RTTY

VOLUSIA COUNTY CIVIL DEFENSE STATION
AT DAYTONA INT'L SPEEDWAY

RYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYR

NEWS OF AMATEUR RTTY

JUNE 1960
25 Cents
Vol. 8, No. 6

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 OR TRADE: Two model TRA-7 dual Diversity converters W5VJP
FOR SALE: New set of 5 tubes and 3 GE coils for W2PAT TU, 7.00; Gonsett 2 meter with Johnson VFO, 5xtals and mike, 125.00 .... K6UQC
FOR SALE: Model 14 Typing Reperf, 135.00; Good condx, O-5B/FR, 50.00 .... W7GEK
FOR SALE: Model 14 TD K6JDN
WANTED: Six polar relay sockets for 215As, also TT-1B/TXC-1 Fax Machine W8KPT
FOR SALE: Model 14 keyboard perforator 85.00 .... W6EV
FOR SALE: DX-40 and S-53A .... KØQBA
WANTED: CV-31—Terminal unit W3LSS
WANTED: Early wireless, telephone & telegraph gear, tubes, books, pamphlets and catalogs. Xtal sets, Crosley Pup, Grebe CR-land CR-7 J. A. Chumley, W4FEE/6, 24540 East Little 3rd Street, San Bernardino, California.
FOR SALE: Model 26 and Table W6RCR
WANTED: 75 WPM gears for Model 26 .... K6KID

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

PASADENA JUN 6 12 PM 1960 CALIF.

LET'S LOOK AT THE SIGNAL!

By DON WIGGINS, W4EHU

One of the favorite indoor sports of many RTTY'ers is trying to build the perfect terminal unit. However, one of the most important elements of the design is often overlooked! I refer to the FSK signal, itself. We should be completely familiar with the nature and characteristics of the signal in order to optimize the circuitry which we hope will remove the intelligence (?) supposedly contained in the signal. In this article, I will try to present a few basic fundamentals which may help some of our newcomers to gain this familiarity.

To describe an electrical wave, or signal, we can talk about several of its characteristics, such as: amplitude, frequency, phase, wave shape, power, and so on. Let's see which description is most useful. The most complete picture is obtained from the "time function" or plot of the amplitude of the wave with time. This "amplitude" can represent instantaneous voltage, current or power. A familiar example is the plot of a sine wave from the 60 cps power line. In Figure 1a, a 120 volt (rms) wave is plotted. Notice that the instantaneous voltage varies from zero to plus-or-minus 169 volts and that the "120 volt" value is the effective voltage used in calculation of average power. A piece of information which is implicitly contained in this plot is the "frequency." However, we must determine the period of the wave (marked T) and divide into one second to get the frequency in cps. A more useful plot, as far as frequency is concerned is the spectrum. Fig. 1-b shows the spectrum for this wave – a single frequency, of course, with an amplitude which can be labeled either the peak value or the rms value, whichever we prefer. Let's use the peak value for this discussion. Note that no phase information is given in this plot and we can not tell the value of the wave at any particular instant in time. Also, this is a "steady-state" representation; that is, we imagine that this wave has been present for a very long time. Later, we will see that turning a sine wave on and off will cause other frequencies to appear!

For a little more complicated spectrum, take a look at a sine wave added to a d-c term. (This might be the d-c plate current of an audio amplifier tube with a single tone a-c signal.) Fig. 2-a shows the time function and the spectrum is Fig. 2-b. Notice that we now have an additional spectral line at "zero frequency" or d-c. Incidentally, this d-c term always represents the "average" value of a complex time function and is the value that a slow-response meter would read.

Well, this has probably all been old stuff to most of you, so let's get on to a more interesting case. Suppose we key the current from a battery through a load resistor off and on at a rate of 23 times per second. (This rate will be useful for our RTTY application.) This will produce a "square wave" of current which is plotted against time in Fig. 3-a. This is a real easy wave to make a time plot! But how about the spectrum? Well, the frequency information is in the time plot, alright, but it takes a little more finageling to get it out! We can certainly expect a 23 cps line to be present in the spectrum since this is our rate of keying and a d-c line which represents the average value of the current. However, these two terms cannot be the only ones since we saw earlier that this was the spectrum of a sine wave plus a d-c term! Without getting too technical, I will simply state that it can be shown mathematically that there are an infinite number of sine waves of different frequencies and amplitudes contained in this square wave! Or, alternately, we can consider that the square wave is the result of adding together an infinite number of sine waves. If this all seems a little "unreal" to you, take a look through a magnifying glass at the grooves of a hi-fi phono record. You will discover that there is only one groove! But our ears do the job of psychologically separating out all of the audio frequencies which, added together, make up that one wiggly groove . . . Back to the square wave—all of these sine waves must be of just the right amplitude, phase

