RTTY

Seasons Greetings

RTTY, INC.

Merril & Margaret Swan

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NEWS OF AMATEUR RTTY

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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: Model 15, less power supply and table $75.00. Keyboard for 15,10.00. Keyboard for 19,15.00. Power supply for 19,20.00. Power supply for 15,10.00. Model 14 TD $25.00. Model 14 KBD (tape puncher) 40.00. KP4GN, P.O. Box 532, Guyama, P.R., 00655

FOR SALE: One model 26 machine like new $75.00. One model TG-7B top condition $120.00. One model 14FRP-23 non-typing chad punching same as on page 21 of the HAM-RTTY book (by 73) top condition, 40.00. One cover for model 14 tape printer, like new will fit 14 reperf, W5SKU, 5864 Louisville Street, New Orleans 24, La.

FOR SALE: Model 14 RO tape printer, w/sync mtr (new condx) 35.00. 14 S&R type reperf w/sync mtr (new condx) 35.00. 14 FOX TEST TD w/sync mtr 45.00. 14 TD w/sync mtr 40.-00. Iron horse perf. 30.00. 15 keyboard (comm) 10.00. XRT 200 tables 10.00. PET 201 table (perf table) 10.00. TW-200 electric tape winders, 5.00. BPREI reperfs 100.-00. FGC TU, 50.00. O5FR exciter 10.00. AM-103/BU TTY TU 7.50. DX-100 75.00. TRIEX 40' crankup tower & ARZZ rotater 85.00. About 75 lbs. of small parts used to repair all types of TTY, 14, 15, 19, 28, etc. 100.00. Two Model 28 table model cabinets 15.00. One 28 RO base, 20.00. One 28 sync motor, 15.00. Misc. amateur gear, write for info. Moving, must sell. W6LSG, 69 Wistaria Avenue, Arcadia, Calif. 446-8038.

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WANTED: One model 26 teleprinter in working condition. Will pick up within 150 miles of Barstow. Will purchase waiver, but can not pay over $50.00 cash or will consider trades. K6HIJ/W0AHU, 26335 Community Blvd., Barstow, California 92311.

FOR SALE: Model 14 TD and typing reperf, $100.00 for both. Will consider trades. W9FRU, 127 Westlawn Drive, R.R.4, Decatur, Indiana 46733

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CURRENT RTTY RECEIVING TECHNIQUES

Irvin M. Hoff, K8DKC
1733 West Huron River Drive, Ann Arbor, Michigan 48103
and
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4626 Rambo Lane, Toledo, Ohio, 43623

1. General Background

Several very interesting articles which have outlined certain FSK receiving techniques that come under the definition of "two-tone limiterless" have appeared in recent months in amateur journals. Jim Haynes, WA9IBB, first pointed out work done in this field in his fine review series that began in November, 1962.[1] In June, 1963, Frank Gaude (then K6IBE but now residing in Huntsville, Alabama), introduced the TU-D converter utilizing the two-tone limiterless linear (AM) detection system.[2]

Although generally unfamiliar to amateurs, commercial use of similar techniques had already been standard for many years. An even more advanced circuit has been patented by Page Communications Engineers, Inc., and used in their equipment since the late 1950's. Their work on this patent was supported in part by Signal Corps contract.

In September, 1963, Bob Weitbrecht, W6NRM, further explored the two-tone technique and adapted the dual-slideback system to his Mark III/IV converters.[3]

Also in September, 1963, Gaude further discussed two-tone methods and proposed the TU-E converter with a block diagram.[4] This converter was to utilize very narrow channel filters in an audio mixing system that would easily adapt to various shifts.

In January, 1964, Vic Poor, K3NIO, examined the deficiences and limitations of the dual-slideback systems as used by K6IBE, W6NRM and others. He introduced a variation of the patented[5] DTC (*D*ecision *T*hreshold *C*omputer) circuit which satisfactorily overcomes the basic disadvantages of other two-tone limiterless systems.[6]

In the same month, the previous works of Gaude and Weitbrecht were reprinted.

In February, 1964, Gaude continued his comments on two-tone limiterless reception and discussed the completed TU-E, which was not published. Irv Hoff, K8DKC, provided interested parties with a schematic. This converter still used the dual-slideback detectors.[8]

Since the DTC was protected by patent, Gaude was attempting to develop a new circuit which he hoped would have some commercial value.

A solid-state version of the TU-D was offered by Rene Belfi, DL3IR, in June, 1964,[9] and another version, using tubes, by G. E. Blanchett, VE3BAD, in July, 1964.[10]

In May, 1964, Poor contributed an outstanding paper on selection of filters for two-tone limiterless systems. In particular he pointed out the importance of a good post-detector, minimum band-width, low-pass filter.[11]

Anyone wishing a full explanation of the two-tone limiterless (linear AM detection) and its merits is invited to read these and other articles.

2. Two-Tone Limiterless Defined

This system has been known since the thirties, and is only "new" to amateur RTTY enthusiasts.

A teleprinter needs on-off DC pulses for its operation. The "on" portion is called "mark" and the "off" portion is called "space".

FSK reception consists of two alternating frequencies being received; the one called "mark" and the other "space". As each of these contains on-off pulses, either one could be used alone to provide complete information for the printer.

The "two-tone" method, then, uses separate linear systems to individually receive and detect mark and space. These outputs are then combined in such a manner that the printer can operate normally from one or both channels, depending on conditions at the moment. This requires some form of automatic threshold correction, which is provided in all such systems.

Beard and Wheeldon, in a monumental work,[12] set up criteria for meeting the optimum two-tone system. This included filter band-widths for the mark and space channels equal to the Baud rate in use; or 45 cps wide for 45 Baud. Poor[11] pointed out this ideal band-width could not be met from a practical standpoint. He suggested that 54.6 cycles band-width (or wider) could actually be used.

3. Variable Threshold Correctors

It was mentioned in Section 2 that a printer needs on-off pulses to operate. These pulses all should be uniform length, except for the stop pulse which is usually longer. If the pulses vary from 22 milliseconds, they are said to be distorted. A normal printer can accept up to ±45 per cent distortion.

In an FSK converter, at some point prior to the printer, there is normally a "slicer" that "decides" whether the incoming voltage should be considered mark or space. It then takes this incoming voltage, regardless of amplitude, and changes it to a specific output level to operate the printer. The voltage at which this slicer changes from negative to positive output is called the threshold, usually zero.

Various authors refer to the "decision point". This can be defined as a point on a waveform (relative to mark and space voltages) where the slicer output will change from mark to space if that waveform is applied to the input of the slicer.

Consequently, the voltage applied to the slicer should vary uniformly around its threshold in order to present correct pulses to the printer.

The job of the variable threshold corrector is merely to present this uniform (symmetrical) swing around the threshold. It must be able to do this whether receiving equal amplitudes from the mark and space channels or not. If properly designed, it will present symmetrical output from only one channel, or a greater output (still symmetrical) if the second channel is present to any extent.

