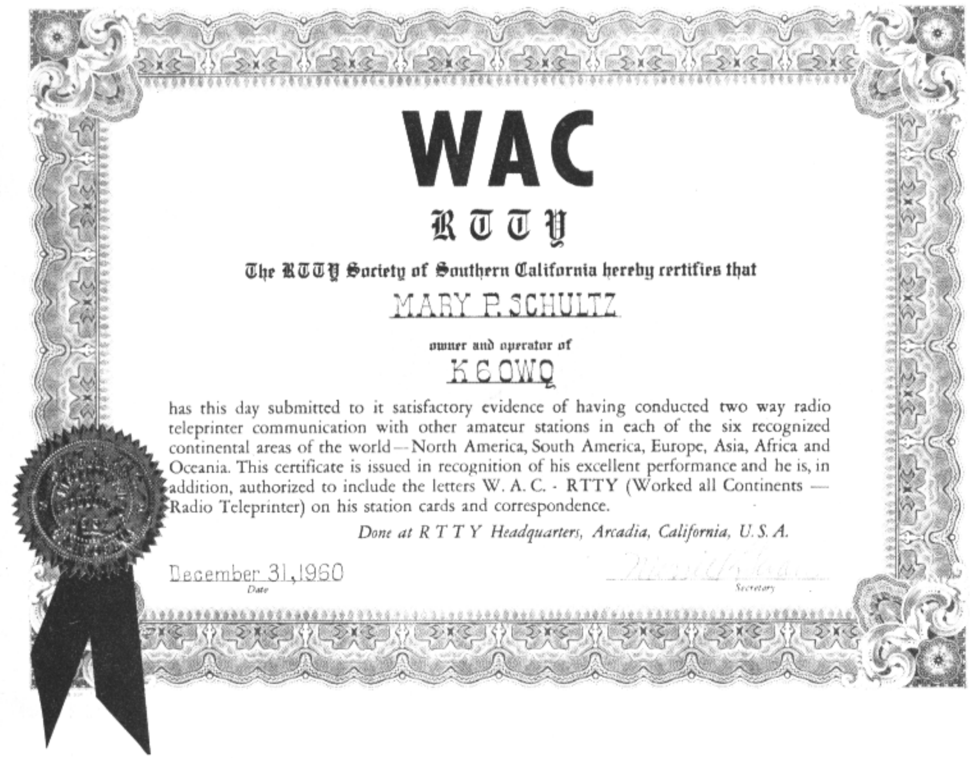
RTTY



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NEWS OF AMATEUR RTTY

FEBRUARY 1961
30 Cents
Vol. 9, No. 2

HORSE TRADES

This page of the Bulletin is for use of amateurs who have RTTY EQUIPMENT FOR SALE OR TRADE and those looking for equipment to buy or trade. It is a free service and may be the means of getting someone on the air.

FOR SALE: Perforator tape, 11/16" $2.50 per pkg of 10 rolls shpg wt. 12# WA6AVJ

FOR SALE: 47 Model 15 keyboards, excellent condx W2ZKV

WANTED: Model 28 KSR printer W5UIR

WANTED: Any tape gear worth $25.00, trade Codetyper, cost $200 new, used ½ hour. Any tape gear. Will trade high quality ink drafting service W4CXY/K4DE

FOR SALE: 1 Model FRA Navy Converter, IF type $50.00
1 Model AN/FGC-1 Converter, AF type $100.00
Panels from AN/FGC-1, while they last—$15.00 per panel W2KXT

WANTED: Model 14 typing reperf and Transmitter-Distributor OA4BN, P.O. Box 538, Lima Peru

FOR SALE: Boehme Keyer and Wheatstone Perf W6EHZ

FOR SALE: Model 26 with AutoCar Return and Line Feed—$55.00

WANTED: Model 14 TD W7YHS

FOR SALE OR TRADE: Model 14 with keyboard in good working condx. Want Elmax Xmtr, mobile gear W5GUU

FOR SALE: Boehme CW Ink recorder driving unit, Boehme 4-G ink recorder, Schutti dversity combining unit and tape puller. 15/32" oiled Wheatstone tape W6DOU

TRADE: Model 15 keyboard for model 14 keyboard. Wanted model 15 printer only W4NZY

FOR SALE: Model 26 with Comm type, model 15 with Wx type and auto car ret and line feed. Model 101A page printer, Model 16A reperf. Want 28 KSR or 28 ASR W2PEE

FOR SALE: Tape Facsimile equipment $50
Riley, 914 N. Cordova St., Burbank, Calif.

RTTY, Inc.
372 WEST WARREN WAY
Arcadia, California
Return Postage Guaranteed

PASADENA CALIF

EIGHTH ANNIVERSARY RTTY SWEEPSTAKES

February 24 and 25, 1961

The eighth anniversary RTTY SS Contest will be held starting at SIX PM EST on the 24th February and running until THREE AM, 26th February, 1961. This provides thirty-three hours of operating for those who can stay at the GREEN KEYS that long. New RTTY calls are the order of the day on all of the bands recently, and we all hope they will join us in this contest to commemorate the authorization of FSK on Amateur frequencies.

Stations will exchange messages consisting of msg number, originating station call, check or RST report of two or three numbers, ARRL Section of the originator, local time (0000-2400 preferred), date and band used. Score one point for a message received and acknowledged by RTTY. Score one point for each message sent and acknowledged by RTTY. For final score, multiply the total message points by the number of different ARRL Sections (see page 6 QST) worked. Two stations may exchange messages again on another band for added message points, but the section multiplier does not increase when the same section is worked again on another band. Each foreign country counted by ARRL for DXCC credit is treated as a new section for multiplier credit.

In order to be scored, contest entries should be received by RTTY, INC., 372 Warren Way, Arcadia, California not later than 15, March, 1961. Certificates will be mailed to the top ten scorers in this contest.

RTTY would appreciate any comments regarding the contest rules, and any changes you would suggest for future contests. These may be included with your contest logs. Best of luck and good printing.

CONTEST PERIOD

Time	Start	End
EST	1800-24th	0300-26th
CST	1700-24th	0200-26th
MST	1600-24th	0100-26th
PST	1500-24th	0000-26th
HST	1300-24th	2200-25th
GMT (zula)	2300-24th	0800-26th

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SEVENTH BEEPSTAKES RTTY SS RESULTS

Top stations in this contest were W2RUI, 8496; W6YJG, 8140; W8JIN, 7210; W2-JAV, 6666; W7ESN, 5841; WØTBL, 4930; tied for seventh, KH6IJ, 4480, WØGK, 4480; W2TKO, 4448; W7FEN, 3942; W6-FYM, 3752.

Other stations taking part, with scores from logs received by RTTY. W1AW; W1-BDI, 91; W1BGW 950; W1FSH 372; W1-KQY; W1MVH; W1LMI; W1TLZ; W1VSA; K1WAR; K1MOD; W1BNZ.

W2EXB; W2FAN 492; W2JAV 6666; WA2MWE; WA2NVA; W2PE 112; W2-RGO; W2RUI 8496; W2RYB; W2ODA; W2OKO; W2LGN; K2SKK 1722; W2TKO 4448; W2YRB; W2VLL.

W3CA; W3CRO 1400; W3DIZ 2016; W3DZD; K3GIF; K3LDQ; W3KMH; W4-BSV/3.

W4DGE; W4EHU; W4GIJ; K4JXG; W4-1377; K5GMI 738; W5NEP; W5JNK; W5-KWL; W5PZA; W5QEO; W5QBU; W5-TVG392; W5VHR; K5ZXG.

W6AEE 2200; WA6BBG; W6CG 1452; W6CBX; WA6ECH; W6FYM 3752; W6-GDO; W6FKQ; W6HIF 476; K6IXA; K6-JPR; K6JWS; W6KUY; W6LIP 3224; W6-NKP; W6MXJ 180; W6OWP 504; K6OWQ 180; W6PTN; W6TPJ; W6VPC; W6VVF 1008; W6YJG 8140; K6ZBL 260; W6ZFT; W6WOC; K5KIB/6 540.

W7BEG; W7CPY; W7ESN 5841; W7-FEN 3942; W7GEK; W7HJC; W7IE 1332; W7JFU 30; W7PHG 3538; W7RQQ/7; W7LI; W7LPM; W7HPH.