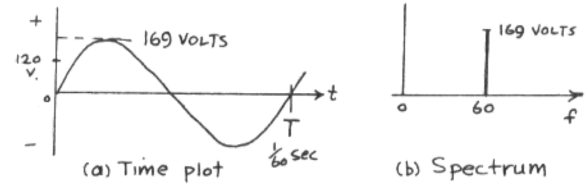


Figure 1

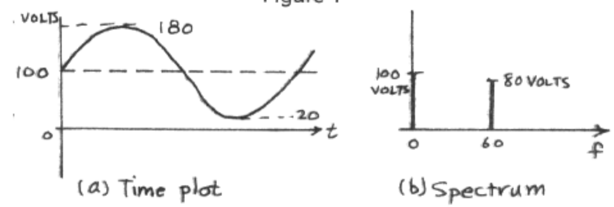


Figure 2

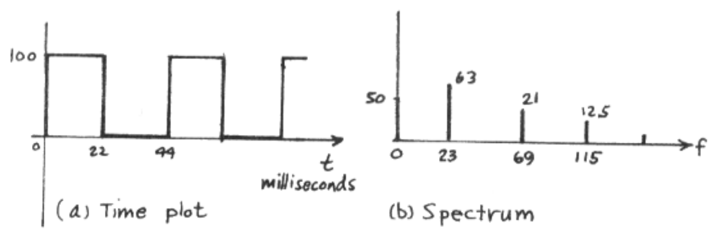


Figure 3

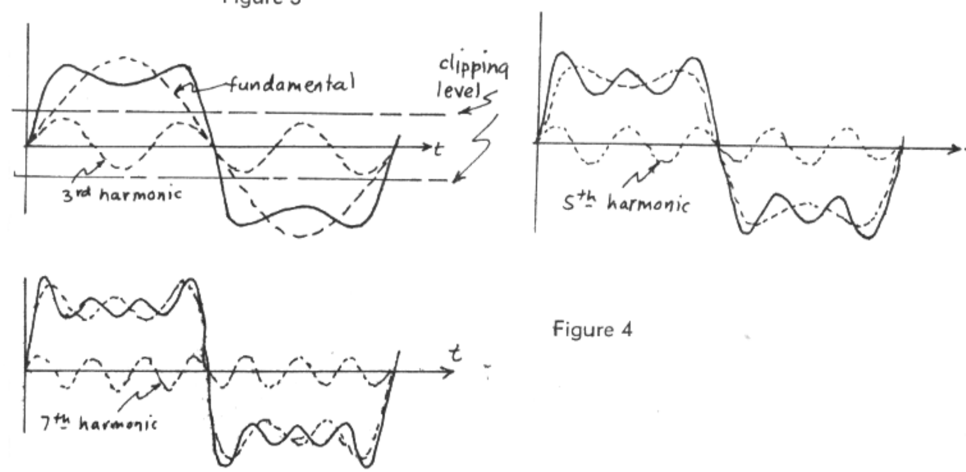


Figure 4

and frequency to add up correctly. If any of these components are missing or are of the wrong amplitude or phase, then the "square wave" will be distorted.

So, completing the spectrum for the square wave, it turns out that the d-c line will be 50 units high (based on a peak value of 100 for the square wave), the 23 cps line, 63 units; the next frequency is the 3rd harmonic or 69 cps, 21 units high. The next is the 5th harmonic of 12.7 amplitude. You can see the pattern—all the odd harmonics are present but their amplitudes get smaller and smaller. Fortunately, after a relatively few terms, the harmonics get so small that we can't tell the difference if they are neglected.

Fig. 4 shows the effect of using only a few terms to try to make a square wave. From this example, the usefulness of spectral plots appears. We can decide on circuit bandwidths by knowing the frequencies to be passed and from their relative amplitudes, which ones will never be missed!

With this quick background in time and frequency plots, let us move on to radio frequency waves. Fig. 5 shows a high frequency carrier wave which is, of course, identical to Fig. 1 except for the frequency. We will use 1 mc as convenient for discussion. The carrier wave is of no use until modulated so that's our next step. There are two general types of modulation of interest: AM and FM. A simple example of AM is our carrier modulated by a pure audio tone; say 2125 cps. The time variation and spectrum are shown in Fig. 6. Notice that the spectrum of the modulating wave is *added* to and *subtracted* from the spectrum of the carrier to give the familiar "side bands." The amplitude of these side frequencies is determined by the percentage of modulation. The amplitude of the carrier line stays the same regardless of modulation percentage (unless overmodulated!) In spite of the name, "amplitude modulation," the carrier amplitude does not change. The reason the amplitude of the time plot changes is due to the presence of the two side frequencies which are very close to the carrier frequency. These add to the carrier in and out of phase in such a manner as to produce the familiar wave envelope. This wave (Fig. 6) could represent one tone of an AFSK signal. If the other tone were the usual 2975 cps, we can see that at least 6 kc bandpass would be needed. Actually, a little more than this is necessary, due to keying sidebands.

