amplifier's grid or cathode as the case may be, while the drop across R_t goes to the cathode or grid respectively. The biasing is obtained from the 6AQ5 cathode resistor network — which is bypassed — and has a fairly constant 15 volt drop at a low resistance. Two resistors are placed in series to provide biasing for that power amplifier stage as well as to furnish the clipping level for the FSK diode driver. The resistors are suitably proportioned to give the voltage for this clipping level.

As a handy means of setting up fixed Mark or fixed Space for adjusting the transmitter shift, a panel control selects Mark, FSK, Space. The controlled circuits are obviously seen to manipulate the amplifier to hold the FSK driver output in the state required for alignment for transmitter FSK setting.

The plate circuit of this amplifier contains a 25K potentiometer, one end of which is grounded to B plus (chassis). This is the shift-control on the TU's front panel, and it adjusts the voltage swing that drives the FSK diode on the transmitter's VFO. The swing ranges from 0 to —50 volts, and its waveform is a clean square wave — all ready to impress onto the shifter circuit. The latter is a separate item and connects right into the VFO — and this will be discussed later on.

An additional portion of the FSK driver output circuit is the clamping diode. It consists of the other section of the 12AX7, and its paralleled grid-plate is biased by another NE-48 regulator. (A silicon diode could serve here, or else a 50 volt Zener diode) Its cathode is prevented from swinging more negative than the —50 volts as held by the regulator, and as a result the connected plate of the amplifier is clamped to —50 volts when it conducts. Thus stabilization of the out-going FSK signal is achieved and hence the stability of the transmitter shift is assured wherever it is set by the TU's front panel control.

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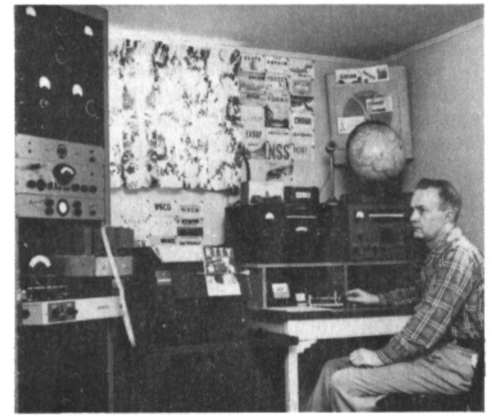

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FIRST ANNUAL BARTG DINNER/MEETING HELD IN LONDON

On Saturday evening, November 26, during the Radio Hobbies Exhibition the BARTG held its first annual dinner meeting. The meeting was well attended by enthusiastic RTTY'ers from all parts of England and The Continent and according to all reports was a huge success. Many of the organizational problems confronting the group were discussed and expedited during the session. A committee to handle the affairs of the BARTG was appointed consisting of G6NZ as chairman, G3CQE G3FHL, G3BST and one additional member from the Southhampton VHF group. G2UK will continue as Secretary and Editor of the BARTG News Bulletin.

G6NZ, the chairman of the committee, is also a member of the RSGB/GPO Liason committee so it is evident that the UK RTTY boys will have a strong voice in the regulatory circles of Amateur Radio in England. Congratulations to the BARTG for a job well done and best wishes for the continued growth and success of this outstanding group! !

fiends to hit the jack-pot! Anyone for a Forty meter WAC-RTTY? Alec, ZL3HJ is still trying to liberate his model 19 from Customs. He sure deserves a gold plated band for effort!

I fully intended to run the DX standings this month but because of lack of space will hold em over for next column so there's still time for you to get your "DX worked" list to me before the deadline. Also don't forget your WAC-RTTY confirmations if you haven't already sent them to me. Best wishes for the Holidays and here's wishing all of you loads of new DX in 1961.

FLASH! ! Too Late to Qualify! As this goes to Press word comes via G3CQE-K3-GIF that Eric, VK3KF and Henry, ZS1FD made a two way RTTY QSO on 21,090 for another "First." During this same session G3CQE and G3BXI also worked VK3KF for the first G-VK contacts. Congrats, fellers!! Will have the details in next month's session. 73 Bud W6CG

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"SOME OUTSTANDING RTTY DX'ERS"
Front, (L to R) G2UK, PAØFB, G3CQE.
Back (L to R) G3BDH, G3BXI, G3GNR.