A storage-system is provided for retaining the signal level of each channel to adjust the threshold level of the detector. A clamp device is included to provide the slicer with a symmetrical voltage swing.

It is the action of this storage-system that allows excellent copy on mark-only or space-only in this type of converter. However, it is this same storage-system that provides problems at times; particularly on keyboard-speed reception—a peculiarity of amateur frequencies.

4. Threshold Correctors for FM Systems

Such a device can well be utilized in FM converters using pre-detection limiting. Some military converters use a simple clamp circuit to provide a symmetrical output swing to the slicer. These are usually AC-coupled and do not work too effectively on slower keyboard-speed. Also, they do not have similar storage-systems to provide information in the event one tone completely fades for a short time.

In a well-designed FM unit, noise output at the discriminator will tend to balance, and peak variation will be less than peak signal voltage. If this noise variation is kept within reasonable limits, a variable threshold corrector can provide many of the benefits it does for the two-tone limiterless system.

To keep this variation to an acceptable minimum, however, a low-pass filter is necessary—the minimum variation coming from a minimum band-width filter. This filter tends to integrate the noise spikes for minimum output variation. With such a filter, action of the threshold corrector approaches that for two-tone limiterless reception.

Such a filter would theoretically be only 22.5 cycles wide, but the practical limit is about 27.3 cycles.[11]

Observation of the noise variation at the output of a normal discriminator with a DC-coupled scope shows peaks often going to 70-80 per cent of normal signal level. After a minimum band-width low-pass filter, however, these same noise spikes rarely exceed 30-35 per cent peak signal voltage.

Variable threshold correctors have not been successfully used in the past on amateur converters primarily because they have not employed minimum band-width low-pass filters. Several of the better units have used simple, single-section RC filters, but such filters do not cut off sharply enough to be highly effective.

5. Use of Low-Pass Filters on Two-Tone Systems

The comments in Section 4 regarding the use of low-pass filters aply equally to two-tone limiterless converters. However, the channel filters on these units are normally more narrow and the improvement noted is not as significant. In the unlikely instance that minimum band-width channel filters are being used, no low-pass filter is needed. As the channel filters are narrowed, the post-detector low-pass filter is altered in its requirements. It is not likely that amateurs will use channel filters narrow enough to dispense with the low-pass filter, not even with the 70-cps Collins filters that a few currently use.

It is interesting to note that the dual-slideback system does not readily adapt to any type of low-pass filter ahead of the threshold corrector portion. Even if the impedance levels were drastically lowered to make this possible, at least two such independent low-pass filters would be required.

Although both Gaude's TU-D and Weitbrecht's Mark III/IV use low-pass filters, these filters not only are the simple RC type, but follow the threshold corrector system. As the noise spikes can adversely affect the threshold corrector, these systems cannot offer maximum performance in adverse conditions. Further, both of these units use quite broad channel filters, compounding the problem.

Most military converters use good LC low-pass filters. These often give better results than amateurs get with other converters. However, these low-pass filters usually are intended for faster speeds than 60 words per minute. An improvement of 2:1 to 10:1 could be realized on such units with a minimum band-width low-pass filter designed for 45 Baud when operated at that speed.

The addition of a good low-pass filter to any converter – two-tone or FM – will do more to improve the performance than any other single step taken.

6. Selection of Channel Filters

Channel filters for the two-tone system can be as narrow as 54.6 cycles.[11] (Section 2) Under many conditions, though, the signal is such that it would take a wider filter than minimum to get best results. The width of the incoming signal can be modulated by multi-path conditions and other phenomena. Also, Hancock and Weiner have noticed up to 50 cycles shift in frequency of signals due to multi-path timing delay. They have observed modulation band-widths ranging from 20-150 cycles in the 3-30 meg. spectrum.[13]

It is likely that use of minimum band-width channel filters would be restricted to certain types of conditions and that for general work their choice would not be suggested.

Filters of approximately 100-175 cycles would probably work quite well for most amateur conditions on two-tone units.

Use of very narrow channel filters requires some special means to allow for receiving the various shifts that amateurs claim to be 850; as well as for intentional narrow shift work. Many audio mixing schemes have been proposed, but most of them are non-linear—a variation in input having a different effect on the space channel from the mark channel.

With extremely narrow filters, any drift in the received signal must be immediately corrected. Heavy distortion can otherwise result. In the process of retuning, it is easy to go the wrong direction and momentarily lose the signal completely.

With narrow filters, a change on the scope pattern leaves the operator uncertain if the signal has drifted or has merely faded to some extent. Thus, one is seldom certain if the signal is actually tuned correctly.

When not tuned correctly, the effective signal-to-noise ratio can also be sharply reduced.

On FM units, a good band-pass input filter makes a very great improvement. The "capture effect" of the limiter is narrowed to those frequencies which include mark and space; rather to whatever band-width the selectivity of the receiver offers—usually 2.1 to 2.5 kc. This filter should be at least 1.0 kc. wide for 850 shift, and probably not over 1,150 cycles wide. This would include the 3rd order harmonic at 1,000 cycles and the 5th order at 1150 cycles.

Use of pre-limiter channel filters gives excellent results, as Wiggins has pointed out.[14] These filters should probably be 4-5 times the Baud rate, or approximately 200 cycles or more for 45 Baud that amateurs use.[11]

However, the extra cost of these filters would hardly be worth the small improvement shown over a good pre-limiter band-pass filter.

Use of fairly narrow post-limiter filters, such as is common in at least one commercial unit presented for amateur use, can give excellent noise balance from the discriminator. Much greater improvement could have been obtained by using these same filters ahead of the limiter with a modest cost discriminator following the limiter.

Use of 200-250 cps channel filters in an FM system either before or after the limiter restricts its ability to copy a wide range of shifts.

Many authors have mentioned that a linear discriminator for use with FM systems offers the greatest number of advantages.[14] These linear discriminators are best made with very low "Q" circuits—typical values being 5-20 "Q". Various inductors can be used, including the 88-mh. toroids, if properly loaded. (Their normal, unloaded "Q" is around 200 at these audio frequencies.) An excellent circuit is obtained through use of TV horizontal oscillator coils.

Any of the filters discussed in this paper can be easily obtained from the Electrocom Corporation in South Bend (contact Burt Jaffe, K9BRL). This company specializes in amateur RTTY equipment.

7. Linear Phase Filters

Maximally linear phase filters (Thomson variation of the Bessel filter) are very likely the optimum type for use with keyed pulses. Van Brunt[15] has worked out data on the construction of such filters using 88 mh. toroids readily available to amateurs at low cost.

However, the little improvement such filters provide (when compared with standard 3-pole Butterworth design of less sections at lower cost) makes their use debatable when other factors such as price, etc., are considered.