The FM wave is more complex than the AM case. Fig. 7-a shows a carrier wave frequency-modulated by a pure sine wave. A possible spectrum is shown in Figure 7-b. Unlike the AM case, there are a large number of side frequencies even for the single tone. The theory predicts an infinite number, but again most of them are so very small and we neglect all less than about 1% of carrier amplitude in practice. The number and magnitude of the various side frequencies is determined by the amplitude of the modulating wave (or frequency deviation). Here, the carrier amplitude does change with modulation, since the radiated power is the same with and without modulation—so the side band power must come from the carrier. For certain deviation ratios, the carrier goes to zero!

We are about ready to talk about RTTY signals (about time!) An actual teletype signal is quite complicated; however, the 23 cps square wave discussed previously will give a very useful representation of the teletype signal. Fig. 8 shows a make-break or c-w signal from such a wave. This can be considered to be a carrier which has been amplitude modulated 100% by a square wave. Again the spectrum is that of the square wave added to and subtracted from the carrier spectrum. We will consider the best bandwidth for this signal later.

Similarly, an FSK signal may be considered as a carrier frequency-modulated by a square wave. The time plot can be drawn quite easily. Using an 850 cps shift, it is simply the carrier for space and the carrier plus 850 cps for mark. (Fig. 9). The exact spectrum is much more difficult to figure out. An easy way to see what this spectrum looks like is to consider the FSK signal as *two* CW signals, one at the high frequency (mark) and one at the low frequency (space). Then we can simply add the spectra of these signals. For our 23 cps keying wave, the specrum of Fig. 10 is obtained.

With this view of our signal, perhaps we can draw some useful conclusions concerning bandwidths of our receiver and TU circuits. The first step is to decide how good a pulse we need. From Fig. 4, it is seen that a perfectly usable pulse can be obtained from only the fundamental and

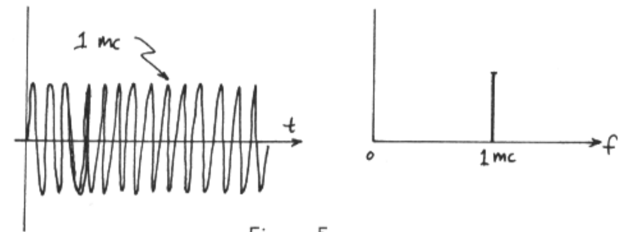


Figure 5

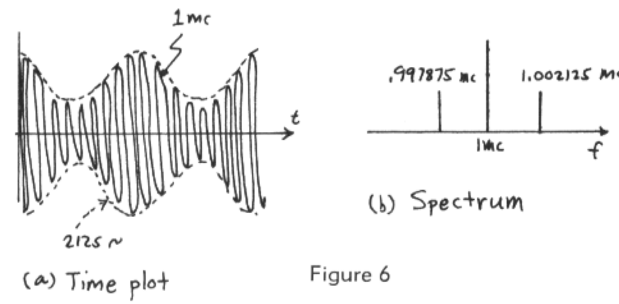


Figure 6

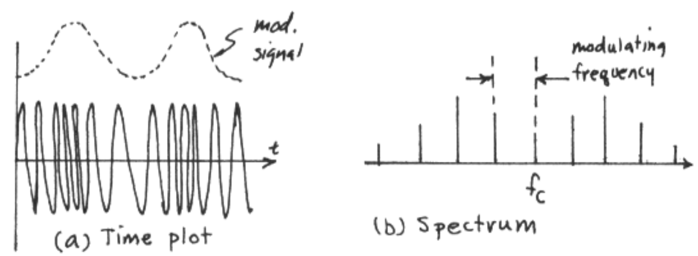


Figure 7

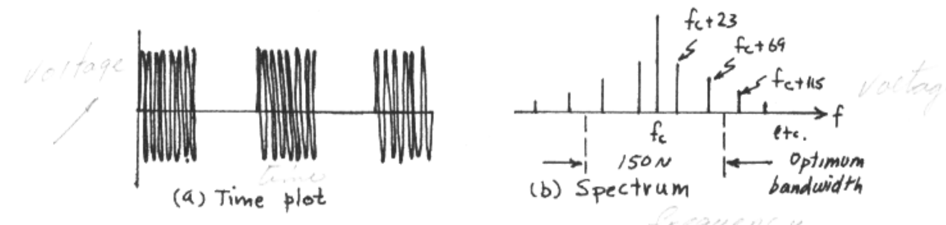


Figure 8

the 3rd harmonic since the printer keyer circuit always clips or limits as indicated by the dotted line. The minimum RF and IF bandwidths in the receiver would thus be 850 cps plus and minus 69 cps or about 1 kc. for FSK, and twice 69 cps or about 250 cps for make-break. See Fig. 8. Similarly, for an audio type TU, the minimum filter widths would be about 150 cps. Note that the 2125 and 2975 cps tones are really new "carrier" frequencies and our receiver detector has simply translated the mark-space signals from RF to audio as in Fig. 11. These minimum bandwidths do not allow any room for drift due to instabilities at either transmitter or receiver. An extra 100 cps in each case should be satisfactory for ease of tuning and drift.

