Product Review Column from *QST* Magazine

March 1983

Bearcat 100

Communications Specialists SS-32M CTCSS Encoder

Cushcraft R3 Three-Band Vertical Antenna

Kantronics CW Training System

Macrotronics Code Class

Mirage C22 And C106 All Mode 220-MHz Amplifiers

Conducted By Paul K. Pagel,* N1FB

Cushcraft R3 Three-Band Vertical Antenna

When asked if I would be interested in reviewing the Cushcraft R3 10, 15 and 20-meter antenna, I was pleased to accept. I had moved from a "no antennas" townhouse to a single-family house just two weeks earlier. Outside antennas were now allowed, but space was limited. I needed an effective antenna system for these three higher-frequency bands; a trap vertical seemed like a good compromise.

The R3 is more than an ordinary trap vertical! It operates as a 1/2-λ radiator on the three bands, and comes equipped with a sealed matching-network assembly and a remote tuning capacitor. A 24-V motor drives the large variable capacitor to match the antenna impedance to 50-ohm coaxial cable. Coupled to the capacitor shaft is a potentiometer, which provides a voltage drop that is monitored in the control box. The tuning control unit meter face is calibrated to show for which frequency band the capacitor is set.

Assembly

I spent a little more than an hour taking inventory of the kit hardware and reading the assembly instructions. As I examined the capacitor tuning assembly, my curiosity caused me to remove the cover to see what was inside. The cover should not have come off as easily as it did! A ceramic feed-through bushing on the top of the unit has a short piece of wire soldered to a lug on the variable capacitor (Fig. 1). This joint was cold soldered and loose on the review unit! Reconnection required that I remove the feed-through insulator, solder the wire and then reinstall the insulator as the cover was being put back in place. Had I not found this problem before installing the antenna, it would have led to frustration and much wasted troubleshooting time.

Antenna assembly took about two hours. I usually work slowly, reading directions several times as I go. The instruction sheet that comes with the R3 refers you to four different drawings for assembly details. Even after careful study, I had a few nuts, bolts and washers left over at the end. As I looked at the drawings again, I saw where I had forgotten to install the parts. I had to disassemble some of my work to correct the errors.

The instruction sheet says the antenna is designed to fit "conveniently" over a 1-7/8 inch OD tube.[1] A check with local electronics shops and TV dealers led to a morning spent trying to locate a short mast on which to mount the antenna. I found a hardware store that could supply galvanized pipe of the proper dimensions, but at a price greater than $5 per foot! I found a 6-foot section of 1-1/2 inch copper pipe at home. With a wooden plug in the top (to prevent crushing), this has served as a mast. The antenna is mounted on a 4-foot-high extension attached to the back of my garage. This places the bottom of the antenna about 10 feet above ground.

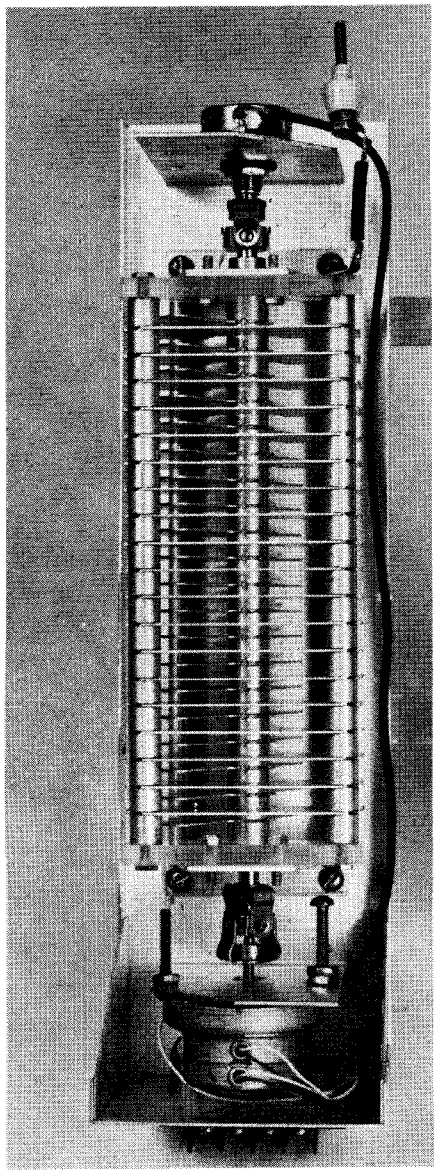


Fig. 1 — A look inside the capacitor tuning assembly. The short piece of wire between the capacitor and the ceramic feed-through bushing can be seen at the top right.

