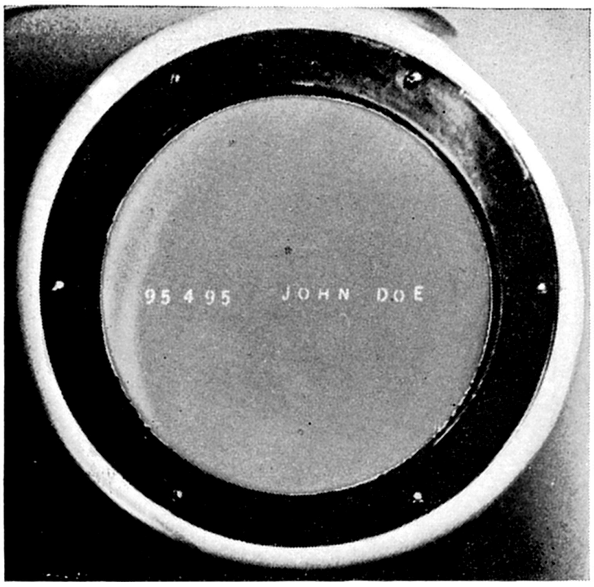



♦

• **Can you imagine a black box that takes ordinary hand-sent c.w. signals and displays their translated message on a screen? Well, there is such a gadget, and some of its basic principles are disclosed in this article.**

♦

# The Application of the Charactron as a Morse Code Converter

## *Instantaneous Visual Display of Translated C.W. Signals*

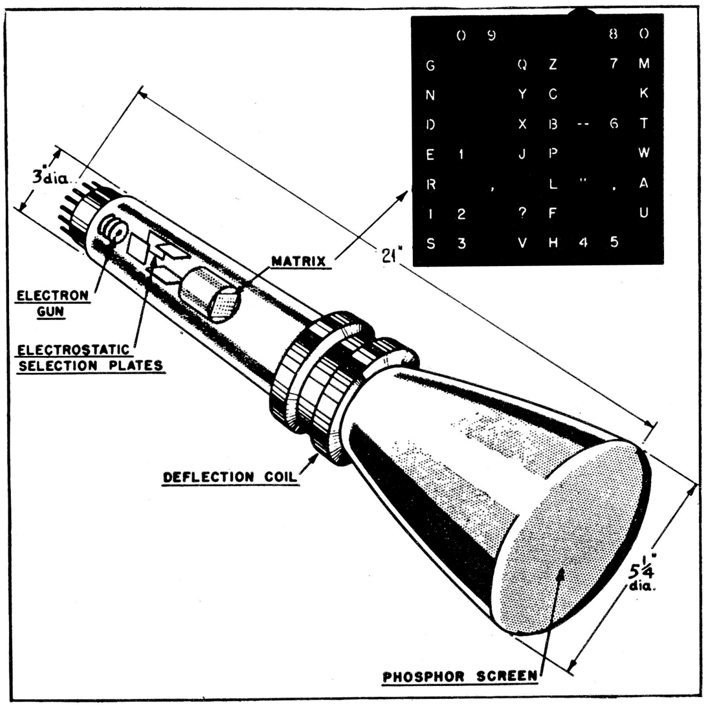
**BY JOSEPH T. McNANEY* AND DONALD F. JACKSON****

The Charactron C.W. Receiver converts Morse Code information into a visual display of printed characters on the fluorescent screen of a Charactron cathode ray tube. The code signals are received in a conventional manner, via radio or landlines. Letters, numerals, punctuation marks, etc., corresponding to the received codes, are printed in one or more lines across the screen of the tube. There are provisions for a total of 32 characters and spaces per line. The persistence of the phosphor will permit the viewing of complete words as the information is received, or the information may be recorded on film or other photographic media.

Messages may be received over a range of speeds comparable to that of hand-worked signals up to the higher-speed transmission rates of modern telegraph systems. The operational rates of the present equipment may vary between 10 and 80 words per minute. Upper speed limits, however, could be extended to several thousand words per minute, if necessary.

The Charactron method of Morse code reception has several distinct ad-

* Chief Engineer, ** Electronics Engineer, Convair Charactron Project, Consolidated Vultee Aircraft Corp., San Diego, Calif.