K8AEH; W8AYT; K8BCH; W8CAT 3537; W8CLX 1368; K8DXV 532; W8-CSH 572; W8CRY; W8JIN 7210; W8KDW 340; K8KBO; W8KJK 1640; W8LEX 1600; W8NLT; W8QMI 384; W8RTZ; W9PXA; K8JIB; W8UEV; W8UFU.

W9AOV 754; K9BHD; W9BQC 385; K9BRL 1444; W9COW 133; K9DAS; W9-DJE; W9DPY; W9DPU; K9EHP 800; W9-GRW 253; W9HJV 1040; W9GMU; W9-PHD; W9PPW 198; W9RDJ; W9QNO; W9SPT 1258; W9WYH; K9VUT; K9TVF.

KØAEK; WØAIS; WØAJL; KØAQO; KØBRS 2; WØEUS; WØFQW 945; WØ-GK 4480; KØBFY; WØEBW; WØIFS; WØJLX; WØJHS 8; KØCDG/Ø; WØ-MNA; WØMPF; WØOKH; WØPPR; WØ-RX 1564; WØDML; KØDRW; WØFLK;

THE W6NRM RADIOTELEPRINTER TERMINAL UNIT, MARK III

R. H. Weitbrecht—W6NRM
3941 Brookline Way
Redwood City, California

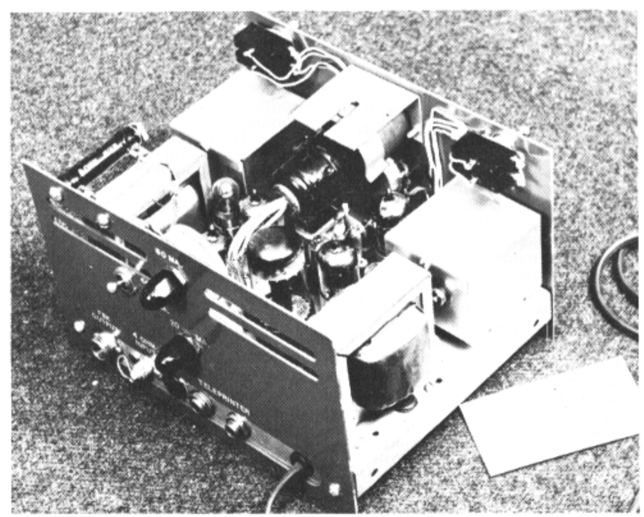
The Tuning Indicator System

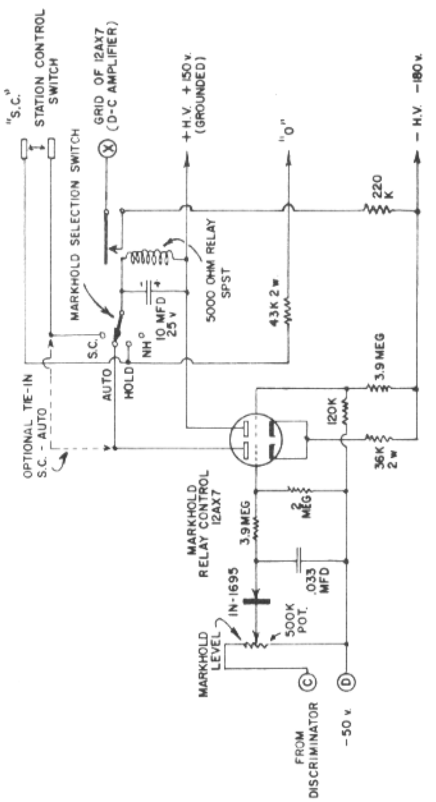
The indicator system used in this TU consists of a 12AU7 amplifier and a 6AF6G twin-ray tube, as shown in Figure 8. There are two shadows seen on the target and they are placed left and right for mark and space respectively. The indicator tube is driven by the 12AU7 paraphase amplifier arranged for single ended input so it accepts the discriminator's —75 volts output on mark, +75 volts on space. The response is as follows: On mark tone input the left hand shadow closes completely and overlaps somewhat, while the right shadow opens wide. On space tone input, the presentation is reversed. On no signal, both shadows are narrow, and in this condition one can judge noise balance adjustments if the receiver is being adjusted for best noise balance into the TU. The indication is sensitive, direct, and simple to install and employ — just peak the RTTY signal until the "eye" opens wide and then there you are!

As the TU is direct coupled from discriminator to teleprinter loop and has an effective zero- axis crossing detection system, it will work well even if the RTTY signal is somewhat off in shift. Such a signal is tuned in for best "eye" shadow balance on both sides, and when this is properly done, it now straddles the zero-axis and enables the TU to deliver the information pulses to the teleprinter loop. This works quite well on NFSK because of the relative linearity of the discriminator.

If the signal has 850 cps shift, then tuning the receiver across this signal causes its mark and space tones to "fall" into the TU's filter peaks simultaneously and then the eye-shadows are minimized at the same time. Simple and quick way to check the other fellow's shift!

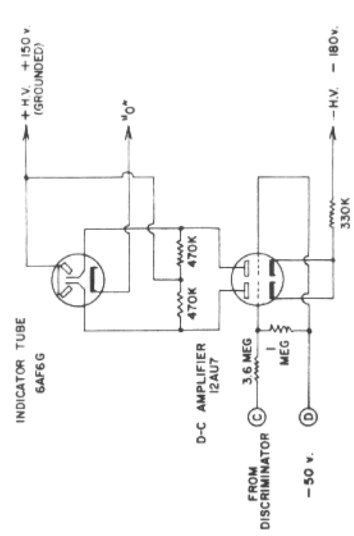
Shown in the diagram (Fig. 2) are some connections for driving a W6AEE style presentation and also a WØHZR phase sensitive presentation. These extra circuits are more complex and require special power supply arrangement — not conveniently available from this TU nor does it have the additional room for the extra parts required. However a companion "scope cabinet" that matches this TU cabinet in appearance has been built up. It has a separate power supply and uses a 2 inch cathode ray tube plus two amplifiers for X and Y channels. Single knob picture control gives a choice of the





MARKHOLD CIRCUIT FOR W6NRM TERMINAL UNIT MK. III

FIGURE 8.



"EYE" CIRCUIT FOR W6NRM TERMINAL UNIT MK. III
-75 v ON "C" CLOSES UP LEFT SHADOW (MARK)
+75 v ON "C" CLOSES UP RIGHT SHADOW (SPACE)
(INPUT WITH RESPECT TO "D")

W6AEE "cross," the WØHZR "X", and also includes a display of the outgoing FSK signal — say a selected teleprinter character such as "Y" or LTRS or anything desired synchronized at 60 wpm rate. This permits evaluation of signal for bias, distortion, or other defects — not only on one's own signal but on the other fellow's. This scope cabinet will be described some other time.

All in all, for this basic TU design, the use of a "double Magic Eye" gives a simple yet effective tuning presentation using the fewest parts possible. It is sensitive enough to permit use of the calibrated peaks in the discriminator as reference points to set one's own transmitter shift quite precisely. This can be consistently done to within a few cycles of the 850 cps shift value.

The Mark Hold System:

Incorporated in the TU design is a mark hold circuit, shown in Figure 8, and it is operatable in one of several modes. This circuit exerts direct clamping hold on the Teleprinter Stage to the Mark condition by means of a relay whose contacts are wired to bias the 12AX7 DC amplifier to cutoff (right on the grid at point "X," after low-pass filter).

The markhold can be controlled by a panel control. "OUT" means no markhold, "IN" means markhold, "AUTO" is automatic markhold in case of signal disappearance and noise coming in, and "SC" refers to Station Control — needed when manipulating the TU between transmit and receive.

In the AUTO position, the operation is similar to "fast attack, slow release AGC" in that appearance of a signal in the Mark channel causes immediate unclamping of markhold. While the signal is sending information, the system remains unclamped. If signal disappears or a "Space" tone is held in, the markhold circuit comes on after about 200 milliseconds delay.

The circuit is activated by the Mark excursions of the discriminator (up to —75 volts) and they feed through a "Markhold Level" control on the front panel into a silicon diode which now gates only negative voltages into a .033 mfd capacitor. RC constants are such that this capacitor charges up quickly on a Mark input, and thus cuts off a triode section of the 12AX7 paraphase amplifier. The 5000 ohm sensitive relay in its plate circuit now opens, unclamping the Teleprinter Stage as has been mentioned before. The other triode section is merely a reference cathode follower in the paraphase system, and its grid is biased somewhat negatively so the other triode section will conduct in case of insufficient signal bias or zero bias.