The instruction sheet cautions you to be sure the four-conductor control cable (not supplied) is connected in the same sequence at both ends. I found no indication of the correct sequence, so I assumed that as I looked at both terminal strips they would be the same from left to right. I connected a color-coded cable in this manner and turned on the control unit. The meter needle vibrated noticeably, and the TUNE control did nothing. I reversed the leads on the control unit and everything worked fine! A label on the terminal strips would be helpful. (As I prepared to write this review, I glanced at the instruction sheet again. Sure enough, the terminals *are* shown there, numbered — you guessed it — in reverse order from each other!)

Included with the literature is a pamphlet entitled, "How to Install your Outdoor Antenna Safely." It begins, "These safety recommendations apply to all Cushcraft CB, TV, Amateur and General-Purpose Communications Antennas." It contains a wealth of information on safe antenna installation procedures, stressing the danger of allowing the antenna to contact power lines. There is an inappropriate warning, however: "Remember that the FCC limits your antenna height to 60 feet." There is no indication that this applies only to CB installations.

Tables of voltage and resistance measurements taken at the control box and at the capacitor tuning assembly are included to aid you in troubleshooting the control circuit. A chart of troubleshooting checkpoints should also prove helpful if any problems develop.

Performance

SWR curves for the completed antenna are shown in Fig. 2. I built it to the dimensions suggested in the instructions. As you can see, lengthening the 10-meter portion would improve the SWR on the low end of the band, but I didn't think it was worth taking the antenna down to fool with it! Of course, the SWR curve doesn't tell the whole story. Even a dummy load should have SWR characteristics like this. The R3 is no dummy, though. When compared to using a 120-foot wire antenna and Transmatch, it provided two to three S units improvement in received signal strength at most times. On transmit, it also performed admirably. In my installation, the antenna is not high above the ground, and is within 20 feet of three very tall maple trees. In spite of this poor location, I was able to work plenty of European and West Coast stations and I received good signal reports.

The R3 requires no radial system, and so takes up almost no horizontal space at all. It is light in weight and mounts easily on a roof or to the side of a house. If you are looking for a good three-band antenna without the expense and effort of installing a tower and triband beam, the R3 could be for you. Leaving the tuning assembly and bottom section together, the antenna should be easy to take apart and put back together. This would make it an ideal