♦

*Fig. 1* — **An artist's sketch of the Charactron tube, and (*upper right*) the stencil.**

♦

| MORSE TO BINARY CODE CHART | | | | | |
|---|---|---|---|---|---|
| A | ·— | 101111 | W | ·—— | 100111 |
| B | —··· | 011100 | X | —··— | 011011 |
| C | —·—· | 010100 | Y | —·—— | 010011 |
| D | —·· | 011000 | Z | ——·· | 001100 |
| E | · | 100000 | 1 | ·———— | 100001 |
| F | ··—· | 110100 | 2 | ··——— | 110001 |
| G | ——· | 001000 | 3 | ···—— | 111001 |
| H | ···· | 111100 | 4 | ····— | 111101 |
| I | ·· | 110000 | 5 | ····· | 111110 |
| J | ·——— | 100011 | 6 | —···· | 011110 |
| K | —·— | 010111 | 7 | ——··· | 001110 |
| L | ·—·· | 101100 | 8 | ———·· | 000110 |
| M | —— | 001111 | 9 | ————· | 000010 |
| N | —· | 010000 | 0 | ————— | 000001 |
| O | ——— | 000111 | , | ·—·—·— | 101010 |
| P | ·——· | 100100 | " | ·—··—· | 101101 |
| Q | ——·— | 001011 | ? | ··——·· | 110011 |
| R | ·—· | 101000 | — | —···—· | 011101 |
| S | ··· | 111000 | : | —·—·—· | 010101 |
| T | — | 011111 | ; | ·—···— | 101110 |
| U | ··— | 110111 | . | ···—·— | 111010 |
| V | ···— | 111011 | | | |

*Fig. 2* — Morse to 6-element binary code chart.

vantages over the more conventional and oral means by virtue of its ability to print out the information in word and numeral forms. In doing so, reception of such signals is no longer limited to the skilled operator, regardless of transmission rates and particular quality of the message codes.

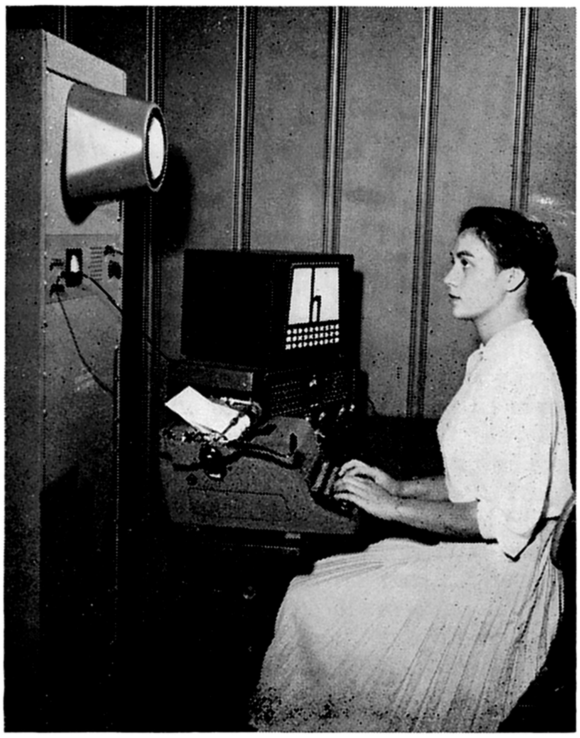
The Charactron cathode-ray tube that makes this possible is shown in diagram form in Fig. 1. This tube is unlike ordinary c.r. tubes in that it contains a stencil of character-shaped openings by which the cross-section of the electron beam is changed in accordance with that of predetermined letters or numerals. Illuminated characters of the independently-shaped electron beams are then positioned on the screen of the Charactron to form the words and sentences.

A stencil layout of characters is also shown in Fig. 1. This arrangement of character-shaped openings in the metal plate lends itself to the system of six-element binary codes shown in Fig. 2, which also includes the corresponding Morse codes and message characters with which they are identified. Although the present equipment was designed to convert Morse codes to letters and numerals of the English language, it could be made to convert such codes to other languages as well by merely employing a Charactron tube having matrix openings corresponding to characters of the desired language.