8. Filters Using One 88-MH. Toroid

Most amateur converters publicized in the past have used only one 88-mh. toroid with a capacitor for each channel filter. This *can be* a satisfactory method, but not unless the very high "Q" of the toroid is handled correctly. Tom Lamb, K8ERV, has plotted the curves of several single-tuned filters against an ideal curve suggested by Dr. Nyquist.[16]

Fig. 1 shows these curves. Filters having a circuit "Q" of higher than perhaps 25 or so would not meet acceptable standards. Since this represents a rather broad filter with quite broad skirt selectivity, their correct use would result in a rather linear curve which would be excellent for FM systems with limiting. To achieve this low "Q", the filters may be placed in the plate circuit of certain tubes as was done in the TU-D, or resistors as in the Mark III/IV units. In any event, to offer proper bandwidth using a fixed inductance, each filter is swamped with a different load.[17]

To properly design even simple filters without merely copying a previous circuit, elaborate testing equipment is needed, including a good AC VTVM, audio generator and audio frequency counter.

9. The ATC Circuit

The dual-slideback system also offers problems with voltage matching and requires use of center-tapped transformers or inductors. We shall now show another less-complicated system which does the same job and avoids most of the disadvantages. This we have called the "ATC" or *A*utomatic *T*hreshold *C*orrector.

It was derived from a Press Wireless patent[18] that seems to have gone somewhat unnoticed by many who infer they have since developed similar circuits independently. The "Assessor" circuit of H. B. Law[19] is essentially identical, although the Press Wireless patent was issued in 1948 as a result of work done prior to 1944 by Bob Sprague. The same circuit forms the basic system used by Elmer Thomas in the DTC patent.

The Press Wireless circuit was only AC-coupled and would not work well on keyboard-speed typing. In 1961, Dick Hilferty, W2HEY, Chief Engineer for Press Wireless, added two extra diodes to remedy the situation by providing a DC path in addition to the AC storage-system.

As far as is known, this particular circuit was never applied to limiterless operation until Harold Carlson, former Chief of the Radio Division of Associated Press, sent the circuit to Tom Howard of Altronics-Howard for possible use in 1963. A form of this circuit is in use in the current Altronics-Howard Model "L" converter, and follows the simple RC low-pass filter.

10. Theory of the ATC Circuit

Refer to Fig. 2—if voltage is placed at point *V*, some current will flow through R_1 and R_2 to ground. If the resistors are equal, the voltage at point *X* will be ½ the original voltage.

Refer to Fig. 3—if positive voltage is applied to point *V*, there will be *no* current flow, as D_3 (and D_4) will not conduct. Point *X* now "dangles in space" and has no voltage. If negative voltage is used, then current flows as in Fig. 2, as both D_3 and D_4 conduct. The voltage at point *X* is negative and ½ the original value.

In Fig. 4, if negative voltage is used, the situation is similar to Fig. 3. If positive voltage is used, C_1 is charged by drawing electrons through D_2. With positive voltage, again there is no current flow through R_1 and R_2 (as in Fig. 2).

If the positive voltage falls quickly to less than ½ the original input level, C_1 then has a discharge path to ground and current will flow. Since C_1 has negative voltage on the right side, this current flow will be as in Fig. 3, and the voltage at point *X* will be negative.

C_1 can discharge at any time the input voltage falls to less than ½ the original positive input, or goes negative.

If the input voltage alternates from positive to negative, there is no output voltage at *X* with positive input; on negative input, C_1 not only dicharges but D_1 conducts. Consequently, the output at *X* is the combination of these two voltages, in this case equalling the original input voltage.

Thus with on-off negative input, there is ½ on-off negative output. With on-off positive input, there is still ½ on-off negative output for a short time, depending on the time constant of the circuit.

With alternating negative and positive input, there is negative output voltage equal to the sum of plus and minus voltages when the input goes negative, and no output voltage when the input goes positive.

11. How the ATC Works

The incoming RTTY signal alternates from mark to space to provide information for the printer. Mark is then an on-off keyed pulse, as is space. Assume a mark-only condition where mark is negative voltage. (The detector circuit can be arranged in any manner that will correctly operate the particular slicer used.) This then would be an on-off negative voltage.

Refer to the complete ATC circuit in Fig. 5—if negative voltage is used at the input; it goes through D_1 (is blocked from ground by D_2), R_1, R_2 and D_4 to ground as in Fig. 3. At the same time, it is blocked by D_3 and charges C_2.

If the negative input voltage is steady, the output voltage at point *X* is negative and ½ the input voltage. If the negative input voltage is an on-off signal, the output becomes positive (½ what the input voltage had been) during the "off" portion, and negative (½ the input voltage) during the "on" portion.

Thus with on-off negative input, the output is ±½ the input voltage, and point *X* is symmetrical around zero with only negative input.

The opposite situation quickly can be shown for on-off positive input voltages—there the output again will swing ±½ the input voltage—during positive "on" voltage, the output will be +½ (through D_3, etc.), and during the "off" portion, the output will be −½ (what the input voltage had been) from the discharge of C_1.

If mark and space equally appear at the input (as occurs with no fading and correctly tuned), the output is the sum of the voltage through the diode plus the voltage from the capacitor; so that full (rather than ½) voltage then appears at point *X*.

If one tone fades completely, the output voltage remains a minimum of plus and minus ½ the input voltage remaining. With both tones present to some extent, the output is equal to the sum of ½ of each of their voltages. It is this feature which assures excellent copy on selective fading[2] where one input tone might fade completely for awhile. It is also this feature that allows intentional copy of mark-only or space-only.

12. Advantages of the ATC Circuit

The ATC circuit is a simple system using only a few parts. It can be readily used after a minimum band-width low-pass filter, a feature few other circuits offer. This allows noise to have a minimum effect on the mark-space decision, particularly when one tone is momentarily absent.

Due to the simplicity of the circuit, minimum bias is introduced, as the output voltage is symmetrical. The length of time this is true, of course, depends upon the time constants selected.

Normal detectors without threshold correction need both tones at the input (except where the slicer has been manually readjusted to simulate the action of the missing tone); for minimum distortion these tones must be equal in amplitude. If one tone fades momentarily into the noise, there is no information from that channel, and an error must be printed. This frequently allows the printer to become unsynchronized, and a disproportionate number of errors result. Consequently, even a normal converter with limiter could greatly benefit from the use of such a system as the ATC. Correct tuning is no longer a basic requirement for presenting a symmetrical output voltage to the slicer, and signals that have badly drifted continue to print properly with little or no distortion.

13. Disadvantages of the ATC Circuit

All such methods using storage-systems (with the exception of the unique DTC circuit) will go to ½ mark voltage at their output on steady mark input. Since the capacitor involved will discharge if mark falls quickly to ½ voltage (6 db.) or less, the system can be considered as unbalanced to "mid-mark" anytime a steady mark signal is being received.