[1]mm = in. × 25.4; m = ft × 0.3048

*Assistant Technical Editor

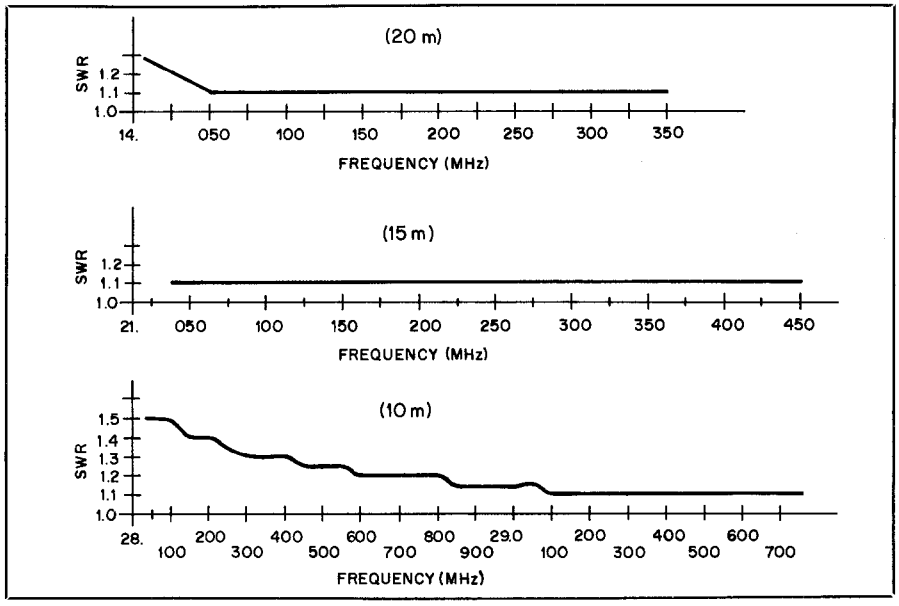


Fig. 2 — SWR curves for the Cushcraft R3 vertical antenna. No length adjustments were attempted after the initial construction.

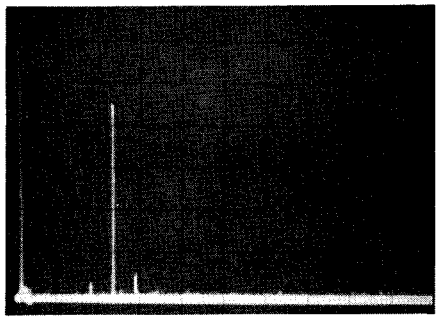


Fig. 3 — Worst-case spectral display of the Mirage C-22. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 20 W at 220 MHz. The fundamental has been reduced in amplitude approximately 23 dB by means of notch cavities; this prevents analyzer overload. All spurious emissions are at least 64 dB below peak fundamental output. The C-22 complies with current FCC specifications for spectral purity.

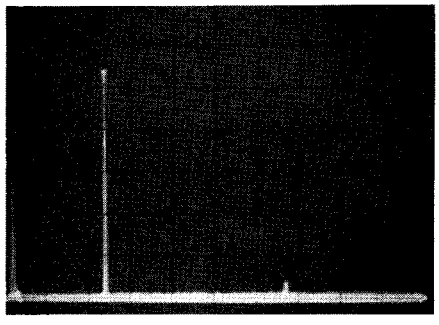


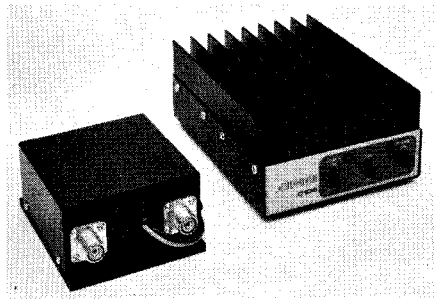
Fig. 4 — Worst-case spectral display of the Mirage C-106. Measurement conditions remain the same as for the C-22. The fundamental has been reduced in amplitude by about 15 dB to prevent analyzer overload. Power output is approximately 60 W at 220 MHz. The C-106 complies with current FCC specifications for spectral purity.

antenna for portable applications.

The R3 is available from Cushcraft Corporation, 48 Perimeter Rd., P.O. Box 4680, Manchester, NH 03108. Price class: $330. — *Larry Wolfgang, WA3VIL*

MIRAGE C22 AND C106 ALL MODE 220-MHz AMPLIFIERS

☐ One of the brighter aspects of vhf fm operation is the wider range of products available for the 220-MHz enthusiast these days. Mirage has introduced two amplifiers ideally suited for use



with low-power hand-held transceivers. As with their amplifiers for the other bands, these are linear amplifiers and may be used for any mode of operation. Depending on input/output power requirements, one or both of these amplifiers might be ideal for the operators on the "low end" of 220 MHz.

The C22 is identical in appearance to the B23 reviewed earlier (May 1981). The resemblance to the 2-meter version goes even deeper than looks. Like the B23, the C22 uses an MRF240 for a single stage of amplification. At 220 MHz, the potential output power for the transistor is lower, but otherwise it functions quite well. Engineers from Motorola tell me that this is true for most of their line of modern "vhf" transistors. The C22 produces 20 W of output power with an rf input power of 2 W. A signal as low as 200 mW will key the rf switching circuit — which is identical to that of the B23. The first C22 failed shortly after it arrived, and Mirage replaced it. The second C22 has performed flawlessly during several months of mobile use. If you are looking for a compact "brick" to go along with your 220-MHz handheld unit, consider the C22.