### *Circuitry*

To convert the Morse code, a dash must be differentiated from a dot. Also, an element space, a character space, and a word space must be sensed as such. In the process of accomplishing this, the input code is routed into four main channels of circuitry that will be described in connection with the block diagram of Fig. 3. The first channel causes the advance of a chain of binary counters. These counters are advanced one count by a pulse produced by the leading edge of each code bit. Each binary counter, in turn, opens Gate 1 through 6 successively, and one at a time. The outputs of Gate 1 through 6 control the condition of a binary code memory block, *F.F.-1* through *F.F.-6*. The input signal to *G-1* through *G-6* is determined by *G-7*.

The input to *G-7* represents the second main channel. The input to *G-7* is pulses produced by the trailing edge of each code bit. Whether



The Charactron Receiver converts ordinary Morse code information into a visual display of characters that can be copied by a competent typist.

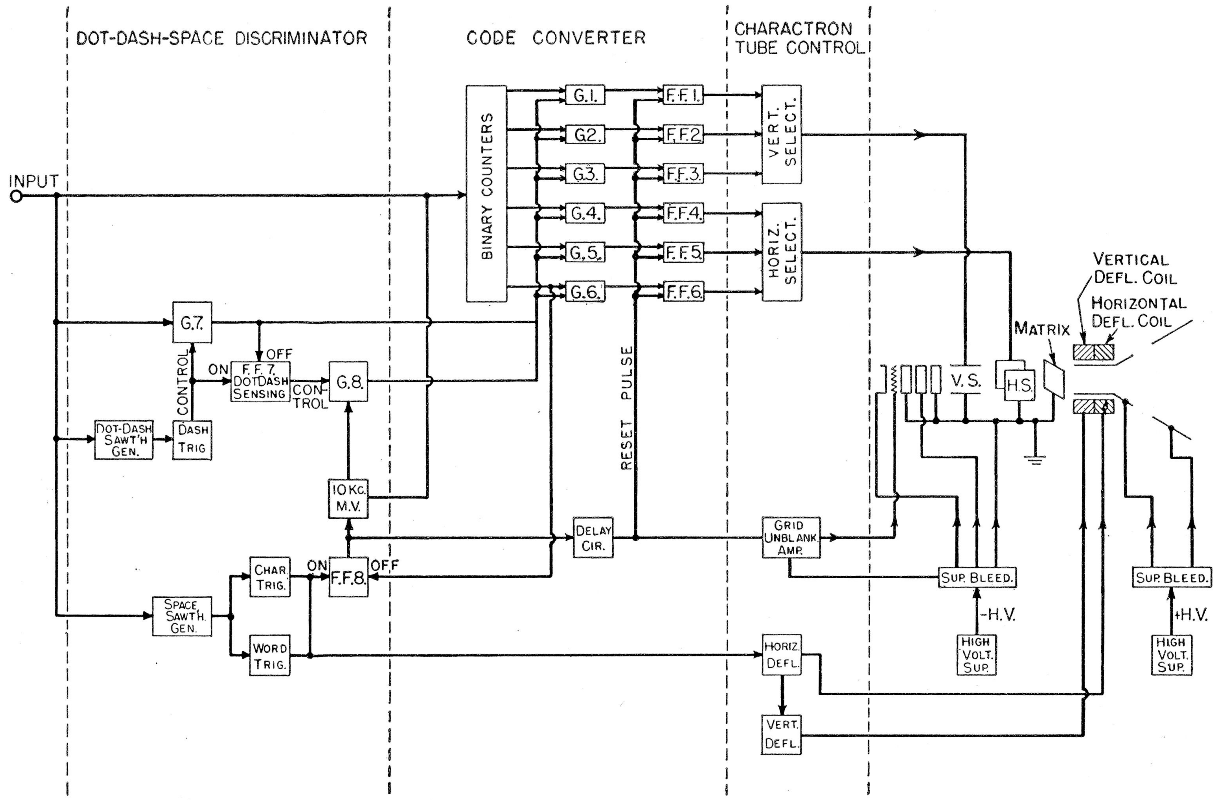



*Fig. 3* — **Block diagram of the code converter.**

these pulses are passed or not passed by *G-7* depends upon the information produced by the third main channel of the dot-dash space discriminator. This channel contains a dot-dash sawtooth generator that produces a sawtooth for each dot and dash seen at its input. The amplitude of the sawtooth function is directly proportional to the length of the input function. For example, if a dash is three times the length of a dot, the sawtooth amplitude for a dash will be three times that for a dot. The sawtooth generator is followed by an amplitude-sensing trigger circuit labeled "Dash Trigger," which will trigger only when dash information is received. The output of this dash trigger circuit will close *G-7* when a dash has been received, but will allow *G-7* to remain open when a dot has been received.