If no marks are coming in (signal gone and noise coming in), the .003 mfd capacitor loses charge through its network and the triode conducts, thus operating the relay. Its contacts close, feeding negative HV through a suitable resistor to "X" to cut off the teleprinter stage's DC amplifier . . . . resulting in a clamp on the teleprinter stage (6W6GT). "X" is indicated in Figure 2 as well as in Figure 8.

The Markhold Level Control is a potentiometer for adjusting the automatic mode for clamp when noise is coming through the TU. In effect it sets the mark voltage level at below which the Markhold will clamp. All it is necessary to do is to adjust this control until the teleprinter stops chattering on noise.

Automatic Markhold is a nice feature for RTTY/MARS RATT net operations where signals pop in and out, wih noise in between signal periods. During such noise periods the teleprinter is effectively held quiet and unnecessary garble is avoided. Another nice point about this AUTO mode is that the required CW identifications do not disturb the printer at all provided the CW is sent on the Space channel. (Under certain conditions, CW keying on the Mark channel does not disturb either).

The "Station Control" features control of the Teleprinter Loop for transmit or receive modes. All it does is to "block off" the discriminator from the teleprinter loop circuits during transmitting. And for reception the block is lifted and received RTTY signal operates the teleprinter loop. Station Control is obtained with a pair of wires from the TU's rear connection to a suitable switch contact that is part of the regular station's transmit-receive control system.

This SC circuit can be combined optionally with AUTO mode merely by paralleing the two switch positions as shown in Fig. 8. Thus the use of a relay in this TU circuit makes the entire Markhold sysem quite versatile. In fact if desired, Markhold could be arranged to shut down the printer motor if no signal is present, by means of extra contacts on the relay.

The Station Control arrangement effectively sets the TU for transmit or receive. One does not need to "tune one's own signal in" on this TU to obtain local copy on the printer. The Teleprinter Loop effectively takes care of both local copy and transmitting at the same time. Of course, the transmitted signal can be tuned in for a check on its shift as for receiver channel check — relying on the effective block interposed by SC on the signal path between discriminator and teleprinter loop to prevent signal feedback from receiver through TU to transmitter.

As a consequence of the TU arrangement, it is easy to retransmit an incoming signal — merely by setting Markhold to OUT or AUTO allowing the received signal to key the transmitter via the Teleprinter Loop. Of course the machine in the loop monitors the traffic flowing through the station, and yet the signal transfer is accomplished without appreciable distortion. This mode is handy in certain "Conference Circuit" operations involving two or more RTTY stations operating in a closed radio frequency loop. The AUTO mode functions effectively as an Automatic Mark Restorer (AMR) in these operations. This will be discussed some other time. By the way, the retransmit feature is handy for relaying RTTY bulletin broadcasts on other frequencies, or patching a RTTY station on another band into an outgiong RTTY circuit on some other frequency.

PART II—Construction and Adjustment

Physical Description

The entire TU as described above is built into a LMB modernistic cabinet, type W-1C, as shown in the various photographs. This form of packaging makes for a compact unit that blends well with the decor on an office desk or similar setting. Of course the circuit could be packaged onto a 19 inch panel, having an height of say 3½ inches, and it would fit right into a relay-rack. It's a matter of taste and conformity to whatever arrangement a particular station may have.

The power transformers are placed at the rear and are positioned for weight balance, and the miniature boxes containing the band pass filter and discriminator are placed in front on the chassis. The tubes generally occupy the middle area of the chassis, and they are logically placed so as to have a signal flow easily followed. The markhold relay is placed in the center of the chassis pan. It's a sensitive relay type, of 5000 ohm coil resistance. Anything of 2,000 to 10,000 ohm size would serve, so long as it is possible to adjust the relay for proper operation.

The 6AF6G is clamped to the front panel by means of a modified 6E5 mounting assembly. Beneath the chassis. two strips of Vector perforated boards are mounted, and the various parts are easily mounted, using Vector clips, and wired to the corresponding sockets.

The miniature boxes, LMB type OOZ, holding the toroid circuits, are made plugin — to facilitate adjustments on the filters themselves or to permit use of other filters having different characteristics. For instance, 425 cps shift, or different audio input frequencies, yet the TU amplifier and keying circuits are adaptable to any of these special frequencies with a minimum bother on adjustments.

Connections for 4 ohm tone input to TU, two seriesed jacks for teleprinter plus keyboard, FSK output, and Station Control facility are on the rear edge of the chassis. Also on the rear panel is a DPDT switch for 20 ma. or 60 ma. loop current selection as well as the two potentiometers for precise adjusting on the above line currents. On the front panel, controls have been kept to a minimum, and consist of markhold mode switch, markhold level control, and output FSK sense control. Along the top of the panel are the two inverting switches for input FSK and output FSK. The twin electron ray tube occupies the top center of the panel, above the markhold level control.

The 5,000 ohm jack is located thereupon and it serves to feed into or feed out the tone signals as previously explained. This jack is self-shorting so if this connection is not used, it shorts the transformer and effectively removes it from the 4 ohm circuit, thus passing maximum tone power to the TU. Finally of course there is an AC switch on the front panel, and under the chassis is a 1 ampere fuse.

Bandpass Filter—Discriminator LC Tuneups:

The toroid LC circuits in the TU need to be carefully calibrated to certain frequencies if the best TU performance is to be had. The discriminator LC's should have their peaks not only separated 850 cps but at 2125 and 2975 cps spots as well in order to provide a "calibrated system" to facilitate precise tuning-in on normal RTTY signals as well as for convenience in setting up one's transmitter shift. The bandpass filter must have its range properly placed so its dual peaks lie over the mark and space frequencies — in order to enable it to lend effective selectivity to the TU.

The tuneup procedure is quite straightforward. Equipment needed consists of an accurately calibrated audio oscillator and an AC - VTVM or oscilloscope. We shall also need a loudspeaker output transformer—or ideally the unfinished TU could provide the necessary driving circuits for the job - as the finished LC's will go right to work when completely tuned up.

Constructing the Bandpass Filter

For the bandpass filter, we require two toroid LC's individually tuned to the same 2975 cps frequency. We take a 88 mh toroid — available from a number of sources known to RTTY'ers — place its two windings in series, and connect the remaining two terminals to a .033 mfd Mylar 150V capacitor. The output from this LC is applied to an high impedance AC indicating meter or oscilloscope. The procedure is illustrated in Figure 9, and is much the same method employed for calibrating toroid filters described in a previous article.

A piece of hookup wire is run through the center "hole" of the toroid and its ends are connected to the 3.2 ohm winding on the loudspeaker transformer. The audio oscillator now drives this transformer through its high impedance (plate) side. Run the oscillator through its range around 3 kc and maximize the response as indicated on the meter or scope. This will be quite sharp, indicating high Q (about 40) in the LC circuit being tuned up. The uncalibrated system will be found to have a peak response at around 2800 cps. This is too low — the .033 mfd capacitor value was deliberately chosen to make the initial frequency low.

To bring this LC to 2975 cps, all we have to do is to remove turns from the free end of the toroid winding — thus reducing its inductance — making one or two tries until the circuit finally resonates at the desired frequency. As much as 30 or 40 turns of wire will be removed. This is the best way to calibrate a toroid LC — and thus avoids the necessity of specifying capacitor size to some exact odd value. Capacitors and toroids as well have manufacturing tolerances and it would seem foolish to attempt to specify "target values" for LC's.

The second LC is similarly tuned to 2975 cps. Having obtained two such 2975 cps tuned LC's, we place them in the pi-configuration with a 0.2 mfd capacitor joining their hot ends. The input toroid has 22 turns of thin insulated hookup wire threaded through — forming a link for connection to the 3.2-4 ohm input circuit in the TU.

Place a 10 K resistor on the output of this filter and connect to the oscilloscope. Running the audio oscillator through its range we obtain a double-peak response — one peak at 2975 cps and the second peak should now lie on 2125 cps. The .02 mfd coupling capacitor in the pi-filter may need slight adjustment one way or other. Try padding with a smaller valued capacitor to get second peak precisely on 2125 cps.