On the transmitting end, it is equally important to use some filtering or "shaping" of the keying pulses from the keyboard to prevent the "infinite spectrum" of the keying signals from causing severe key-clicks. This is much the same problem we have on CW except that it is easier to cure since the class C amplifiers will not effect the FSK waveform. Most FSK circuits use a simple RC filter to round off the keying wave. A time constant of about 5 milliseconds should be about right.

A point often overlooked in the terminal unit is the passband of the keyer circuit. If this is limited to about 80 cps by use of a low-pass filter, the keying wave will be perfectly useable yet false keying due to impulse-type interference will be held to a minimum. This type of interference punches "holes" in our signal by saturating limiters or detectors. These impulses represent frequencies higher than 80 cps and will be attenuated by such a low-pass filter. The filter should be of the LC type to get a sharp cutoff with good phase characteristics.

I hope that this discussion will help you in visualizing the FSK signal. It is a good idea to know the IF pass band shape of your receiver, the location of the BFO with respect to center of the pass band, and to sort of visualize the signal as you tune through it. This should help in digging out the weak ones!

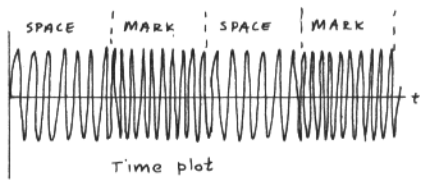


Figure 9

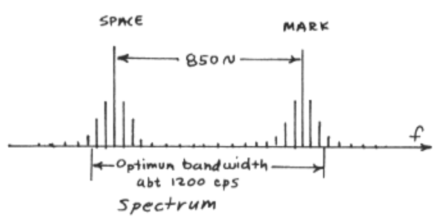


Figure 10

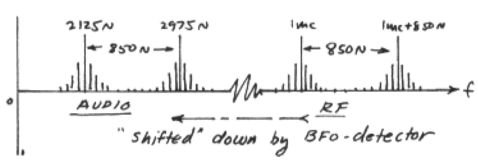


Figure 11

"Modification of the Collins 75A4 Amateur Receiver for Use in the Reception of 850 Cycle Shift "FSK" RTTY Signals"

By WM. H. CARTER, JR. W5ANW
Houston, Texas

The Collins, Model 75A4, is perhaps the best available amateur receiver for "FSK" RTTY reception. It has very little frequency drift in the "VFO" and the "BFO" and contains, as well, a very good filter which passes the two RTTY tones without much interference from adjacent noise or other signals.

These audio tones are created in the receiver by beating the "FSK" signal (after conversion to the IF frequency) with the local "BFO" to generate a "mark" frequency of 2125 cps and a "space" frequency of 2975 cps (as the transmitted signal frequency is shifted .85 kc).

In the 75A4, these audio tones result when the "pass-band" control indicator is set to the 2.5 kc mark of the "lower" sideband. The main tuning or "kilocycles" dial must then be detuned by 2.5 kc. In the opposite (or high frequency) direction since the "VFO" and "BFO" are mechanically coupled and (for SSB reception) the "BFO" must "zero-beat" at the calibration point. This results in the "kilocycles" dial calibration reading 2.5 kc high when an RTTY signal is properly tuned in. It also results in the detuning of the "RF" and tuned "IF" by an amount equal to the 2.5 kc. Indicated by the dial reading. If the above tuning method is used (without modification to the receiver). The signal may also be tuned to the other side of the zero beat which results in an "upside-down" or inverted signal.

For improved RTTY reception with the 75A4, the following is to be desired . . .

First: the signal should be received at the correct calibration as indicated by the figures on the "kilocycles" dial.

Second: The two tones (or the converted "IF" signals) should pass through the mechanical filter well centered so that the signals from "mark" and "space" are as near equal as we can get them and at the same time the edge or adjacent frequencies are cut off sharply above and below the passband.

At this station a 75A4 has been modified, so that in the "FSK RTTY" position, the two tones are received at the proper tuning control calibration and, at the same time, maximum advanage of the mechanical filter passband in the IF circuit of the 75A4 is secured.

This is accomplished by electrically shifting the frequency of the "BF," 2.5 kc. so that when the dial is set at the mid point between "mark" and "space" frequency (of the incoming "RTTY" FSK carriers) – the beat notes from the "BFO" will be 2125 and 2975 cycles.

The "kilocycles" dial of the receiver will then read at a mid point between the two received RTTY frequencies (the "pass-band control is in the centered position).

Please refer to the schematic diagram of the 75A4 in the Collins instruction book for identification of the reference components in the following instructions.