Suppose now that the code for "N" (dash-dot) is received. The leading edge of the dash will advance the binary counter chain and open *G-1;* the dot-dash sawtooth generator will produce a sawtooth that will trigger the dash trigger which in turn closes *G-7*. The pulse produced by the trailing edge of the dash will not pass through *G-7*, since it is closed, and as a result no information reaches *G-1*. Therefore, *F.F.-1* remains in a "no" position.

The leading edge of the dot will advance the binary counter chain and open *G-2*. The Dash Trigger will not trigger, and *G-7* will remain open. A pulse produced by the trailing edge of the dot will pass through *G-7*, and through *G-2*, and then change *F.F.-2* to the "yes" position.

The fourth channel contains a "Space Sawtooth Generator" followed by two trigger circuits connected in parallel, a "character" trigger and a "word" trigger. This channel discriminates between an element space, a character space, and a word space. The sawtooth amplitude derived from the Space Sawtooth Generator is directly proportional to the length of the input signal space. An element space causes no action in this channel. A character space will cause the Character Trigger circuit to function, and a word space will cause both the Character Trigger circuit and the Word Trigger circuit to function. The latter action occurs by setting the Word Trigger circuit at a higher triggering level than the Character Trigger circuit.

When a character space is received, the Character Trigger circuit is energized, and *F.F.-8* assumes an "on" condition that turns on the 10-kc. multivibrator. The function of this multivibrator is to complete the binary count in the code converter and to set up either "yes" or "no" information in memory sections *F.F.-1* to *F.F.-6* that has not been set up by the input code.

If the last element preceding a character or word space is a dot, the remaining flip-flops (*F.F.-1* to *F.F.-6*) remain in the down or "no" condition, while if the last element preceding a character or word space is a dash, the remaining flip-flops assume the up or "yes" condition.

The above action occurs as follows: The Character Trigger is triggered, which flips *F.F.-8* to its "on" state, which turns on the 10-kc. multivibrator. If the last element of the code was a dash, the output of the Dash

Trigger flipped *F.F.-7* to the "on" condition, which opens *G-8* and allows pulses produced by the 10-kc. multivibrator to pass on to *G-1* through *G-6*.

At the same time, the 10-kilocycle multivibrator is advancing the binary counters and opening the remaining gates of *G-1* to *G-6*, allowing the pulses passing through *G-8* to pass through the above gates and change the remaining flip-flops (*F.F.-1* to *F.F.-6*) to the on or "yes" condition. If the last element of the code was a dot, the pulse out of *G-7* will flip *F.F.-7* to the "off" condition and close *G-8*. The output from the multivibrator will not pass through *G-8*, and the remaining flip-flops (*F.F.-1* to *F.F.-6*) will remain in the down or "no" condition. When the last count of the binary-counter has occurred, it will produce a pulse that flips *F.F.-8* to the "off" condition, which turns off the 10-kc. multivibrator.

The output of *F.F.-8* is fed also to a delay circuit that allows time to set up the binary memory circuit and then produces an unblanking pulse that is fed to the grid of the Charactron tube. The trailing edge of this unblanking pulse initiates a reset pulse that is fed to the memory circuit (*F.F.-1* to *F.F.-6*) and resets these flip-flops to the normal "no" condition in readiness for the next input code.

The outputs of the Character Trigger circuit and the Word Trigger circuit are fed to the deflection circuits that cause screen position advance. If a character space is received, only the Character Trigger circuit is energized, and one pulse is fed to the deflection circuits. If a word space is received, the Character Trigger circuit is triggered, and then the Word (space) Trigger circuit is also made to function, allowing two pulses to be sequentially fed to the deflection circuitry causing a two-space advance.