Next, we construct a LC circuit having a response at 3400 cps — this provides the trap circuit which is placed in series with the output from the pi-filter and into the 10 K load resistance. The 3400 cps trap is quickly made using a 88 mh toroid and a .022 mfd Mylar capacitor — we may find the first try at calibration to be close enough to 3400 cps for all practical purposes. After all we want to steepen the cutoff on the high side of our complete bandpass filter.

All the three toroids fit nicely into the LMB box, using neoprene washers to separate the coils. A single bolt goes through the centers of these coils and into the box's sides. A particular note here — insulate one end of this bolt with a bakelite or fiber washer — otherwise the bolt, together with the box walls, forms a shorted turn on the toroids and this adversely affects the response. The capacitors are mounted on a piece of Vector perforated board, and the whole thing is fastened into the little box, using angle brackets. On the box is mounted a four prong plug. This completes the bandpass filter unit.

The Discriminator Unit

The LC's for the discriminator is tuned in much the same way — using the calibrated audio oscillator and oscilloscope. The input links could be first wound right on — as indicated in Figure 2 — 9 turns for the Mark toroid, 5 turns for the Space toroid. Each LC is adjusted to its required peak frequency (2125 cps for Mark, 2975 cps for Space). These LC's are mounted into a small box similar to that for the bandpass filter. The resonating capacitors are likewise mounted on a piece of Vector board and this same board also receives the two 1N1695 silicon diodes and their RC loads. The discriminator box is wired up as indicated in Figure 2, and connections are made into an octal plug mounted on the box. This brings out the extra connections for driving a W6AEE presentation on an external oscilloscope.

Discriminator Voltage and Balance Adjustments

It would be well to recheck the filter peaks with the discriminator installed in the TU. Feed the audio oscillator into the TU's

[1]RTTY, Vol. 5, January 1957 issue, pp. 3-6

input, and measure the output voltage between 1N1695 cathodes using a 20,000 ohm/volt meter. The peaks ought lie exactly on 2125/2975 cps, and the developed voltage on each peak at least 75 volts. Polarity reverses between the two frequencies. This gives a total of 150 volts "swing." The 820 ohm resistor in the 6AQ5's B plus feed regulates the amount of drive into the discriminator, and it can be adjusted as needed to get 75 volts fom between the silicon diode cathodes.

However both Mark and Space voltage outputs must match if we are to obtain correct keying waveform into the teleprinter circuits. If there is a difference, some bias will be introduced, and also there will be an imbalance when the TU is receiving noise (no signal) and this affects the TU's performance on weak noise buried RTTY signals.

Balance is achieved by accurate voltage measurements on mark and space peaks, and adding an appropriate valued resistor across the RC load that delivers excess voltage — to bring it to equality with the other. (Note —always connect the voltmeter to the 1N1695 cahodes, never to the midpoint connection between the RC loads. We are designing a single ended discriminator output and we are not interested in the midpoint as fas as teleprinter keying is concerned).

It will be necessary to do this balancing right in the TU, delivering signal to the teleprinter line set for the current required (60 or 20 ma.). The simple TU power supply, not having perfect voltage regulation, has somewhat different voltages when the teleprinter loop is on mark (150 volts) and on space (about 165 volts) — and this tends to affect discriminator drive through the 6AQ5 tube powered off this same supply. Hence the discriminator peaks should be balanced with the teleprinter loop in action. Be sure to set the Input FSK reversing switch to normal 2125 cps mark, 2975 cps space.

On reversed input FSK setting when receiving "upside down signals," the discriminator will be somewhat unbalanced — one peak may read 80 volts, other reading 65 volts. Obviously a slight bias in the keyed waveform results, but it will be quite small — and the reversed input switching is purely a convenience to handle the occasional RTTY signal that happens to be upside down. Tell him to get his "sunny side up"!

This completes the alignment and balancing on the discriminator. On mark and space peaks, approximately 250 cps bandwidths at 3 db points are obtained. The linear slope between the two peaks—coupled with the zero-axis crossing detection — enables the TU to print narrow shift signals using the straddle method. And likewise the system is quite tolerant on drifting or mistuned signals — will still print in spite of a 200 or 300 cps drift in signal tuning.

A bonus feature of this discriminator setup is its use as a "calibrated reference" for setting up the transmitter shift. Using the markhold control, a "block" is inserted between the discriminator and the teleprinter loop. We can now tune in our own signal and compare its shift, relying on the discriminator peak responses as displayed by the double magic eye indicator. We set output FSK control to Mark, then to Space — and note the responses — and we adjust the shift control until both mark and space are maximized on the indicator. An easy way is to tune in the "fixed" part of the signal and maximize its response, then flip the sense switch to the moveable part and adjust the shift control until its response is maximized. Quite precise enough!

PART III—Transmitter FSK Circuit

The Mark III Terminal Unit, as described above, is a complete package in itself to operate with a communications receiver and a teleprinter. The remaining detail is the frequency shift keying diode circuit for the transmitter's oscillator.

The TU has a coaxial cable connector on its rear panel. As described earlier under the FSK Diode Driver Circuit heading, it delivers a squarewave voltage adjustable from zero to —50 volts by means of the front panel shift control. This voltage swings between zero (chassis potential) and a set value sufficient to provide the required on-the-air frequency shift value. Now it remains to describe the simple FSK circuit that can be easily attached to any of the common types of variable frequency oscillators as found in amateur transmitters.

The typical VFO is of the Colpitts or Clapp type, using a single tube, and generally its cathode is at a low RF potential — being part of the oscillator's feedback system necessary to sustain its oscillations. This cathode connection is a convenient point-of-attachment for our FSK circuit because it is at a relatively low impedance level and the added circuit does not upset the VFO's stability so much as it would if a connection was made directly to the "hot" or grid end of the VFO's tuned circuit. Also usually the RF is taken out from the VFO at the cathode.

The essential purpose of the FSK circuit is to provide a small capacitor that can be electronically switched in or out by the teleprinter signal pulses, and thus the switched capacitance influences the VFO's frequency to the required degree to cause the desired frequency shift. This capacitor, usually a small unit having a few micromicrofarads capacitance, is connected to the VFO's cathode, and its other end is connected to a "switching diode" which is in turn controlled by the teleprinter signal voltage through a suitable RF isolating and waveshaping network. The required parts are few, and consists at least of two capacitors, two resistors and a crystal diode; and all these components can be mounted say on a piece of Vector board and fastened in some suitable way next to the VFO circuit of the particular transmitter involved. A piece of coaxial cable, say RG-58A/u, of a few feet in length, then connects from the TU's FSK Diode Driver Output to the just-described FSK circuit.

A Reliable and Sure-Fire FSK Circuit

Shown in Figure 10 is the entire FSK circuit. This is the same circuit that has been in use at W6NRM and at many other RTTY stations since it was published almost nine years ago[2]. The 27 K and 120 K resistors forms a waveshaping and RF isolating network, together with the .005 mfd capacitor. The 1N100 germanium crystal diode is the switching diode, and it is polarized so that its "plate" end is grounded, and its "cathode" is connected to the RC network and the switching capacitor. The latter may have a value ranging from several micromicrofarads when it is connected to the cathode of an ECO type of VFO up to perhaps 10 or 25 mmfd when connected to a Clapp or Colpitts circuit having relatively large swamping capacitors in its RF loop. A suitable capacitor would be an adjustable Erie Ceramicon, of 3 to 15 mmfd type it being of course of the "NPOK" type (zero temperature coefficient) so temperature effects have a minimal disturbance on not only the transmitter's frequency but is shift as well.

It should be easy to devise a mechanical arrangement that will permit mounting of these parts right next to the VFO's cathode circuit, using the shortest leads possible. Some transmitter VFO's may be hermetically sealed, so it may be necessary to drill a very small hole to pass a thin insulated wire to the tube's cathode pin so the FSK circuit, mounted nearby, may exert an influence[3].

Another convenient method is to assemble the FSK circuit onto a Vector tube adapter unit that then can be plugged into the VFO tube's socket. The tube itself then plugs into the Vector adapter, and then it results in a ready made shifter system that does not harm in any way the transmitter's resale value. This arrangement has been applied to the Hallicrafter HT-32 exciter unit, such as used at W6CG, and it results in a stable and reliable FSK system. Likewise, there is a description on a HT-32 application by W8CAT[4].