Additional parts needed (parts list):

1—International Rectifier Corp. "Semicap" type 6.8SC2Ø.
(See International Rectifier Corp. data sheet #SR-2Ø5)
1—50,000 ohm 1/4 watt resister
1—.01 disc ceramic condenser.
1—100,000 ohm 1/2 watt resister.
1—10,000 ohm variable resister, linear (pot)
1—Single pole single throw switch.

Procedure:

Remove the bottom plate from the 75A4 receiver and unsolder all of the leads to the "BFO" can assembly. (Be sure to make notes of all disassembly so that the reassembly can be properly and correctly executed.)

Disconnect the brass belt connecting the "VFO" and the "BFO" shaft pulley. (Mark all mechanical connections, so that the entire linkage can be returned to exactly the same relative position). Remove the coupling from the "BFO" condenser, at the can, and remove the entire "BFO" assembly from the chassis, remove the inside assembly from the can.

Locate C-136 inside the "BFO" can assembly and make the following changes:

Remove the grounded lead of C-136 and connect it to the "positive" or case terminal of the "semicap."

Connect the "negative" side of the "semicap" to ground (we will refer to the junction between the "semicap" and the condenser C-136 as "Point A.")

Connect "Point A" through a 50,000 ohm, 1/4 watt, resister, to a convenient tie, "Point B," (insulated).

By-pass, "Point B" to ground through a .Ø1 MFD. Ceramic disc condenser.

Connect an insulated lead wire to the tie "Point B" and bring the other end out of the bottom of the "BFO" assembly (about 12 inches).

Reassemble the "BFO" in the can and re-install in the receiver in a reverse procedure to that used in removal.

Reconnect the lead wires and connections as originally connected.

Install the 10,000 ohm variable resister (pot) in a convenient location so that it can be adjusted from the top of the chassis.

Connect the "CW" rotation end of the variable resister to ground.

Connect the extra control lead wire, from the "BFO," to the arm of the variable resister.

Connect the other terminal of the variable resister through a 100,000 ohm resister to pin #5 of the OA-2 (V-18), which is the voltage regulator.

Install the SPST switch in a convenient location and connect it so that it will tie the arm of the variable resister to ground in the "RTTY" position and open the connection in the "normal" or "CW SSB" position. The modification which we made included the replacement of the "AM-CW-SSB" switch with a three position switch. In this case the third position is marked "RTTY" and maintains all of the circuits of the "SSB" position and in addition it shorts the arm of the variable resister to ground.

Preliminary adjustment:

After the modification is complete and the receiver is reassembled the shift must be calibrated and the "BFO" re-aligned.

First the shift must be adjusted to aprox 25ØØ cycles, this is done as follows:

Turn the function switch to "SSB" position.

Set the shift switch (if not installed on function switch above) to the "open" or "normal" position.

Set the variable resister to full "CW" position.

Set the "pass-band" control to the center position.

Turn on the calibrate signal and tune it in at some convenient dial point.

Zero-beat with the "kilocycles" dial and note the reading. (It will not be correct). Then turn the "kilocycles" dial to read at a point 2.5 dial divisions or 25ØØ cycles lower in frequency (this will result in a 25ØØ cps note).

Turn the variable resister in a "CCW" direction until "zero-beat" is again obtained. This will result in a shift of 2.5 kc when the "RTTY" switch is closed and the calibrate signal will again be 25ØØ cps.

After the above, the "BFO" must be re-aligned so that the dial will again read correctly. This is done as follows: turn on the calibrate signal and set the "shift" switch in the "normal" or open position. Set the "kilocycles" dial at some exact 1ØØ kc point. Now adjust the variable condenser in the top of the "BFO" can for zerol at with the pass-band control centered.

Subscription Rate $2.75 Per Year

RTTY is the Official Publication of the

RTTY Society of Southern California

and is published for the benefit of all RTTY Amateurs and Experimenters

Permission to copy is granted provided credit is given.

For Information Regarding the Society Contact the Following:

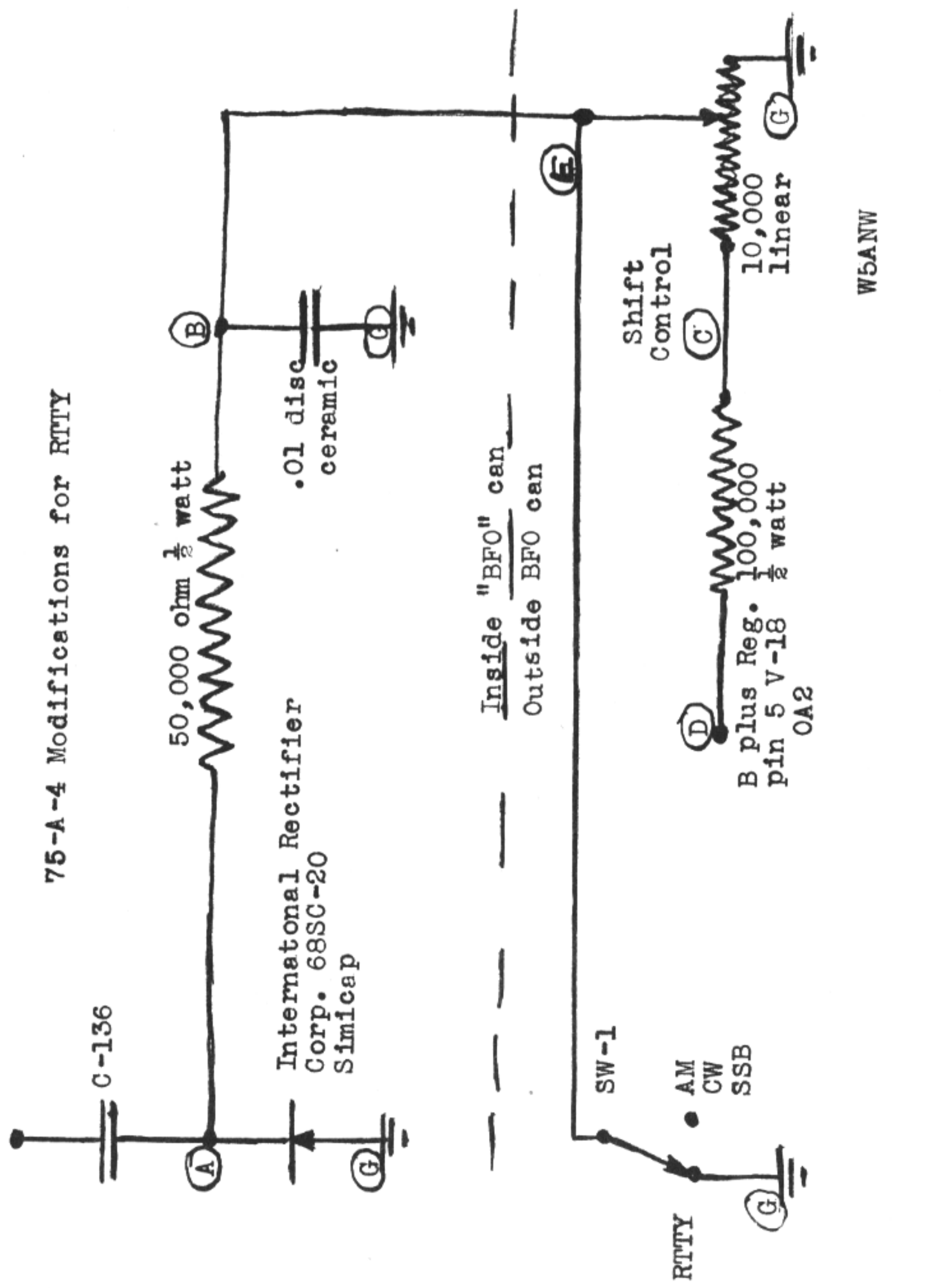
W6AEE — Merrill Swan

W6SCQ — Lewis Rogerson

For Traffic Net Information:
W6FLW W6IZJ

For "RTTY" Information:
W6DEO W6CG W6AEE

This should complete the modification and the receiver should now tune in an "RTTY" signal with the "passband" control in the center and the switch should restore the receiver to normal operation when it is opened.



RTTY-DX

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

Due to the usual seasonal slump and a couple of king size magnetic disturbances, DX activity took some real body blows this month. However, because of the increasing number of DX stations putting in appearances there was still lots to cheer about. Fifteen meters was the major victim of the slump with the usual good openings to Europe cut down to one or two per week. However, fifteen continues to furnish excellent contacts to the South Pacific area nearly every day. Some really fine contacts with Bill, G3CQE, and Jan. PAØFB were logged on 21,090Kcs when the band was in a cooperative mood. Jan, PAØFB, has been quite active on both 15 and 20 meters. His xmitter is a DX-100 and an SB-10. He uses beams on both fifteen and twenty. He prints like a local here on the Coast and is very anxious to get W QSO's. Strangely enough, Jan is plagued by an old American bug-a-boo; TVI, which cuts into his operating hours. He says there are five PA Ø stations licensed for RTTY and that PAØYG will join him shortly on the active list.

Lots of news from my European correspondent, G3CQE, this month. Bill reports a CW contact with ZK1BS but not enough signal strength for RTTY but is continuing the skeds in hopes of making an FSK contact with Rarotonga soon. Bill says that EI6W should be on soon because he bought a complete RTTY set-up from some G station who built it but never put it on the air. Bill also reports some activity from G3BST. Also from G3CQE's report is word that Shank, GM8FM, and Arthur, GW2-FUD, are really running a full head of steam over RTTY and will be putting in an appearance on the bands very soon. A new source of Teleprinter gear in England is really helping to speed things up there. In a recent QSO with G3CQE, two visitors in the shack—namely G3FHL and G3LFU, were given a chance to use the keyboard and now both are badly smitten with the RTTY poison!! No further reports at this time from the DL stations listed in last month's column. Both G3CQE and PAØFB have been putting in an occasional appearance on 14,090 Kcs around 0300 GMT so it might pay to give 'em a look-see every once in awhile.