Mirage has provided for the mobile or base operator who wishes to boost the output of the typical 10-W transceiver to the 60-W level. The C106 is similar in appearance to the B108 2-meter amplifier, and it has the same features. Like the C22, the C106 can be keyed with as little as 200 mW. With a 2-W drive level, it will deliver approximately 20 W of output power, making it useful with "hand-helds." With 10 W of drive power, the output power climbs to 60 W or more. A single MRF247 provides this gain.

The C106 also has a built-in receiver preamplifier which provides 10-dB gain with a 2.5-dB noise figure. A front panel switch permits the user to turn the preamplifier on and off. A second switch allows the user to add a dropout delay to the antenna relay, facilitating use with an ssb transmitter. The third switch on the panel of the C106 applies power to the transistor driving the antenna relay. If the amplifier is located near the operating position, the user has complete control at this fingertips.

Of course, I wanted to mount the C106 in the trunk of my car. Mirage has very wisely taken care of that contingency. An option for the C106 is the RC-1 remote-control head. The RC-1 is a 1-1/2 × 3-1/2 × 1-1/2 inch (HWD)

Mirage C22 220-MHz Amplifier

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency range: 220 to 225 MHz.	As specified.
Power output: 20 W (nominal) at 13.6-V dc with 2-W drive.	As specified.
Input VSWR: Not specified.	Less than 1.5:1.
Spurious and harmonic output: Not specified.	−65 dB (See Fig. 3).
Size: (HWD) 2.25 × 4.75 × 4 inches (57 × 120 × 100 mm)	
Weight: 1.25 pounds (0.567 kg)	

Mirage C106 220-MHz Amplifier

Manufacturer's Specifications	*Measured in ARRL Lab*
Frequency range: 220 to 225 MHz.	As specified.
Power output: 60 W (nominal) at 13.6-V dc with 10-W drive.	As specified.
Input VSWR: Not specified.	Less than 1.5:1.
Spurious and harmonic output: Not specified.	−65 dB (see Fig. 4).
Receive preamp: Nominal 10-dB gain with 2.5 (±0.5) dB noise figure.	6-dB gain with 2.8-dB noise figure.

box with three switches and two LED status indicators that connects to the amplifier with a 20-foot-long cable (supplied). One simply sets the amplifier switches to POWER OFF, FM and PREAMP OFF; control of these functions is then accomplished with the RC-1. I've used the C106 and RC-1 with a Midland 13-509 transceiver for several months and am delighted with the performance. The combination of the receiver preamplifier and the extra output power is ideal for fringe-area usage. If you are on 220 MHz with a "barefoot box," you may want to consider the C106. It'll help you "hear" as well as "talk."

Price classes: C22, $90; C106, $200; and RC-1, $25. More information may be obtained from Mirage Communications Equipment, Inc., P.O. Box 1393, Gilroy, CA 95020, tel. 408-847-1857. — *Peter O'Dell, KB1N*

KANTRONICS CW TRAINING SYSTEM

☐ Contrary to the belief of some, cw is *not* dead! With this thought in mind, Kantronics developed a system that teaches cw to the beginner, and it also can be used by those who are already familiar with the Morse language to increase their proficiency. The system consists of a booklet and a computer code-practice program.

The Text

Morse Code, Breaking the Barrier, by Phil Anderson, WØXI, is a step-by-step instruction manual written to familiarize the beginner with the Morse code. The booklet contains five chapters. The subjects range from the structure of the Morse code right through copying off the air.

Chapter 1 introduces the "mechanics" of the code. The reader is made familiar with the elements that letters are "coded" from. Several examples are given, with the proper timing emphasized through "real-time" figures.

Chapter 2 defines the FCC regulations regarding the speed at which one must copy cw to obtain an amateur ticket. This chapter then presents a method for determining the speed of a tranmission.