Since the parts are so small and few in number it may be well to wire them into the VFO circuit directly, as in the Heathkit DX-100 type of equipment. In any case it should be possible to install the Figure 10 FSK system in any transmitter, whether the Heathkit VFO or the Collins KWS-1[5].

Diode Comments and FSK Circuit Performance

It will be noticed that a 1N100 germanium crystal diode is specified in the Figure 10 circuit. This choice is apparently a happy one now that these germanium diodes have been considerably improved over the years and that the FSK output from the Mark III TU is in a negative direction from ground. For many years vacuum diodes such as 6H6 or 6AL5 have been in use various FSK exciters at W6NRM primarily because in the earlier years crystal diodes were found to be rather unstable and hence caused erratic - temperature sensitive variations in transmitter frequency. However successful use of germanium diodes by W6CQI[6] and others prompted further tests on the 1N99/1N100 series of diodes by W6CG and W6NRM, resulting in the successful installation on the HT-32 at the former station, using the basic W6NRM circuit with a keyboard arrangement switchable from a series to parallel keying to accommodate the reversed FSK characteristic on the hetrodyne exciter operating on certain bands. (Special note — the

[2] "The Useful Diode Modulator," by W6NRM, CQ Magazine, April 1952

[3] "FSKing a Collins 32V Transmitter," by W6NRM/W9TCJ and W6ZNU, RTTY, May 1954

[4] Frequency Shifting your HT-32, by W8CAT, RTTY, June 1958

[5] Modification of Collins KWS-1 for Frequency Shift Keying," by W3PYW, RTTY, October 1957

[6] HT-32 Frequency Shift Keyer Addition, by W6CQI, RTTY, June 1959

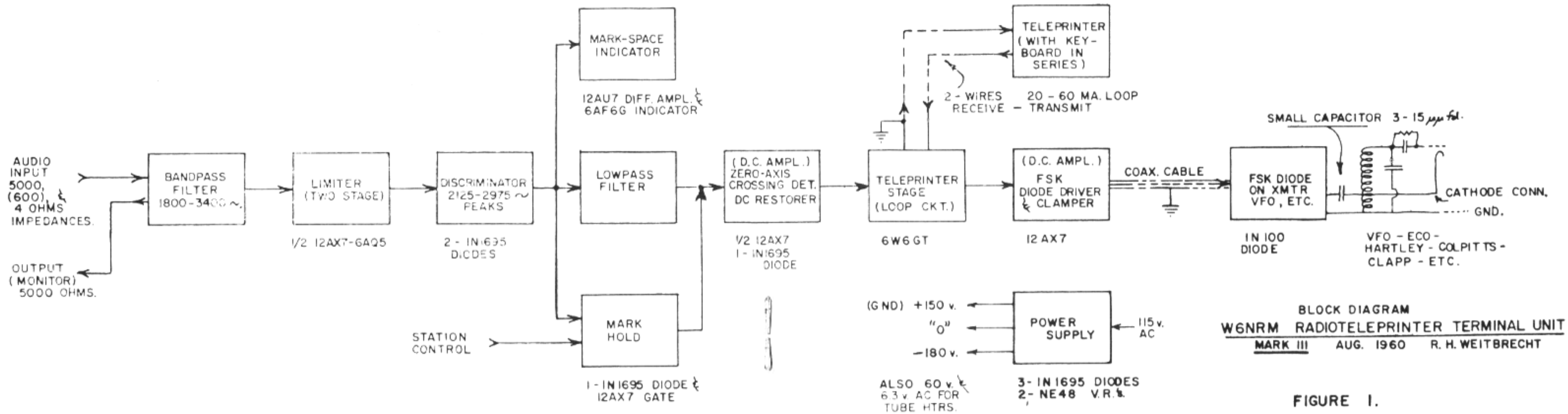
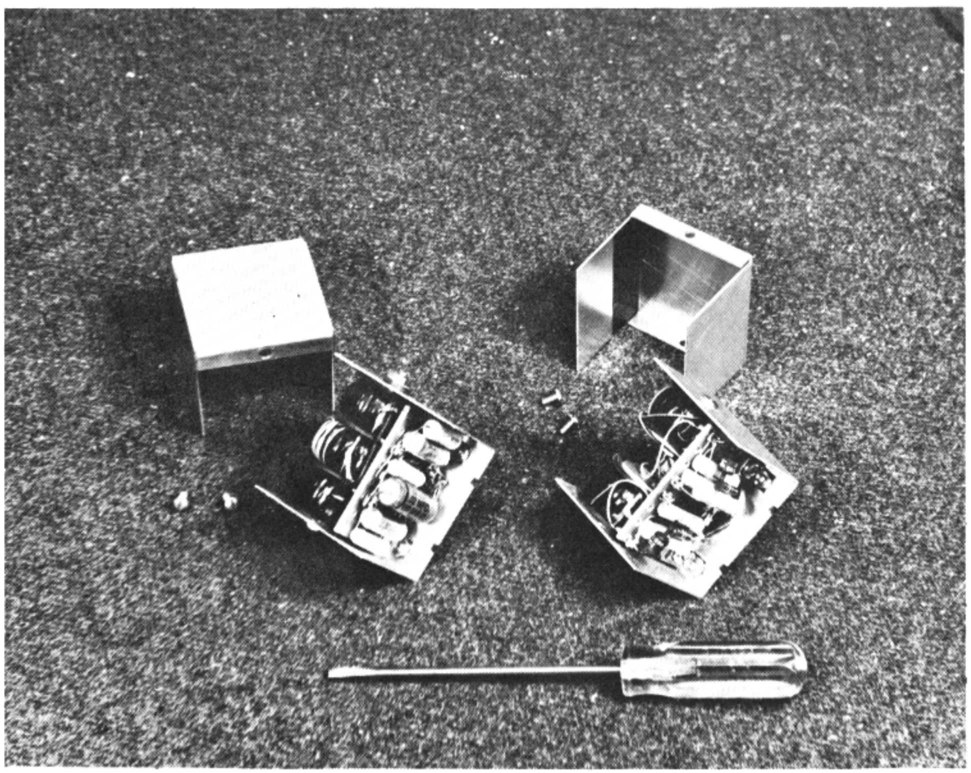
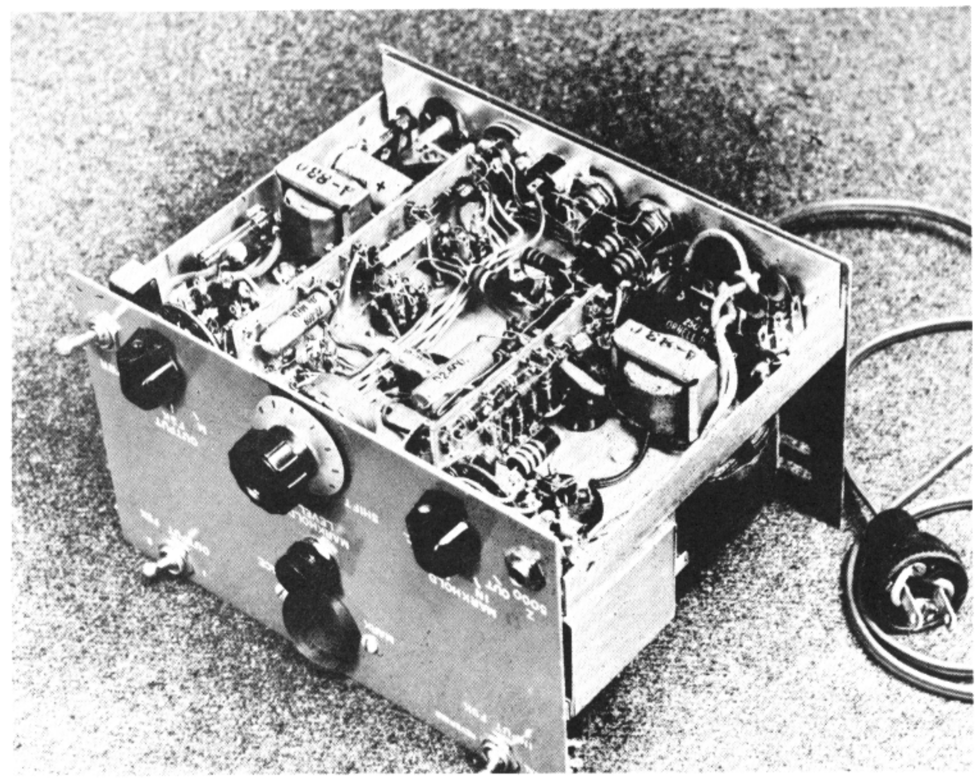
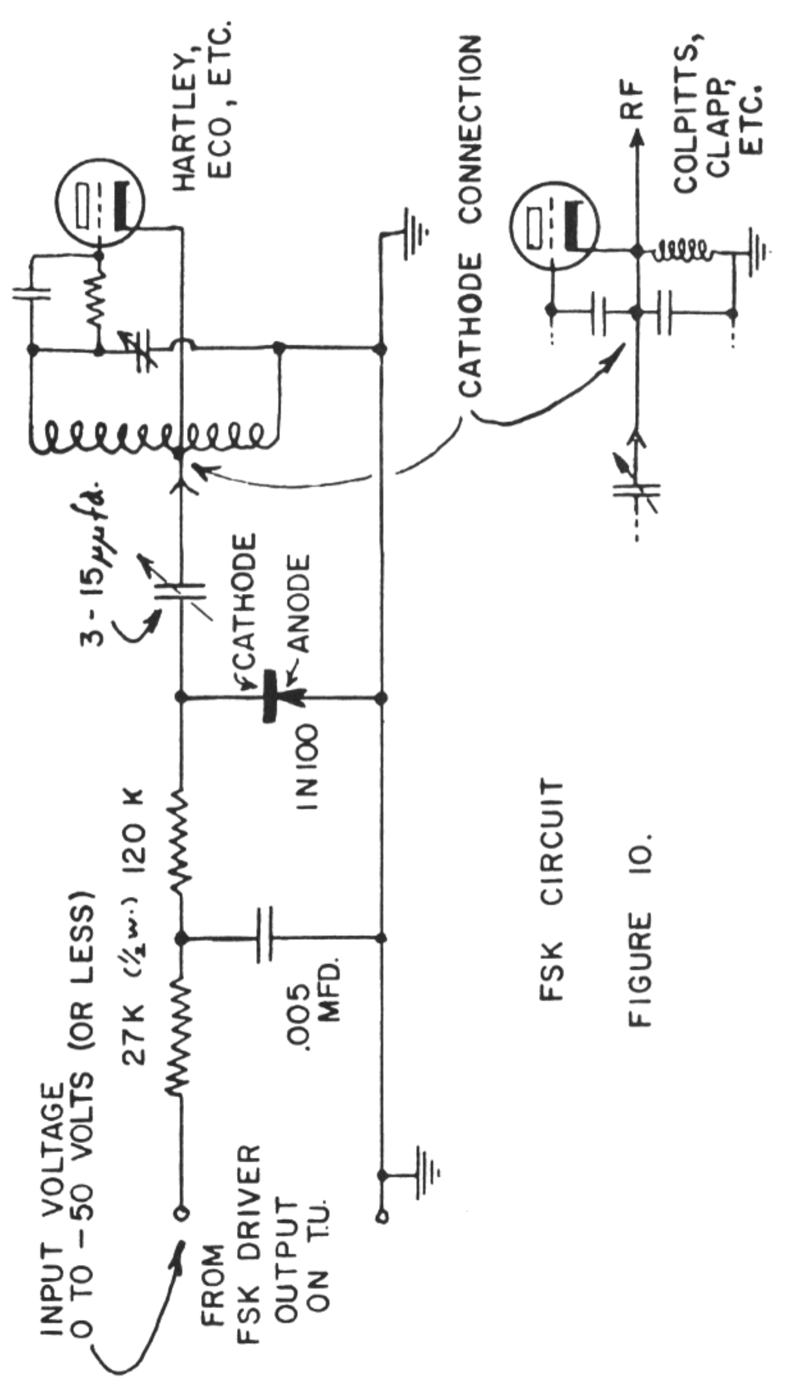