LIBRARY PROPOSED OF RTTY MANUALS

RTTY, INC., is proposing to start a rotating library of RTTY manuals of those which are available here. To borrow a manual, postage to send and return manual is required. Also an assurance that such manuals loaned will be returned in three weeks. This should provide enough time to copy information needed. At present many of the various Teletype manuals are either out of print or very hard to obtain, hence RTTY will try this idea out. We have a fair number of the various manuals, and will try and add those which are most needed. Let us know what you think of this idea. First come, first served. RTTY, INC.

DX - RTTY

Bud Schultz, W6CG
5226 N. Willmonte Ave.,
Temple City, California

Happy Days ! ! – the old mail bag is so full this month that we can only hit the high spots. A million thanks to all of you who responded so generously to my frantic appeals for Dx news ! ! Wnthout your help the ole column would have gone down in flames.

From Europe comes word that the UK boys are really rolling now and each week finds a couple of new ones on the air. G2-UK reports that the BARTG now has a membership of 66 ! ! In addition to the UK stations listed in last month's column can be added G3LMR, G3KKY, G3HDG, G3NGA, G3FHL and G3DSF as active participants in RTTY activity. My European Editor Bill Brennan, G3CQE, writes that Jan, PAØFB, spent an overnight visit at G3CQE during a recent visit to Norwich. While there Jan appeared on the local TV station for an interview concerning his consistent "fringe Area" reception of British TV stations in Holland. Bill also writes that Ex-VS1HU is going to operate RTTY from aboard ship in March from VR1, VR2 and VR4. Unless he takes the gear ashore these won't count as new countries so keep your fingers crossed. G3CQE is trying to stir up some 7MC activity on RTTY so any of you who are interested should get in touch with Bill as soon as possible because conditions seem excellent at this time for such a deal. While mentioning PAØFB I forgot to mention that through his efforts with the Authorities it appears that a maximum shift of 900 CPS will soon be in the bag for Netherland RTTY'ers. Nice work, Jan! !

From the Dark Continent comes a most interesting letter from Henry, ZS1FD, describing RTTY conditions over there. Henry reports that his TU is going thru its ninth transformation and this time he has written to Eric (VK3KF) for some further advice. ZS1FD operates an HT-32 (barefoot! !), 75A-4 and a TA-33 Beam. He has his gear built into a four by six foot alcove in the living room and can hide it by means of folding doors and a space of panelled wall. —As Henry puts it—"this stops the usual idiotic questions but does not leave much room." By way of K3GIF Henry reported he heard ZK1BS on FSK but was unable to make contact. Stay with it, fellers, you'll make it yet! Ed, K3GIF, also managed a good three-way QSO with ZS1FD and G3-CQE on 21,090 with all parties printing each other in good shape. Nice work! !

WØAJL relayed an interesting story from Bob, TG9AD explaining his absence from the FSK frequencies. The Guatemalan Government recently declared a state of Siege during the Rebel uprising automatically putting all the hams off the air. In order to retake a captured 10KW broadcast transmitter the Government Airforce was forced to strafe a brand new set-up completely wrecking it. Bob and his crew have been busy restoring the station during the past month and expect they will be allowed back on the ham bands shortly. As Bob put it: "It was a crying shame to be forced to shoot up brand new gear but it was the only way they could wrest it from the rebels without getting a lot more people killed than was absolutely necessary to recapture it." From the Florida RTTY group comes word that Frank, OA4BN, states that the Lima Radio Club is anxious to get on RT-TY and are looking for gear. Frank says interest is high and that he himself is using a Model 15 and a TU made from one of the circuits in the bulletin. The Gang down there send their regards to all and hope to be on FSK shortly. Erosa, XE1-UNM has been showing up quite frequently of late on fifteen meters (transmitting FSK only and receiving CW). He expects to be on regularly as soon as he completes his new TU. He reports that XE1AX is also active.

The "down under" gang are still very active on both fifteen and twenty but the band conditions have been very feeble for them. Eric, VK3KF, is still trying for ZS1-FD and has his fingers crossed. He expects to be away on a trip for a few weeks but should be back shortly. Bruce, ZL1WB, says he is also going to try and break thru the magnetic belt around Anarctica and work ZS1FD. Bruce was overheard talking to Eric about some forty meter RTTY DX— Sounds like another chance for you.