The South and Central American lads continue to dish out QSO's and conditions seem to be holding up quite well to this part of the world. Rumor has it that TG9AD will be QRT while on a trip out of the country. TG9PS will be able to keep you fellers occupied while Bob is away. Pete continues to put in a really big fat signal to the States. OA5G is still your best bet for a South American contact although a couple of reports on CE3WZ have filtered in here recently. Erosa, XE1BI, was logged on 21,085 Kcs this month with his usual fine RTTY sigs.

Now to the Pacific; Bob W6DTN/MM reports that KR6TB, KR6RN and KR6GF are all active on RTTY. Bob says that all of these lads are willing and able to give RTTY contacts on either fifteen or twenty and are putting tremendous signals into the States. If you still need Asia for WAC-RTTY here's your big chance! Dick, W7-LPM, has been working with Luke, VS6-AZ, on SSB and getting him organized for a big FSK spree. Dick says VS6AZ is all set to go but is having a bit of TU trouble but with Dick's able assistance this soon will be straightened out. In spite of speed and TU problems Bill, ZK1BS, has managed to dish out a goodly number of contacts during the past month. After finally overcoming tremendous frustrations in arranging shipment, Bill Gates' fine TU is finally on the way to ZK1BS. This item should go a long way to making ZK1BS a "regular" on your daily tour of the RTTY channels. Those needing a QSL from ZK1BS should send a S.A.S.E. to W7ZAS.

Last, but by far not the least active this month, are the "old reliables" from down under, ZL1WB-ZL3HJ-VK3KF. These three continue to pound in day-in and day-out. Any time you are needing a lift one of

these three is around to raise your DX morale. Bruce is on nearly every day and always seems to have plenty of "takers." Alec, ZL3HJ, finds time from his ranching to keep his keyboard active on most days. Eric, VK3KF, is still "grounded" by his lack of a printer but this difficulty is now shortly to become a thing of the past. In the meantime he keeps in touch with all his RTTY friends on CW.

In closing I would like to salute RTTY'ers W6AEE, W6NRM, W7LPM, KL7AUV and Bill Gates for their unselfish efforts spent in time, expense, and equipment to help some of the overseas gang get going on RTTY. Merrill, W6AEE, along with Bill Gates cooperated to get a TU down to ZK1-BS. Dick, W7LPM, shipped motor and printer parts to both ZK1BS and VS6AZ in a fine gesture to get them over the "rough spots." W6NRM made a shipment of Toroids to the English lads and is collaborating with Jack, KL7AUV, in getting a model 15 printer to VK3KF. With RTTY gear so hard to come by in these far away places such efforts are of inestimable value to both the recipient and the gang on this side of the world. Undoubtedly m:ny of the rest of you are giving this same sort of friendly assistance, also; so to all of you fine DX'ers goes a tip of the old sombrero. Thanks a million!! C U next month—73 Bud W6CG

AUTO-MATE K5/50

5226 N. Willmonte Ave.
Temple City, Calif.
May 9, 1960

Hi Merrill:

Just wanted to tell you how much I'm enjoying the Auto-Mate K 5/50 keyer. I think it's the greatest thing that ever happened to CW. I can't thank you enough, Merrill, for "needling" me into assembling the kit. This was the first construction job I had ever attempted. Boy oh boy!!, considering that I hardly knew which end of the soldering gun to use and that I had to run to the Handbook for the color code–it only took me twelve and a half hours to put it together.

You would have gotten a kick out of seeing me with a magnifying glass in one hand and a flashlight in the other, trying to see if I had everything lashed down properly to the right terminals. I felt real good when Jerry, W6TPJ, who is an expert, told me he could only find two soldering joints that looked questionable and one mistake in wiring. Afer I corrected these it took off and worked just fine.

Now I am having lots of fun trying to break myself of some of the bad habits I have acquired on a bug. It took me a little time and a few hours of practice to get used to it but by now I can use it very nicely.

The keyer sends perfect CW when the "nut" that holds the paddle is functioning properly. HI. I could suggest that if any of your ham friends are avoiding RTTY because of the CW requirements, the K 5/50 is a practical solution to their problem. It won't help them copy CW any better but it sure will make their "CW Ident." look like they are old time brass pounders. The "hold" switch on the keyer makes it very practical for use during RTTY QSO's.

My main pleasure in hamming is strictly CW and RTTY so the keyer has been a most welcome addition to my operating desk. I just love to hear a good fist on the air and with this Auto-Mate and a little practice I am sure anyone could have a perfect fist.