AUDIO INPUT 5000, (600), & 4 OHMS IMPEDANCES.
OUTPUT (MONITOR) 5000 OHMS.
BANDPASS FILTER 1800-3400 ~.
LIMITER (TWO STAGE)
1/2 12AX7-6AQ5
DISCRIMINATOR 2125-2975 ~ PEAKS
2 - 1N1695 DIODES
MARK-SPACE INDICATOR
12AU7 DIFF. AMPL. & 6AF6G INDICATOR
LOWPASS FILTER
MARK HOLD
STATION CONTROL
1 - 1N1695 DIODE & 12AX7 GATE
(D.C. AMPL.) ZERO-AXIS CROSSING DET. DC RESTORER
1/2 12AX7 1 - 1N1695 DIODE
TELEPRINTER (WITH KEY-BOARD IN SERIES)
2 - WIRES RECEIVE - TRANSMIT
20 - 60 MA. LOOP
TELEPRINTER STAGE (LOOP CKT.)
6W6GT
(D.C. AMPL.) FSK DIODE DRIVER & CLAMPER
12 AX7
COAX. CABLE
SMALL CAPACITOR 3 - 15 μμfd.
FSK DIODE ON XMTR VFO, ETC.
1N100 DIODE
CATHODE CONN.
GND.
VFO - ECO - HARTLEY - COLPITTS - CLAPP - ETC.
(GND) +150 v.
"0"
-180 v.
POWER SUPPLY
115 v. AC
ALSO 60 v. & 6.3 v. AC FOR TUBE HTRS.
3 - 1N1695 DIODES
2 - NE48 V.R.'s
BLOCK DIAGRAM
W6NRM RADIOTELEPRINTER TERMINAL UNIT
MARK III AUG. 1960 R. H. WEITBRECHT

FIGURE 1.







FSK CIRCUIT

FIGURE 10.

Mark III TU, described in this paper, has an Output FSK Sense Reversing Switch on its front panel to accommodate just this idiosyncrasy of the HT-32 type of transmitters, enabling quick correction of shift sense when shifting from band to band)

Anyhow, to permit on-the-air evaluation tests of this new TU, the W6NRM heterodyne VFO was modified for negative-going squarewave keying by substituting a correctly polarized 1N100 in place of the 6H6. The diode's polarity was determined simply by taking a battery and a voltmeter — and determining which end of the diode is the plate — by having that end on the positive terminal of the battery — and the voltmeter indicating a reading — showing conduction through the diode. These tiny glass diodes are so confusing sometimes it would be well to check in advance.

Coming to the point, it was found that the transmitter's frequency and shift neither changed a detectable amount (less than several cycles would have been noticed) during transmitter operation right from a cold start to a hot run after several hours of operation. So it seems safe to say that these 1N100 diodes are good enough for use in FSK circuits. It would be well to check their back resistance with an ohmmeter — which should indicate at least one or two megohms reading.

Doubtless the Varicap type of silicon diodes would work well in a similar circuit to that in Figure 10. These diodes are operated in a "reverse-bias" condition, and as a result they do not draw any current — and various voltages impressed on such a diode causes various values of capacitance effect to be generated — an a generally hyperbolic pattern. In other words, shift is not linear with applied voltage.

The germanium diode shifter circuit is quite perfectly linear with applied voltage, and hence the dial reading on the shift control is linear in respect to actual transmitter shift. This makes the shift adjustment smooth and easy to calibrate. (This circuit is operated in a forward bias condition — with diode conducting all the time.)

Adjustment on the FSK Circuit and Setting Up Shift

After the FSK circuit is installed in the VFO, it remains to adjust its switching capacitor so that approximately 1000 cps shift is generated on the lowest frequency used by the transmitter with the shift control on the TU panel turned to maximum (full 50 volts swing). Merely rotate the ceramic trimmer until the required shift is obtained. With some VFO's it may be necessary to use more switching capacitance, so pad up with some small fixed value ceramicons. In any case, begin with the smallest value the trimmer has — say 3 mmfd — and see how much shift is obtained as the TU's FSK output control is switched between Mark and Space.