A similar situation exists for a steady space signal, but this condition is of no importance as steady space is not received. It is, however, important to realize that if this condition *did* exist, the system would unbalance to "mid-space".

Fades considerably in excess of this 6 db. figure occur quite frequently. This is why operators with limiterless two-tone converters print so many errors on slow-speed typing and during steady mark. Even a normal converter without such a variable threshold corrector will not print errors unless the signal fades near (or into) the noise level, rather than merely to this 6 db. point.

On static bursts and impulse noises, the limiterless two-tone will again print a disproportionate number of errors on slow typists (and steady mark signals) due to this unbalance.

Only during machine-speed is the normal two-tone system in a somewhat balanced condition. This is easily illustrated by considering that with continuous "letters" keys, the threshold goes to nearly "mid-mark"; while with continuous "blank" keys, it goes to nearly "mid-space". The threshold can then wander between these two extremes (even at machine-speed) but with normal text, it will average about zero. With machine-speed, this system will be more nearly immune to errors during noise bursts than a normal FM system not using threshold correction. In the case of the limiterless two-tone, the system must remain linear, which is not likely to occur with instantaneous noise bursts. A good limiter system with threshold corrector would probably have a noticeable advantage under these conditions. This threshold corrector should follow a minimum band-width low-pass filter to be effective. (Section 5)

14. The DTC Circuit

This circuit is protected by patent until 1978. Thomas described the conditions leading to such a circuit in 1960.[7] Poor described an example of the circuit in January, 1964.[6] Little else has been written. Several versions are described in the patent, one of which is now described.

If the decision point could remain at zero, most of the problems mentioned concerning "mid-mark", etc., could be avoided.

The DTC incorporates a very clever "disconnect" system that effectively removes the storage-capacitor from ground, allowing it to lose its charge. At the same time, the current through R_1 and R_2 ceases as this disconnect system also lifts one of the resistors from ground. This causes the input voltage to now rise to full output voltage, rather than the usual ½ value. In this condition, there is no variable threshold circuit remaining, and action comparable to a "normal" converter results. Thus the threshold remains in a stable, balanced condition at all times, giving maximum immunity to errors during slow typing or during static bursts.

COMPARISON OF SEVERAL 2125 FILTERS WITH A COSINE CURVE

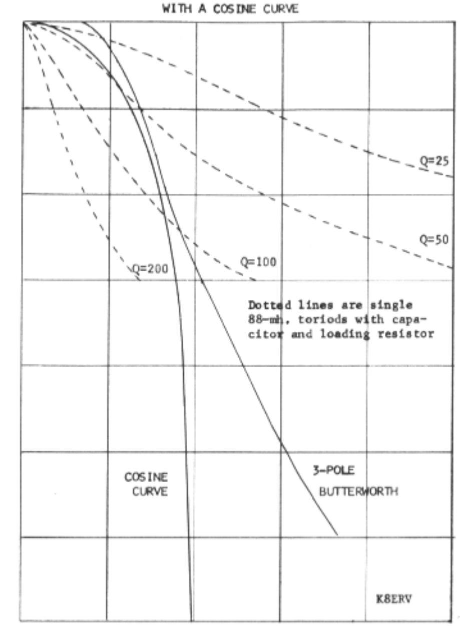

Fig. 1

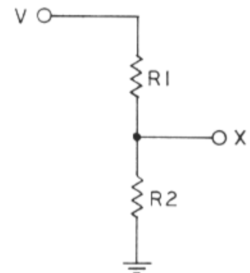

FIGURE 2

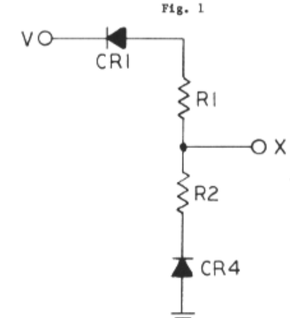

FIGURE 3

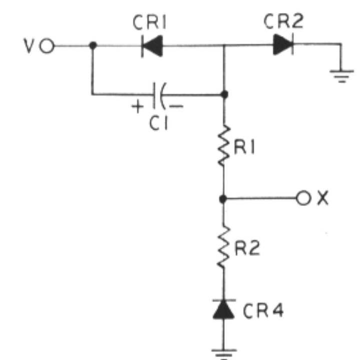

FIGURE 4

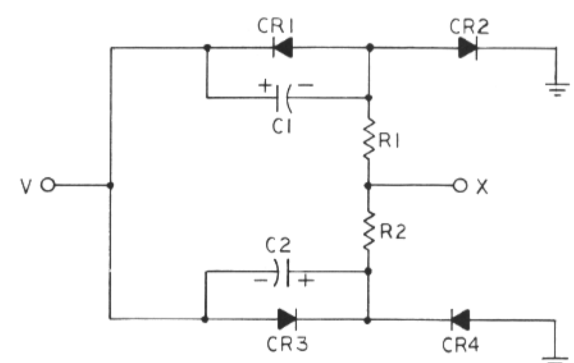

FIGURE 5

Poor[6] went into some detail on this system, but at the time did not mention one of the prominent features of the DTC circuit. Even during machine-speed, this circuit is superior to all other two-tone detectors as the threshold remains at zero. This occurs since the time constant of the disconnect system has been carefully chosen to equal that of the storage-system. Thus the DTC immediately demonstrates its superiority over any other two-tone system at any speed.

If this seems to be strongly stated, it should be remembered that the broad wording in the patent covers any device that would allow the threshold to automatically remain at zero while still providing a symmetrical output voltage.

To properly use this circuit (as well as the ATC), its output must look into an extremely high impedance at all times. Consequently, it cannot be introduced directly to any tube that would draw grid-current on positive voltage. Further, the time constants are considerably more critical than in other more simple circuits.

Use of the DTC in "normal" converters will make an immediate improvement, just as in limiterless units. Again, it should only follow a minimum band-width low-pass filter to be effective.

It is felt that the introduction of the DTC circuit is as important to the advancement of RTTY as was the introduciotn of the atomic bomb to the outcome of World War II.

15. Disadvantages of the DTC Circuit

The only disadvantage occurs during single-channel reception (mark-only, etc.) at keyboard-speed. It then acts like a cross between an ATC and a "normal" system using no threshold correction. If reliable mark-only copy is desired, a simple switch can be used to short out the disconnect system, returning the circuit to ATC action.

16. Driving the ATC or DTC

Since capacitor-charging in the ATC circuit and capacitor-discharge of the disconnect system in the DTC circuit must take place in one bit-time or less (22 milliseconds), these circuits must be driven from a high-current low-impedance source such as a cathode follower circuit. This circuit also isolates previous circuits from being loaded down during charge or discharge.

17. The Time Constants

The time constants of any two-tone systems must be carefully chosen to minimize distortion during single-channel copy, yet follow the specific fade rate of the incoming signal. Since the opposite channel information comes from capacitor-discharge (which diminishes with time), certain combinations of letters require longer time constants to be correctly printed. The "hardest" test one could make would be to copy continuous "letters" keys on space-only.