Chapter 3 is entitled "Learning to Receive Code." The text in this chapter instructs the student in the proper method of learning "letter codes," with the intent of learning to copy the entire alphabet, a few basic procedure signals and punctuation.

Chapter 4 contains flashcards for initial memorization of letter sounds. The user is instructed to "read" a sound from the card and say the letter that corresponds to that sound. The correct letter, by the way, is printed on the back of each card.

Chapter 5, entitled "Special Codes/Copying Off the Air," introduces the aspirant to some Q signals and a few procedure signals.

In addition to the five chapters mentioned previously, the book contains separate appendices for symbols, numbers, abbreviations and Q signals. After reading these the user will be familiar with the jargon likely to be encountered in typical QSOs.

Software

The second portion of the training system is a computer program, "Hamsoft Code Practice: APPLE," written for use with a disk-based Apple II microcomputer system. The program is divided into six segments, ranging from beginner to actual QSOs (similar to the format used by the FCC). Each of the segments allows the user to select the desired speed, from 1 to 60 wpm.

The Beginner selection contains a choice of seven four-letter groups, with the XCAD group suggested as a starting point. Using this option, the student can practice the letters that are the most troublesome. After a slight pause, the previously sent letter is displayed on the screen.

"Letters" and "Numbers" choices send 18 five-character groups, and print them on the screen after the 18 groups have been sent (a handy tool for checking the accuracy of copy).

The "Calls" option sends a list of 15 call signs and displays them on the screen after the group is sent. This selection is handy for the experienced ham who is planning on going on a DXpedition and wants to practice call sign copying.

The program also contains an "Abbreviation" option, which sends 16 short words/abbreviations at a clip, displaying them on the screen.

"QSOs" allows the user to copy two FCC-type QSOs, and then check the copy by comparison to the "sent text" shown on the screen. I noted that the software could provide sending faster than 60 wpm in this mode, but after the text was sent, the computer "crashed" or locked up.

Comments

The program performed flawlessly during the time I was reviewing it. The training system is available from Kantronics, 1202 East 23 St., Lawrence, KS 66044. Price class: $30. — *Michael B. Kaczynski, W1OD, ARRL Hq.*

MACROTRONICS CODE CLASS

☐ Learning the Morse code can be difficult if one does it the wrong way (as I did). I memorized the code from a list of dots and dashes. When I copied the code off the air, I had to translate each character from a sound (di-dah) to the dot and dash equivalent, and finally to the alphanumeric equivalent. At 5 wpm, I could perform these mental acrobatics easily. As the speed climbed toward that enigmatic 13 wpm, however, I could not make the translation fast enough — getting it down on paper was impossible.

At that point, I discovered that I had to relearn the code by character sound and translate that sound directly into an alphanumeric format. The Macrotronics Code Class is a computer program for the Radio Shack TRS-80® Models I and III that teaches code in this manner. You never encounter a dot or a dash — only sounds and their alphanumeric equivalents. To hear the code, you must connect an audio amplfier and a speaker to the TRS-80 cassette audio input. The video display will "tell" you or "test" you on the code that is being sent.

Code Trainer

The code may be sent at speeds of 1 to 1000 wpm. Transmission speed is controlled by pressing the up-arrow and down-arrow keys on the computer keyboard. The program has five functions. A "code trainer" function consists of 11 lessons that drill you, four characters per lesson, in the following manner:

1) The program generates the code audibly for one character.

2) You press the key of the character that the sound represents.

3) If you are correct, the program tells you so both visually and aurally.

4) If your entry is wrong, you are visually and aurally informed and you hear what your guess actually sounds like (instant feedback). You are then retested for the incorrectly guessed characters. As you progress, you can include all the characters from previous lessons in the current lesson, or you can limit the drill to the four characters in that particular lesson.

Code Practice

Three of the other functions, the "code practice" portion, fill the video display with random words, random alphanumerics (in five-letter groups) or random call signs. The program generates the code for all of the characters on the screen at the speed you desire, and you attempt to copy the code. When the program has generated the full screen of characters, you can check your written copy against the display to see how well (or how poorly) you did.