Final adjustments of the shift value to 850 cps is done relying on the TU's calibrated descriminator peaks and tuning indicator, as suggested under the heading "Discriminator Voltage and Balance Adjustments" in Part II of this paper. Once set, should be quite stable as has been verified by long continued tests on the HT-32 at W6CG and on the W6NRM heterodyne exciter — the latter operating on 80, 40, or 20 meters without the necessity for readjusting shift when changing bands. On other transmitters using harmonic generators (multipliers) it will be necessary to adjust the shift control downwards as such rigs multiplies to higher frequencies. This is the reason for making the shift-control easily accessible — right on the TU's front panel — and the knob is equipped with a simple shaft-lock so that it will not be accidentally turned during ordinary RTTY operations on a single frequency or band.

PART IV—Concluding Remarks— "An Open Letter From W6NRM"

This so-called Mark III Terminal Unit is the third and latest completely operational RTTY system at W6NRM — supplementing (and ultimately replacing) the "Little Gems" TU[7] (the second operational system) that was designed in 1952. The performance of the Mark Three fully equals or exceeds that of the older TU and at the same time the transmit/receive circuitry is considerably simplified.

All these years the transmitting method at W6NRM depended on initial AFSK geneartion (2125/2975 cps) from a LC audio oscillator shift-keyed by the teleprinter keyboard contacts. This was originated by W2BFD over 13 years ago as a necessity for RTTY operations on VHF bands ("The VHF Teletype Society"). In order to enable direct FSK work on the low frequency amateur bands, the Little Gems TU had a FSK driver system to generate DC pulses to FSK a radiotelegraph transmitter. However to transmit from the keyboard, AFSK had to be first generated. Thus a "tone patching

[7] RTTY, April 1953

[8] QST, October 1948

concept" grew which included an electronic TD (still in operation), provision for retransmitting incoming signals, and a Conference Circuit setup. Ultimately this tone patching system became quite awkward.

I believe it was Bud Schultz, W6CG, who inspired my plans for a simplified TU system depending on DC patching only for the various machines and functions. Bud complained about the inconvenience of "tuning one's own signal in" for local copy — a procedure that is apparently followed by the great majority of low frequency RTTY'ers nowadays. We feel that there is no strong excuse in existence for such a procedure unless the meaning is to "monitor the transmitter's output signal." However there are other perfectly adequate monitoring methods, so the feeling arose that if one could generate local copy in a direct manner — say by having the teleprinter magnet and keyboard contacts in series in a suitable powered loop — then not only true local copy is obtained under any condition but teleprinter circuitry would be much simpler. This naturally brought up the problem of a suitable FSK circuit to be operated from such "Teleprinter Loop."

An "easy" salution would be to install a polar relay in this loop to obtain FSK keying. However this relay method involves a number of complications peculiar to the electromechanical device — such as that it is difficult to adjust properly without special relay test equipment, that its contacts tend to generate RF noise, that its windings require special biasing currents from additional power supplies, and — above all — that adjustments on currents through relay coils are somewhat uncertain when used in the typical amateur RTTY station due to lack of proper distortion measuring techniques. KØWMR, take note!

I have employed an electronic teleprinter keying circuit — using a 6W6GT triode connected stage with the teleprinter magnet in its plate circuit plus a 150 volt power supply in all my RTTY TU's since 1953, and I find it to be a most satisfactory distortion-free circuit. Circuit data on this was made available privately from W6NRM/W9TCJ, and a number of RTTY'ers in the Chicago and the Far West areas have confirmed my findings. Moreover, one experimental TU for autostart RTTY work on low frequency amateur bands uses this plate circuit keyer[9].

Don Wiggins, W4EHU, published a paper[10] dealing with these electronic keyer designs — which confirms the performance of the plate circuit keyer. In that paper a separate independent power source was suggested to permit "grounding one side of teleprinter line" yet retain the distortion-free characteristics of plate circuit keying.

It is a moot point as to whether "grounding one side of teleprinter line" is necessary because most landline TTY circuits may be and are often indiscriminately hot at 150 volts with respect to machine ground. Or else the line itself may be floating. The teleprinter machine magnet coil appears to have adequate insulation to frame ground in any case. Still it is considered by many that one side of the teleprinter line should be grounded at least to minimize shock hazards, and this is a very good reason.

During the summer of 1960 I did research work on circuits for obtaining electronic FSK drive directly from a "teleprinter loop" containing teleprinter magnet and keyboard in series. Satisfactory performance was obtained by sampling the loop voltage developed across a resistance ("R_t") in the 6W6GT cathode. This lead to the design of the simple yet effective adjustable-FSK-sense amplifier circuit which now delivers the "FSK Driver Output."

Power supply arrangements were studied in a new light and it was found that the 150 volt Teleprinter Loop power source could just as well power the entire TU — thus simplifying the circuitry. With particular attention paid to discriminator voltage balance — as explained in Part II — it was determined that large clumsy voltage regulators are untirely unnecessary.

"Grounding of one side of teleprinter line" is an incidental yet welcome feature of this TU design — obtained by grounding its power supply's B plus. This was done to simplify the FSK Driver circuit, and now its negative going DC pulses, direct from its plate, circuit, drives a 1N100 diode shifter circuit in an optimum manner.

My interest in the Markhold circuitry was inspired by conversations with F. C. Bartlett, W6OWP, who developed various markhold arrangements to keep his teleprinter quiet during no-signal periods as is common during MARS/RATT net operations. Studies and experiments at W6NRM showed that several markhold arrangements of varying complexity could do the job — "instantaneous" as well as "fast attack-slow release," or "noise-gated" versions. The second method was chosen according to particular circuit and operational considerations. And this Markhold circuit is precisely where "Station Control" comes in to accomplish the terminal unit changeover between receive and transmit modes. Very simple and direct way of doing that — "The Cards Fell into Place!"

[9]The W9TCJ Autostart System, RTTY, June 1957

[10]Vacuum Tube Keyers, by W4EHU, RTTY, July 1957

Recently, W4EHU has published a most interesting paper — this time involving "Interference Characteristics of FSK Systems"[11] He gave the impression that the mark and Space points should lie on a linear discriminator characteristic and implied that it is one of two general types of audio TU's in common use. However to my knowledge all TU's—whether "linear" or two-filter type —always have located their peaks right on the Mark and Space points. This seems to be a logical and effective way of getting maximum discriminator swing from the telegraph FM squarewave signal properly tuned in. It also enables maximized response on any tuning indicator system—oscilloscope or magic eye type—connected into this discriminator system. Having peaks—in either linear or two-filter circuit — on Mark and Space frequencies equalizes noise effects so they tend to be effectively cancelled out in the discriminator output—thus enabling the TU to translate weak noise buried signals.

About the only justification for wideband linear discriminator appears to be in radio-photo facsimile reception where all shadings between black and white must be linearly reproduced. Don't forget, RTTY signals are essentially squarewave modulations at a basic 22 cps rate as generated from "on-off" contacts of a keyboard, and it appears that wideband linearity would not give improved results as compared to "maximized linearity" (as in this Mark III TU) or its close relative ,the two-filter system. Having discriminator response maximized at Mark and Space areas brings in the bandwidth consideration—so the 2125 cps (and the 2975 cps) "subcarrier" with its 22 cps intelligence is passed through its appropriate "hatch." As the intelligence is essentially squarewave, we will add its third harmonic to obtain a fair reproduction and this turns to be 66 cps. Doubling this frequency, we obtain a bandwidth of 132 cps—at least the width of the above mentioned "hatch." In this Mark III T_u the bandwidths are about 250 cps at 3 db points, so it works out well for accommodating off-shift signals as well as leeway in receiver tuning. As Don pointed out, selectivity is all but helpless in the discriminator circuit against QRM on account of the saturating effect on all signals —desired and undesired—by the preceding limiter stages. Hence the simplest tuned circuits suffice to enable the discriminator to detect and handle transitions between Mark and Space.

The proper place to introduce selectivity in any TU is in its input circuit, before the limiter. This is where the bandpass filter comes into the picture—aided and abetted by any receiver I-F selectivity—and helps define the "RTTY channel" to minimize or eliminate adjacent channel or intra-channel interfering signals. The three-toroid filter presented in Figure 2 is just an approach towards input filtering. A new type of filter could be constructed using two pi-type sub-filters—each say 250 cps bandwidth— and paralleled so the Mark and Space frequency areas are passed through into the TU yet a good "null" exists in the 2250 cps area. This is the "comb filter" proposed by Don and quite a few others. Perhaps the three toroid circuit could be elaborated a bit with a fourth LC circuit to form a "trap" to produce a "valley" in the 2550 cps area. Thus there is plenty of room for design and experimentation here, and the plugin arrangement was made with that idea in mind. In the near future I hope to have some improved filters for this Mark III TU.