If the total distortion for each of these conditions is acceptable, the time constants are adequate. If no distortion occurse, probably the time constants are too long to faithfully follow quick fading conditions.

Thus the time constants become a compromise between the fade rate and allowable distortion.

18. Use of AGC in the Receiver

Since all two-tone methods other than DTC can go to an unbalanced condition on keyboard-speed typing, it has been necessary in the past for advocates of limiterless two-tone to rely heavily upon receivers that have excellent AGC systems in an effort to keep those sudden fades from affecting the output of the receiver by the "magic" 6 db. figure. Even with such receivers a radical decrease of errors was noticed during machine-speed reception. Several advocates have also found with current types of two-tone systems not incorporating DTC that better results were obtained with small amounts of limiting – this turning the linear two-tone into a non-linear system.

AGC does not particularly help dynamic range. Unless the AGC gets its feedback from the output of the channel filters (Henry Hall, W4MGT uses such a system rather successfully) or the output of the detectors, it will not be of great help in maintaining dynamic range. As a signal drops into the noise, the AGC is controlled completely by the noise or by nearby signals and even can make matter worse. Use of AGC will likely make a greater demand (rather than lesser) on dynamic range of the converter.

Use of AGC can also adversely affect reception during those times a quite stong nearby CW station is present. The AGC quickly "locks on" the CW station during key down, and then quickly back to the RTTY signal (which is weaker in this case) during key up. This can cause an extremely rapid fluctuation to the audio level presented to the converter that no two-tone system can satisfactorily handle. In this instance, one would need to disable the AGC, or back off on the RF gain to the point the AGC is effectively out of the circuit.

With the use of DTC, AGC is not needed except in an effort to remain at a somewhat uniform input level. This assumes the converter has good post-detector dynamic range to handle a wide variety of input voltages. For such a system, a receiver of a specific brand is not required. In general, ANY receiver that works well on single-sideband will then work well on RTTY.

19. Advantages of Two-Tone Reception

Exhaustive testing has shown one major and one minor area in which this method is undoubtedly superior to the FM limiter-discriminator with variable threshold corrector.

(1) Strong nearby stations (QRM)—A nearby signal disrupts the "capture effect"[14] of a FM limiter, rendering it somewhat useless at times, as owners of "normal" converters will quickly accede. Use of a good band-pass input filter of course helps immensely in this situation. The more narrow filters normally used for limiterless operation have a distinct advantage, the maximum signal-to-noise ratio occuring when only the wanted signal is received. The ability of the two-tone to copy well on either mark-only or space-only is of interest under these conditions, although space-only is not satisfactory on keyboard-speed typing.

(2) Very weak signals exhibiting selective fading. Haynes has discussed the problems inherent in weak signal detection.[1] Poor[11] has also emphasized that a minimum band-width pre-detection system inherenty is better than one with broad imput. Few amateur two-tone converters use channel filters narrow enough to take advantage of this situation.

Other situations favoring the two-tone over a well-designed FM system using threshold correction are not presently known to the authors.

20. Limitations of Two-Tone Limiterless

If no DTC is used, then the two-tone system is subjected to increased errors during slow typing or steady mark. DTC provides a solution for these problems.

On fast flutter fades like aurora and certain backscatter conditions, the two-tone system fails miserably in contrast with even a "normal" FM system without threshold correction. Of course these conditions often so badly distort the signal that the best system will be second-rate. The fact remains, however, that under certain conditions the FM system is the only method that will produce acceptable results.

To design the two-tone system properly, more must be taken into account than just the converter. The entire system must remain linear.[3] That means the receiving system must stay out of saturation during a static burst and the converter not be over-driven. It is not likely this can be done, so the best compromise is a limiter.

For optimum performance on two-tone, very narrow filters should be used. This poses many problems (Section 6) which must be considered.

21. Advantages of Well-Designed FM Systems

It is not likely that even a half-dozen amateurs have ever had access to an optimum designed FM converter. This might cause doubt, but it shouldn't if the foregoing comments have been evaluated and the reference material studied.

This FM system would include:

1. A good band-pass input filter (Section 6);
2. A limiter with zero time constants that would fully limit over the entire range of input levels experienced;
3. A linear discriminator for optimum noise cancellation;[14 18]
4. A minimum band-width low-pass filter;[11]
5. Some adequate threshold correction such as the ATC or DTC; and
6. A slicer that provides a faithful output voltage for the printer.

No amateur design has ever incorporated all these criteria. No known commercial converter available to amateurs at reasonable prices will meet these stringent requirements, either. As a result, one cannot properly criticize FM systems as having no advantages over limiterless operation until an optimum FM system has been evaluated.

The Altronics-Howard model "L" comes closer to these criteria than any other simple circuit in use at present. The Mainline TT/L FSK Demodulator offers all these advantages plus others intended for limiterless operation.

A good FM converter offers many over-all advantages:

1. They make possible the use of simple and inexpensive filters in the linear discriminator section;
2. With threshold correctors they allow great latitude for drift or mistuning—this being advantageous for round-table QSO's where the stations involved are seldom on the same frequency;
3. They provide a stable indication of tuning on the scope, etc.;
4. They recover quickly after a static burst;
5. They adapt readily to automatic auto-start or mark-hold reception so the operator can absent himself during reception; and
6. They need not be carefully monitored for correct input level.

Such FM systems are not typical to what the amateur has had available to him in the past. This is not a "new concept"', but does offer new horizons for amateur development.

22. Disadvantages of FM Operation

There is no doubt that during heavy QRM the more narrow filters in use on some limiterless two-tone converters offer great opportunity for improvement. However, most amateur two-tone converters proposed to date have used channel filters as broad as those used in typical FM systems. In this event, the limiter on the well-designed FM system could be by-passed for equal results.

23. Use of Partial or "Controlled" Limiting

Several authors have suggested use of partial limiting by retarding the receiver's output to the point the limiter is at its threshold level. This and a "half and half" system which has been proposed and tried many times. It is poorer than either technique alone (FM or two-tone). The result is an FM system with a defective limiter in the one case, and a non-linear AM detector in the other. The S/N ratio of the receiver itself is degraded somewhat by turning the volume extremely low to circumvent limiting on those units which offer reduced limiting (usually as a result of poor design).

24. Testing FM Against Two-Tone

On two-tone systems not incorporating DTC, a radical improvement is noticed on machine-speed typing. Most observers have compared the two-tone with normal FM systems at machine-speed. This of course gives the two-tone an optimum opportunity to "show up" the usual FM system.

Such machine-speed conditions are seldom encountered on amateur frequencies, and a more reliable test would incorporate the use of an audio tape recorder. Typical signals would be recorded from the receiver and later played into both systems for error comparison. Another method in use by several observers involves a separate facility with independent printers operating. This system is acceptable, but has the disadvantage of additional variables.