The fifth program function allows you to send cw to the computer to check the quality of your sending. Whatever you send is displayed on the screen, allowing you to see how others copy your "fist." The program also displays your sending speed. (To use this fifth function, you must have Macrotronics interface — models M80, M83, CM80, CM83, TM80, TM83 or Terminall — connected to the TRS-80 to provide interface for your key, bug, etc., to the computer.)

Evaluation

The program runs flawlessly; I found no bugs. Documentation (a nine-page manual) is good. The program loaded from diskette perfectly (it is available in both disk and tape version for the TRS-80 Models I and III). This program teaches Morse code in a logical manner and can be adapted for classroom code learning.

Code Class is produced by Macrotronics, Inc., 5125 N. Golden State Blvd., Turlock, CA 95380. The cassette version costs $29; the disk version costs $39 (when ordering, specify Model I or III). — *Stan Horzepa, WA1LOU*

COMMUNICATIONS SPECIALISTS SS-32M CTCSS ENCODER

☐ When the ICOM IC-3AT came in for review and was assigned to me, I had only one question, "How am I ever going to get a CTCSS (PL) encoder inside that tiny little thing?"[2] Some of the people on W1NI/R had already purchased IC-3s and installed encoders, so I knew it was in the realm of the possible. Upon callng ICOM, I was told they did not have a CTCSS option for the IC hand-held series, but they did recommend the Communications Specialists SS-32M. Communications Specialists happily supplied us with an SS-32M for use with the IC-3AT.

The problem was the installation — a miniature encoder must fit exactly into a miniature space inside a miniature transceiver. Finding my medicine cabinet devoid of "dauntless technician" pills, I called Arnie Chase, WA1RYZ, and asked if he would help. Sure, he had already installed several in other IC-3s.

Arnie performed the surgery with minor assistance from me. The encoder nests in a

[2]Product Review, *QST*, February 1982.

hollow spot between the two circuit boards — it is critical that the encoder board be positioned properly. Instructions provided with the SS-32M give detailed installation information for any of the ICOM hand-helds. Three wires coming from the encoder must be routed to the proper circuit board areas. Communications Specialists suggests modifying the IC-3AT by adding a 4.7-μF capacitor (supplied) in parallel with C13 (2.2 μF) on the PLL. Arnie felt it was easier to remove C13 and replace it with a 6.8-μF capacitor. A subminiature 100-kΩ potentiometer (included) serves as a deviation control.

Circuitry and specifications of the SS-32M are similar to the Communications Specialists TE-64;[3] the SS-32M is designed for the 32 standard CTCSS tones only and does not have provisions for generating the audible tones. Frequency selection is accomplished by grounding pins on the single IC with solder-bridge jumpers. A programming chart provides information on which pins should be grounded to produce a specific CTCSS frequency. For example, the code for 100.0 Hz is 01011 (the sequence represents pins 10, 11, 12, 13 and 14); pins 10 and 12 are grounded with the jumpers, and pins 11, 13 and 14 are left unconnected. Any of the other 31 standard tones can be selected by grounding different pin combinations.

Before starting the installation, I estimated it would take about 20 minutes to complete the job. It took closer to 60 minutes, and Arnie said it was typical. If you are not intimidated by the thought of working on miniaturized equipment and you have some experience, it is reasonable to expect a similar installation time. If you are hesitant to tackle the installation, I suggest you turn the project over to the service department of a qualified dealer (if you don't have a friend like Arnie).

Price class is $30 (without installation). Additional information can be obtained from Communications Specialists, Inc., 426 W. Taft Ave., Orange, CA 92665. — *Peter R. O'Dell, KB1N*

Bearcat 100

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Sensitivity for 12-dB SINAD:	Sensitivity for 20-dB quieting:
Low band — 0.6 μV	33.760 MHz — 0.85 μV
High band — 0.6 μV	138.150 MHz — 1.2 μV
Uhf — 1 μV	406.125 MHz — 1.8 μV

BEARCAT 100

☐ The Bearcat 100 is a 16-channel hand-held programmable scanner featuring coverage of the 30-50 MHz, 138-174 MHz and 406-512 MHz bands. It is about the size of a typical amateur hand-held transceiver 7 × 3 × 1-3/8 in. (HWD) and weighs approximately 1 pound[4]. It has a liquid crystal display and a two-second scan rate, and is powered by six AA NiCd batteries.