Needless to say—to enable the bandpass filter, of whatever design, to work at its best efficiency, the receiver audio stages *must not* be allowed to overload on a strong adjacent interfering signal — otherwise the audio circuits themselves become a limiter in their own way and nullifies the beneficial effects of the bandpass filter. This means that in the face of severe QRM from an adjacent strong signal, it will be necessary to disable the receiver's AVC, and reduce its audio gain so that the QRM does not swamp out the desired RTTY signal.

The Mark III TU is a straight FSK converter, making use of both Mark and Space channels on a continuous basis. No provision for mark-only or space-only copying have been included. Such features have a way of compromising TU design, rendering it less than optimum for straight FSK reception. Mark only/Space only systems require a different approach using regulated gain controls—as different from limiter circuitry—and as such is entirely outside the scope of this paper.

[11]RTTY, November, 1960.

All in all, the most important part of this Mark III Terminal Unit is its unique "Teleprinter Loop" system – permitting appreciable simplification of teleprinter machine connections, transmit/receive control, mark-hold system, and so forth–resulting in a compact yet optimally performing audio-type FSK converter. It is a worthy replacement for the veteran Little Gems TU with which I have had countless hours of solid RTTY QSO's over the years past. Either TU is a sensitive instrument that readily "reaches into the noise" to capture the fleeting RTTY signal and delivers it to the teleprinter machine.

I am well satisfied with the general design of the Mark III TU. I believe it is the simplest, smallest possible yet optimum FSK system, containing the fewest possible tube and parts–and at the same time including the above mentioned Teleprinter Loop–a most useful circuit for transmitting from the teleprinter's seriesed keyboard with its "local copy" advantage. However there are plans for a transistorized version of this TU, a diversity system, and further repackaging. Time will tell. In the meantime I would be glad to have comments from anyone in regard to this TU circuit. And of course I am available for help in any way I can. Good luck!

73 de W6NRM

Nov. 22, 1960 Bob Weitbrecht

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KH6AED 4480; KH6ANR 992; KH6IJ 4480.

KL7ALZ; KL7MZ.

G3CQE; TG9AD; VE2ATC; VE3OE 100; VE4BJ 816; VE7TF; VK3KF 2; YV5AFA 3; ZK1BS; ZL1WB; ZL3HJ; ZS1FD 6.

DX-RTTY

BUD SCHULTZ, W6CG
5226 N. Willmonte Ave.
Temple City, California

Hi Gang!! The big news this month originated right here at Temple City. The first six WAC-RTTY awards were finally completed and sent to the qualifiers. Jim Hepburn, VE7KX, is the proud possessor of the first award having topped his nearest competitor by three months. The other five stations receiving this award were W2RUI, W7LPM, W6AEE, K6OWQ, and W6CG. This completes another milestone in the story of RTTY and the SCARTS hopes that many more of "the green key fraternity" will receive their WAC-RTTY certificates during the coming year. To qualify for this award send confirmations showing two-way RTTY QSO's with the six continental areas of the world to the address at the top of this column. After examination by the committee your QSL's will be returned to you. The Award Committee would like to thank Frank Wood, W6UQL, for the beautiful hand lettering job on the certificates!!

Due to the distractions of Holiday activities coupled with poor band conditions the reports of overseas operations has dropped off to a mere dribble this month. Henry, ZS1FD, continues to make news with his daily contacts into the States with a fine solid FSK signal. In addition to his Stateside contacts Henry had QSO's with VK3KF, ZK1BS for a couple of "firsts." He also continues working Europe in the person of G3CQE and G3BXI. Ed, K3GIF, reports that ZS1FD is arriving in London about April 1st with his XYL on a tour of Europe and expects to visit Bill, G3CQE, Jim-G3BXI and other G RTTY stations. Gene, K6DSQ, sends word that Henry worked another first in PY1LM. PY1LM works on 14,070 Kcs daily about 2130 GMT. Nick, KL7MZ, printed both PY1LM and ZS1FD but failed to work either although Henry has printed Nick on several occasions down in Capetown. YV5AFA in Caracas still puts a booming signal into the States on 14,090. He has a Johnson KW, 51J-4 receiver and a Gonset tri-bander so if you are still hurting for a South American contact Joe is a real good bet! VK3KF's trip to New Guinea and Cocos Island was delayed due to a back injury but he is OK now and will probably be off the air until February.

In last month's issue there was a slight mixup in the identification below the photo of "some outstanding DX'ers." If you read it from R to L it will all come out OK. Sorry, fellers, but I never was quite sure which was my right hand and which was my left. My sincere apologies for this error.

Ye Editor in Chief wants me to remind all of you not to overlook the Eighth Anniversary Sweepstakes on the week-end of February 24, 25, 1961. We had hoped to change the scoring to allow a bit more for "out-of-the-country" contacts but insufficient time to make the necessary changes forced us to abandon the idea for this time. However, let's all give the DX gang a good listen during this contest Week-end and do ourselves a favor at the same time.

That's 30 for this month but I'm looking forward to hearing from all you before my next deadline. Remember – this is your column so help! help!

73 and Happy Hunting

Bud W6CG

Following is the up-to-date RTTY-DX standings as listed in my file. If your score is not listed or is incorrect please let me know as soon as possible.

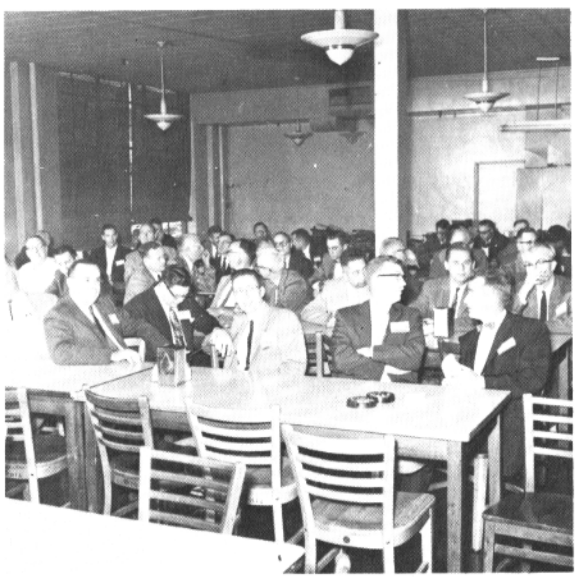
DX-RTTY BOX SCORE
(Countries worked on 2-way RTTY)

W6CG	20
W2RUI	18
W6AEE	17
W7LPM	16
W2JAV	15
K6OWQ	14
ZK1BS	14
W6TPJ	13
VE7KX	11
ZL1WB	11
KL7MZ	10
KL7ALZ	9
G3CQE	9
W6MTJ	8

–0–

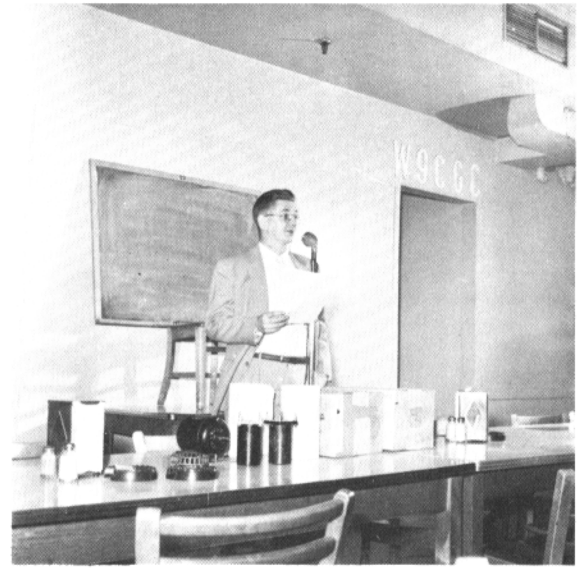
CHI - RTTY

Group inspects electronic distributor using beam switching tube belonging to K9BRL, Burt Jaffe



Overall view of group at technical discussions

October 9, 1960



George Boyd, W9SPT, official host for Hallicrafters

Representative of the RATS reports on progress of the WØBP memorial station

Photos by John L. DuBois, K9YHQ