Thanks again for your interest, Merrill, and hope to see you on the printer here often. Lots of DX and best of luck.

73

Mary K6OWQ.

W4DGW/MM at W5YHR

Earl, W4DGW/MM

LOCAL LOOP AND PRINTER CIRCUIT

FRANK W. TAYLOR, W2KXT

Here is the circuit for the gadget which sure helps as you can copy, off the air, from the keyboard and make tape etc. and you do not have to be tuned to your exact frequency.

It is made on a piece of bakelite and all jacks are insulated from each other. The diodes are top Hat type 1N-93 or 200 volt units at 300 MA.

Adjust the resistor for the number of items in the circuit and resistance of the coils etc. to a value of 60 MA, which when you hit the keyboard or TD goes into operation the MA goes to 10 or 15 then back to 60.

Just 5 Closed circuit tel jacks, 2 Diodes, 1 Resistor and 1 meter, which can be left out when adjusted.

You may have to juggle the polarity of the plugs around but once done it works beautifully, first you copy then you send and receive what you send, then you send tape and also receive same, then you listen and back to copy all without a switch or relay in the circuit. Simple? ? ? I'll say so and it works.

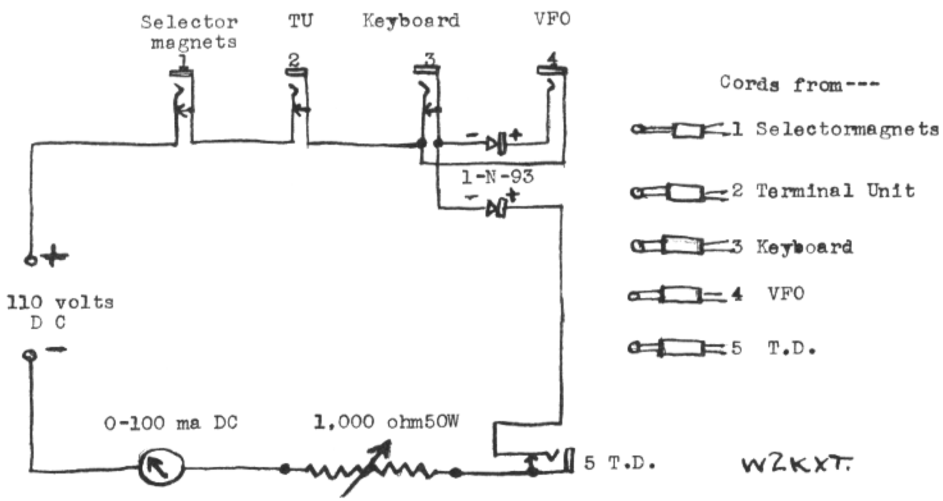
All of the boys on the Air Force RTTY net are using it.

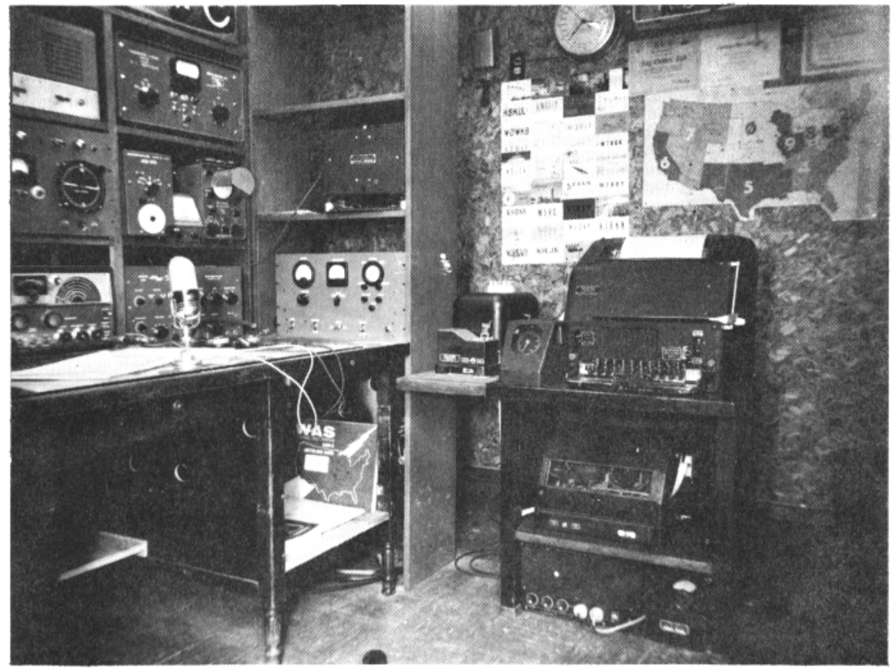
Best 73's, Frank

—0—

NOTE: May RTTY pages 8 and 9, terminal 7 of varistor should be grounded. Also page 15 titled simple printing telegraph was reprinted from Popular Mechanics, 1920.

—0—





K9CNG