An optimum system, not merely for testing but normal use, might, in fact, consist of two separate systems—one a good FM system and the other a good limiterless system. These would operate independent printers. When one failed, the other might produce satisfactory results.

25. Conclusions

Few amateurs have had access either to a good FM or to a good two-tone system. Neither system will give optimum results under all conditions. Of the two, the FM system offers the greatest advantages the majority of the time. The limiter on a good FM system could be by-passed to offer some advantages of the optimum two-tone limiterless.

The "ideal" converter would be one in which either a good FM system or a narrow band-width two-tone system could be selected. The MAINLINE TT/L FSK DEMODULATOR was designed with this in mind.

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Additions to "THE MAINLINE TT/L FSK DEMODULATOR" Article in the November 1964 Issue of the "RTTY Bulletin"

Page 5 bottom of first column—some copies missed a few words which should read:

> A system was developed that we call the "minum-minus" system. Since mark and space are never present at the same time, they can be alternately displayed on the same display—thus our system is really a direct-reading voltage comparison system. (etc.)

Page 6 second column fifth line from the top—A word presently "not" should instead read "now".

Page 7 the RF chokes in the FSK system are to be "2.5 mh"—the dots may be too small to be easily seen.

Page 7 in the ATC diagram—exchange the numbers of CR9 and CR10; also exchange the numbers of CR13 and CR14 which makes them similar to those on page 9.

Page 7 the missing words on some copies on the optional filter system should be a "Miller 6324—L9".

Page 8 the voltage to the driver transformer T2 should be plus 210. (Not minus 210 as shown on some copies.)

Page 9 the voltage to R12 (cathode circuit of V2A) should be minus 150.

There are no drawing changes.

If you have difficulty locating the Stancor A-4778 transformer (T5) in the "FM" section on page 10, try Burstein-Applebee in Kansas City, Mo. Also one can readily substitute a triad T-2X or a Thordarson MIT-154—all of which are interchangeable. Other substitutions are not recommended.

The substitution of any of the rest of the transformers is not recommended as the authors cannot predict the performance that would result.

It might be a good idea to by-pass the 110-VAC leads with 0.01 disc ceramic (1,000 volt) capacitors to guard against any possible RF pickup.

The chassis should be directly grounded to the other equipment in the station; all of which should be grounded to earth.

———————

The opinions expressed in this and the November article are those of the authors. Correspondence regarding either of these articles should be addressed direct to the authors, enclosing a SASE. Editor.

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

In the Matter of
Amendment of Appendix 1,
Part 97, regarding radio
operator examination points

ORDER

The Commission having under consideration a modification of its amateur radio operator license examination points; and

IT APPEARING, That Lubbock, Texas is better situated than Amarillo, Texas as an examination point to serve the west central portion of that state; and

IT FURTHER APPEARING, That the increased demand for examinations at El Paso, Texas and the remoteness of that city from other examination points warrant the conducting of examinations semi-annually instead of annually at El Paso; and

IT FURTHER APPEARING, That said changes in examination points and the frequency of examinations would be in the public interest; and

IT FURTHER APPEARING, That the amendment herein ordered is procedural in nature and not substantive and therefore compliance with public rulemaking procedures required by Sections 4(a) and (b) of the Administrative Procedure Act is not required.

IT IS ORDERED, This 28th day of October, 1964, pursuant to authority of Section 0.261 of the Commission's rules, and to authority contained in Sections 4(i) and 303(r) of the Communications Act of 1934, as amended, and pursuant to Section 3(a) of the Administrative Procedure Act, that Appendix 1 of Part 97 of the Commission's rules be amended in accordance with the Appendix attached hereto, effective November 12, 1964.

FEDERAL COMMUNICATIONS COMMISSION
Ben F. Waple
Secretary

Attachment
Released: November 3, 1964
NOTE: Rules changes herein will be covered by T.S. VI(64)-3.

APPENDIX

Part 97, Appendix 1 [Amendment]

Appendix 1, Part 97 of the Commission's rules is amended by

(1) deleting Amarillo, Texas as an annual examination point;

(2) adding Lubbock, Texas as a semi-annual examination point; and

(3) changing El Paso, Texas from an annual to a semi-annual examination point.

FSK MODIFICATION OF HEATHKIT SB-400 EXCITER

WM. CASMAER, WA6JZU
7527 Astoria Place
Goleta, California 93017

Maybe some of the boys have one and would like a quick easy way for FSK without using audio tone oscillators into the mike jack.

As you may, or may not know, the SB-400 kit has a pre-assembled and aligned VFO or as Heath Co. calls it, an LMO, Linear Master Osc.

It is a thing of beauty really. As its stability and reset-ability are something we all strive for and few of us achieve in our home brew VFO's.

On with the story. In order to maintain the correct dial calibration on the SB-400 when it is switched from LSB to USB/CW position the frequency of the LMO must be shifted approximately 2.5 kc to stay within the xtal filter passband and as said before and most important, maintain dial accuracy.

They do this very nicely with what appears to be a varicap diode within the LMO. Now since the LMO is a factory sealed and aligned unit, and not wanting the wrath of Heath Co. upon me, I haven't opened the LMO to verify this. But it's quite apparent this is the method used.

Ahead of my story again. Referring to their schematic shows a + and – bias voltage is applied to this diode in the LMO when the mode switch is in the LSB or USB and CW position.

A VTVM placed on the bias term of the LMO revealed a change from –43 VDC to +43 VDC when the mode sw was changed from LSB to USB or CW position.

A few moments later a pot and 6V battery were connected to the bias term instead of the existing wire and what do you know, a beautifully adjustable shift circuit with no major changes and especially no holes to drill.

With my unit, about 3 to 6V is all that is required to shift the standard 850 CPS, and naturally, less for narrow shift.

Since we do operate SSB & CW also, I brought out the shift voltage supply and return points thru an existing jack on the rear panel and use a crax jumper when RTTY isn't being pursued.

Now for the step by step modification procedure.

a) remove exciter from cabinet.

b) on the real panel, under the chassis, locate the ALC input phone jack.

c) remove existing green/white wire. Tape up and stow in the near by wire bundle running toward the front of the rig. This is assuming that the Heath Kit Linear Amp SB-200 is not being used, if so, you'll have to choose some other jack that isn't being utilized.