Discrimination and tolerance figures of Morse codes are shown in Figs. 4 and 5. Areas of acceptance for dots and dashes are explained in Fig. 4, while in Fig. 5 an explanation of the areas of acceptance will be found for word spaces, character spaces, and element spaces. The discriminating ability of the equipment regarding the length of dots, dashes and spaces will be found to be more than adequate over the range shown from 10 to 80 w.p.m. For example, at 60 w.p.m. the time of a dot may vary between 3 and 23 milliseconds; a dash, between 24 milliseconds and infinity; an element space, between 2 and 23 milliseconds; a character space, between 24 and 73 milliseconds; and a word space between 74 and infinity.

It should be kept in mind that the indicated speeds are based on normal time lengths of elements and spaces. For instance, if at a 60-w.p.m. rate the time of a dash is increased from 47 to 57 milliseconds, the average rate would, therefore, be less than 60 w.p.m. While the equipment is in the process of adjusting itself to instantaneous changes in speed, it is at the same time discriminating between the different length code elements and different length spaces of message codes. This automatic compensating action of the Charactron C.W. Receiver thereby permits the reception of individual codes without interruption, provided the tolerances set forth in Figs. 4 and 5 are not exceeded.

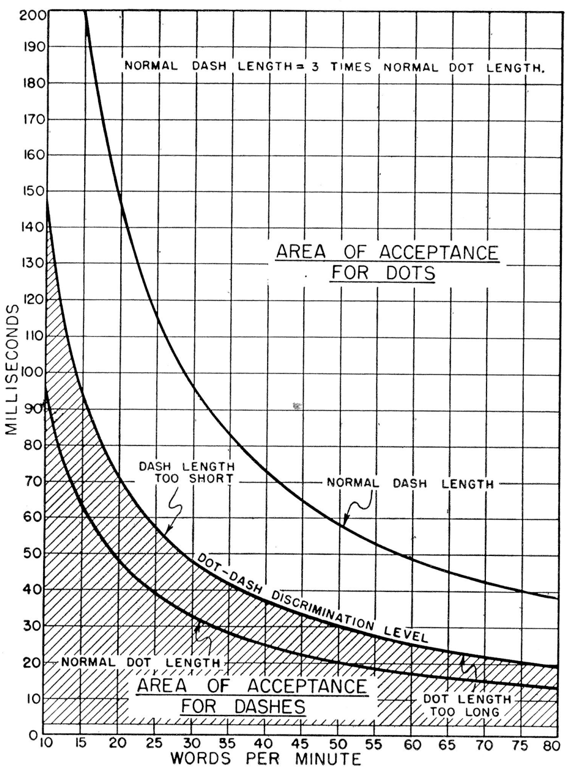



*Fig. 4* — Dot-dash discrimination and tolerance of the Morse code converter.

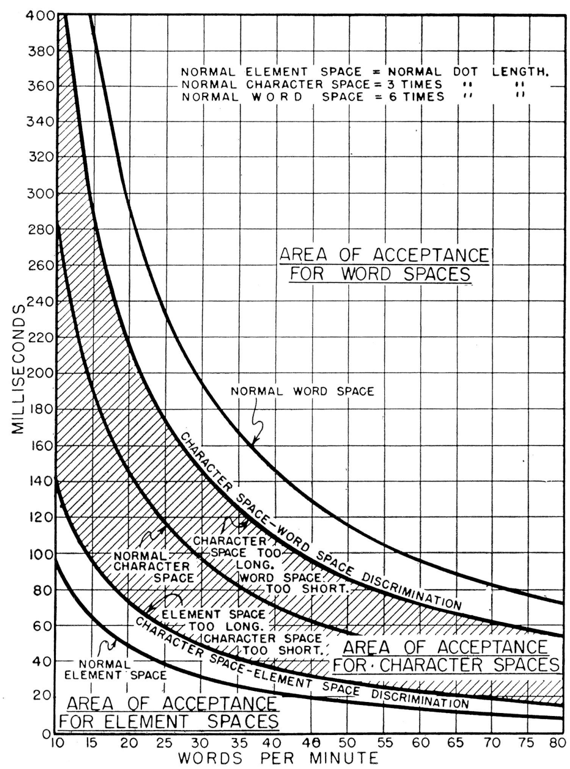



*Fig. 5* — Character and word space discrimination and tolerance.