In addition to the scan feature, which will sample up to 16 discrete frequencies that you have entered into the unit's memory, the Bearcat 100 has a search mode. It will sample all frequencies within a specified range of frequencies to locate signals that would otherwise be undetectable. All you have to do is enter the lower and upper search limits.

A logical question is, "Why would an amateur want to have a portable scanner?" There are at least four good reasons, not all of which might apply to you. I live within range of at least a dozen 2-meter repeaters. With the Bearcat 100, all of them, plus simplex frequencies, can be monitored with ease. For those who travel and frequently find themselves in strange cities, the search feature can be used to locate active repeaters — even those not listed in the *Repeater Directory*. Police, fire and other public service channels can be monitored, potentially improving response time in emergencies. Of course, scanning can be fun, too.

One disadvantage of the Bearcat 100 is that the front-panel pushbuttons have a distinct lack of tactile feedback; they fail to give you a positive indication that the data has been successfully and accurately entered. You'd best keep your eye on the display. This can cause problems at night or when driving. The unit comes with a heavy-duty carrying case with a belt loop. You can't access the pushbuttons while using the case unless you use a razor blade to cut out a suitable opening. All in all, if you feel you have use for a portable scanner, the Bearcat 100 packs a lot into a small package. Price class: $450. Available from Electra Co., Div. of Masco Corp. of Indiana, 300 East County Line Rd., Cumberland, IN 46229. — *Hal Steinman, K1FHN*

[3]Product Review, *QST*, September 1980, p. 41.

[4]kg = lb × 0.454

New Books

☐ *Ferromagnetic Core Design & Application Handbook*, by M. F. "Doug" DeMaw. Published by Prentice-Hall, Inc., Englewood Cliffs, NJ. First edition, 1981. Hard-bound, 6 × 9 inches, 256 pp., $24.95.

There is hardly a circuit today — from the milliwatt QRP rig to the most complex computer — that does not employ a ferromagnetic-core device of one kind or another. Are you one of those who simply wondered what these modern-technology devices are all about? Or are you the experimenter and "homebrewer" who has collected folders full of manufacturers' data sheets for toroids, rods and pot cores, and who prayed for a comprehensive reference manual? Cheer up! Doug DeMaw, W1FB, who has contributed so much to the pages of *QST* as Senior Technical Editor, has written an outstanding book on the subject. It has all the ingredients to become the standard reference manual on ferromagnetic-core devices for amateur, technician, student and engineer alike in the years to come.

The 256 pages of this handsome hard-cover book, comprising five chapters and appendix, are well organized and illustrated. The author covers a seemingly complex subject in easy-to-understand language and superb writing style. He refers to basic formulas associated with ferromagnetic-core technology only when essential and keeps cumbersome textbook-type math to a minimum. This handbook does not seem to omit anything, yet is not technically overpowering — going from basic theory and application to proper selection and use of design concepts. For a layman such as I, it is especially gratifying that the practical aspects of ferromagnetic cores are covered so well for amateur and professional alike. For instance, the author's treatment of ferromagnetic-core baluns is most valuable and suitable to the amateur. Likewise, the reference table for standard core sizes of ferromagnetic material will be a real asset to anyone trying to wind a coil, choke or transformer. The circuit examples given are practical, lab-researched and proven.

The many topics presented in this book defy individual listing. Rods, bars, slugs, beads, sleeves and pot cores — all are dealt with in a "hands-on" manner. Sample circuits are added throughout. The appendix is full of valuable references, including IEC publications, magnetic-core symbology, manufacturers' names and locations, core size and selection charts — just to mention a few. Ferromagnetic-core technology is ably presented in this remarkable book. — *Hans J. Meurer, W2TO*