There is another "spare" jack on the back panel adjacent to the RCVR ANT jack, but this in the final amp stage compartment and I felt the high level RF in the transmit position might foul things up so I stayed away from that one.

d) Connect to the ALC input jack the shield and center conductor of a piece of subminiature coax, known as "Subminax" or RG 174/U, and pass the other end thru the grommet in the chassis between the xtal filter and the rear of the LMO box.

e) Mount a two (2) term tie point under the sheet metal screw on the right hand side, rear, of the the LMO as viewed from the back of the LMO. Place the term lug in a vertical plane with the insulated lug on top.

f) locate the (3) three term miniature tie point between the LMO & xtal filter, just to the right of the grommet in step (d).

g) disconnect the end of the 1K½W resistor from the term with the white/violet wire. The other end of this 1K res. should be connected to the "bias" term of the LMO.

h) Now connect this end of the 1K resistor removed in step (g) to the insulated term of the (2) two term tie point installed in step (e).

i) connect the center conductor of the sub minax, running from ALC input jack thru grommet in step (d) to the end of the IK resistor on the insulated term of the tie point and the shield to the ground term.

j) Locate the spare jack adjacent to the ALC input jack. Connect center conductor and shield to this jack.

k) Pass the other end thru the same grommet as in the previous coax routing.

l) Connect the center conductor to the term with the White/Violet wire, from which the 1K bias resistor was connected, and the shield to the center ground pin of the (3) three term tie point between the LMO & xtal filter.

This completes the modification of the transmitter.

Continued . . .

For normal operation of the exciter, a short sub minax jumper between the "ALC input" jack anl its adjacent "spare" jack and everything is normal.

For RTTY operation, remove the jumper plug from *both* of these jacks, as if left hanging from the spare jack it has +43 VDC on it, and plug in another cable of sub minax, or most any coax cable handy, as follows:

Connect center conductor and shield to a phono plug.

On the other end, connect the center conductor to the + term of your shift supply. A 6 volt battery with a shunt pot across it is fine. Connect in series with the shield a 1K½W resistor. The other end of this resistor connects to one term or the other of the keyboard contacts (or a contact of a polar relay). The other contact of the keyboard (or polar relay) completes the circuit to the (–) neg term of the shift voltage supply.

I use a variable 0 to 20V transistor power supply and set it next to the transmitter for easy and quick access.

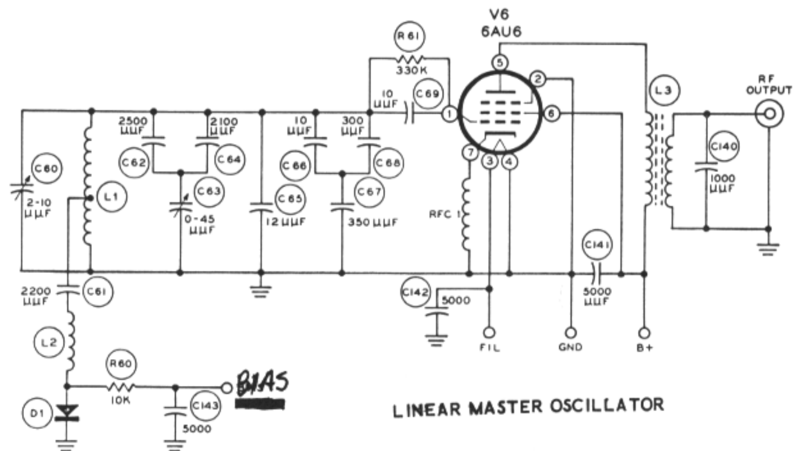
That's all there is to it. It's really much simpler than it reads here, as I have gone into considerable detail and to be perfectly frank I'm not too good with technical writing.

Almost forgot, I put the 1K resistor in series with my supply for *safety* purposes.

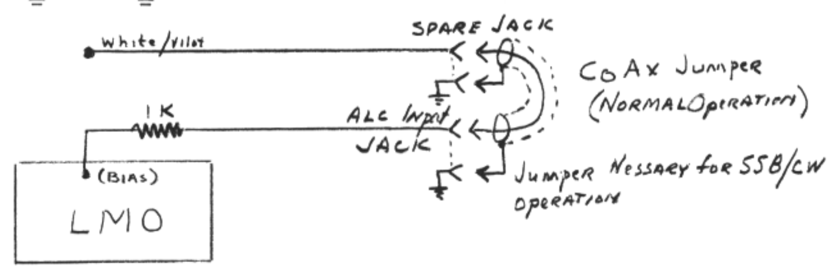
Number 1, if the cable shorts out I lose one supply as it isn't current limited.

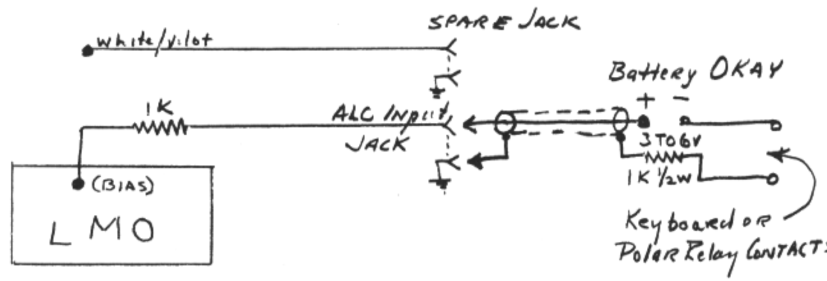
Number 2, I'm still paying for the SB-400 and can't afford another supply.

73's Bill, WA6JZU



LINEAR MASTER OSCILLATOR





DX-RTTY

BUD SCHULTZ, W6CG
5226 N. Willmonte Ave.
Temple City, Calif. 91780

Hi DX'ers:

It's sure good to be back on the job after a three month lay-off from these DX chores. A million thanks to Ed, K3GIF, for the handling of the DX department while I was away. My plans included a week at Ed's place in Bethesda but fate and the flu bugs worked against me and I had to replace it with an enforced stay in bed while nature took its course. Better luck next time, Ed but thanks again for carrying on.

It has been traditional that the December column includes a post mortem of the DX contest. However, Ed did so well on this subject last month that this will be rather an anti-climax. The complete run-down on the contest will be in the February issue but I will just skim across the letters and logs received to date and give you a rough idea of how the big wing-ding came off. The logs are still pouring in and at this time yours truly is really swamped. It appears that this contest was by far the biggest in attendance that we have ever had. In general, the comments bear out what Ed said last month about the propagation conditions being better than the past two years. Many of the scores are fabulous!! The only exception to the improved conditions seem to be the "down under" boys who had a rough time even hearing stateside stations. Eric, VK3KF, writes that what was supposed to be a regular "bun fight" turned out to be just an afternoon tea party in his part of the world. Eric reports that he did not contact or even hear a single USA station during the test. Bruce, ZL1WB, writes "Condx were quite strange during the SS—the European boys had excellent sigs but I only worked one Statesider!! This must constitute a record for sure—only 2 other W sigs were printed here through the test!" On checking the logs I also note that Bill, VK2EG, also failed to work anything from the States. To the best of my knowledge this is the first time such a situation has existed during the Contest period.

Some rather exciting news came in along with the overseas logs that I am pleased to report on at this time. Two offers to sponsor RTTY-DX contests were received from opposite corners of the world. Eric, VK3KF, submitted a set of rules for the consideration of the DX Committee for a contest that would be along the same lines as the present with some changes in the scoring multipliers. Eric has offered to handle the details and take care of the logs if and when the contest takes place. In the same mail was a letter from Bruno, I1RIF, who writes "after seeing how many new ones came on RTTY I now will give serious thought to your suggestion that a European sponsored contest be promoted some time next Spring and think that the most active club that could organize it is the SSB-RTTY Club." The committee is rushing to make copies of VK3KF's rules to forward to Bruno for the consideration of the Italian group in case their contest offer becomes a reality. It appears now that the dream that we had five years ago of a real going RTTY DX contest will finally come to be a fact. The committee will give both VK3KF and I1RIF every bit of help possible in publicizing the events and in any other way we can.

While on the subject of Contest rules I would like to mention that in reading over the hundreds of comments received so far I have only come across three "gripes" on our scoring set-up as against a great many compliments on the way the contest was handled. Two of the complaints were rather mild queries as to why the scoring favored some areas of the world over others. The third was a bitter indictment of the entire scoring set-up which gives the overseas stations a "five to one" advantage over the North American Area Stations. Actually the "five to one" claim is an over simplification of the facts. The number of Stateside stations participating in the contest each year is many times greater than the five to one ratio when compared to the foreign stations in the test. All of these stateside stations can build up their multipliers by working each other during the periods when the DX stations are not available due to conditions. I must again point out that the contest was originally set up to encourage foreign participation and it would seem that this aim has been accomplished. In the February Anniversary contest where the rules allow everyone exactly the same scoring opportunities, foreign activity was almost nil and as a matter of fact our last February contest was so short of even Stateside contestants that the committee was forced to call it "no Contest". The fact that the scoring system in the DX SS contest works is proven by the following facts; in the 1961 contest—among the top ten there were 6 USA stations and four foreign; in 1962 and 1963 the ratio was seven USA winners and three foreign among the top ten. It

Continued . . .

HORSE TRADES

FOR SALE: Drake 2B like new, built-in calibrator $170.00. 14 typing reperf $50.00. 14TD with sync motor $50.00. One model 15 excellent condition (minus cover and crank) with keyboard, Holding magnet type, aluminum frame $60.00. W4AIS, 7 Artillery Road, Taylors, S.C.

FOR SALE: Model 15 aluminum, 20/60 ma type, like new. Model 14 typing reperf, and 14 tape distributor. W6OJF, 9337 Gotham Street, Downey, Calif. TOpaz 9-3292.

FOR SALE: Test Tape, AFSK on magnetic tape at 2125/2975 cps at 3.75 ips runs 15 minutes with voice explanation. RY's, Foxes, complete keyboard special exercises for adjusting end-of-line, auto CR, etc. Two track: half is low mark, half high mark. $2.00 postpaid. Same tape in chadless paper tape 11/16", $1.00 postpaid. Model 15 page printer with 19 keyboard, sync motor 60 wpm gears, $100.00. Model 14 TD sync motor 60 wpm, BRAND NEW $90.00. 88 mhy toroids, 50c each, 5/2.00. K5B QA 11040 Creekmere, Dallas, Texas 75218.

FOR SALE: (Europeans) Sixty Creed 7B Teleprinters with covers, ex-royal navy, serial Nos. from 21,000 to 53,000. Some requiring attention, or as excellent source of spares. Others in mostly FB condx range from £10 for earlier models to £17.10 for the later models, Carriage extra. Also 100 new spare autoheads for Creed 1B 6S/3 auto transmitters 25/- plus postage. G3LSD, Netherton Cottage, The Elms, Stoke Damerel, Devon, England.

FOR SALE: Two complete Model 15 Teletype, estate of W6HIF, Mrs. Rita Bennett, 1347 Walnut, San Bernardino, Calif.

FOR SALE: 28ASR $500.00, 28ASR (includes typing reperf with gear shift for 60, 75, 100 wpm) $650.00. 51-J-4 (this is an R388/URR recently factory converted to a 51-J-4) 500.00. SP-600 250.00. W9WKC, 517 South Market Street, Hoopeston, Illinois.

FOR SALE: Mercury wetted relays, Western Electric 276F and 276G. Used but tested in local loop circuit. Octal keyway may be missing but seal is intact. Base diagram and local loop circuit included. Used as a substitute for a polar relay. See CQ mag., Mar. '64. $5.00 each postpaid. 88 mhy toroids 5 for $1.75 P.P. Used parts for Model 15 typing unit. Inquire about specific parts. W9FTE. 5665 North 38th Street, Milwaukee, Wisconsin 53209

WANTED: 28ASR with sync motor, must be complete. No junk please. Prefer local source but all offers will be considered. Also SELL model 15 KSR complete with sync motor, cover, etc. Can be seen working, this machine is in A-1 condx. I will pay freight to your door. K3AUD, P.O. Box 524, Republic, Pa. (412) 785-6329.

DX-RTTY Continued . . .

would seem that the so called "five to one" advantage was not as great as some would lead you to believe. It may be that there are now enough overseas stations on RTTY to make some adjustments in the rules. Only time will tell. The rules submitted by VK3KF for his proposed contest make some changes in this area and we hope to be able to submit them here for your approval in the next month or so. One thing more before I climb down off of this soap box—the present rules were drawn up by a committee of eight RTTY'ers on five Continents after a great deal of discussion and compromising and represent a lot of head scratching. We realize they are not the ultimate in simplicity but RTTY contests have a great many more problems than the CW or Phone lads have in their DX contests. Thanks to all of you who have put up with this system and have helped by your participation in the contest. All of you have helped to make the thing a real success.

Thanks for the use of the hall—see you next month. —73

Bud, W6CG

WANTED: One cover for Model 14 printing reperferator. VE3DSX, 250 Mont Sacre Coeur, Timmins, Ontario, Canada.

FOR SALE: Gears and pinions for 14's, 15's, 28's, others, $3.00 a matched set (gear and pinion). 60 or 75 speed. Green keytops, by the set or by each, Cheap! Slant 0 over "P" for 14 or 15, $1.00. Platten cranks for 15s, 1.00. TD dist. plates (77070) 2.50 19 Tape containers, with reel & cover, green, wrinkle finish, excellent condition. $4.00. W9YVP, 11001 South Pulaski, Chicago, Illinois 60655.

X **FOR SALE:** Motor, sync Teletype with fan and base, used, good, $10.00 each. Power supply for model 15 Teletypewriter, used, good, $10.00. Send for catalog, Atlantic Surplus Sales, 181 Sackett Street, Brooklyn 31, N.Y.

FOR SALE: Clearing our sale AN/FGC-1 Radioteletype Converters $50.00 USED. New with spare parts $125.00. ALA-2 Panadapters with free conversion instructions $29.95. 19"x72" Open racks, new and used, as low as $12.50. Write for free list. Gulf Electro Sales, Inc., 7031 Burkett, Houston, Texas 77021.

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