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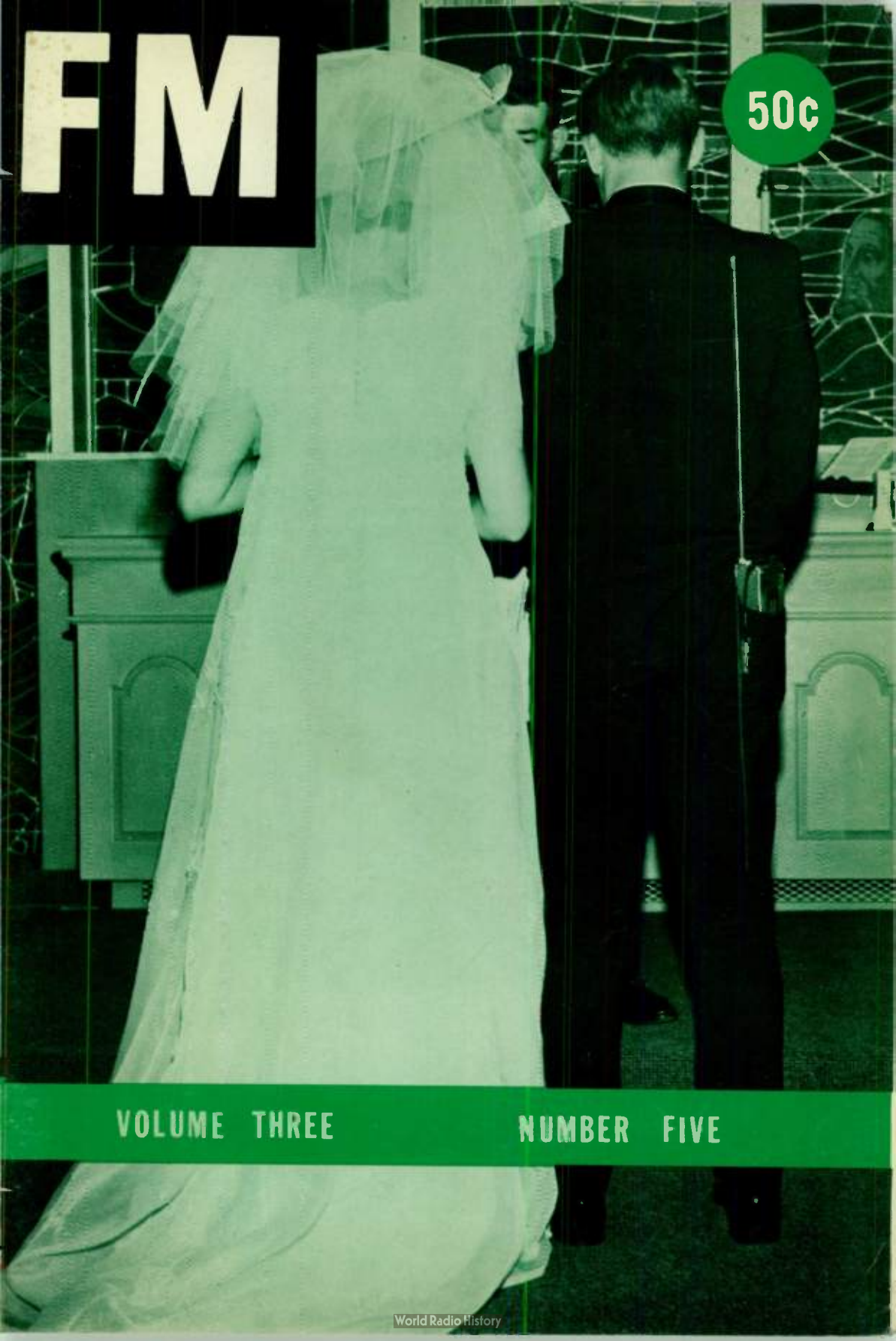

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Volume 3 Number 5

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Wonder where to put the groceries in the trunk of your Mustang when a two case rig has been installed.

Get speared in the basement by a 432 antenna being prepared for desk top operation.

Run your last pair of good stockings on the two meter rig that takes up "just a little" space under the dash.

Serve cold suppers because a final final final really isn't.

See more of your basement than your upstairs if you want to see more of your husband.

Knit knee warmers to wear in the basement.

Know the answers for telephone TVI complaints.

Know what mail is important (FM magazines, FM ads, FM catalogs) and what is unimportant (bills for electricity, gas, etc.).

Be able to smile and look interested when your husband tells you how great his brand new 41-V is. (Whatever that is.)

Be able to smile and look like you believe it when he tells you what a bargain it was.

Be able to smile when you write the check.

Know which tone of "gosh darn" means to stay away and which tone means to come here quick and hold the soldering iron.

Hug him and say "That's great, dear" when he shows you the schematic of his of his new super oscillating capacitance blurb.

Grin and bear it when he digs up your best rose bush because that's the place for the base of his new antenna, and besides dear your roses look so much better where I transplanted them. (Behind the garage.)

Look concerned and say tsk, tsk, when he tells you about the squeak in his squelch.

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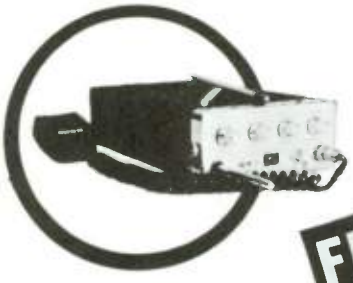

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Each month, FM Magazine will publish a notice as to how many subscriptions have been sold by the leading contender — this as an incentive to others who are trailing by only a few subscriptions. (Be sure to keep an accurate account of your status for your own records, in the event that some of the mail gets lost between your city and Grosse Pointe.)

The subscription rates are:

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Michael
Van Den Branden

editorial

Instant FM communications has burst into the lead for public service budgets throughout the country. While manufacturers working closer to Dick Tracy's wrist radio, developments in Ic's, transistors, and Ni-cads are responsible for the miniaturized hand-held units presently being marketed, which are just a little larger than a pack of cigarettes and weigh just under a pound. Next might be the development of a new power source – the size of the energy cell presently being used in wrist watches.

New York's Mayor John Lindsay recently announced his city's purchase of the entire first production run, over 600, of Motorola's model HT 220. Heading toward his goal for every patrolman to be in constant radio contact, the latest order will provide a total of 2200 walkie-talkies in that service. A request has also been entered by the Mayor for funds to purchase over 2200 additional portables

It is further forecast that, in the major cities, the portables will replace the 12-volt, mobile units altogether. The success of the satellite receivers and multiple repeaters positioned throughout the city have proved that portables will indeed maintain reliable and speedy communications.

The service technician will find himself working on compact components and laying aside his sledgehammer quite often used for installing mobiles. The service garage will be replaced by a service shop, and the need for more technicians is evident. Considering the complexity of the components and the constant in-service handling, it is not out of balance to have a serviceman for every hundred units.

Where is this new breed of technician – in the volume required to support the industry going to come from? We can look to the younger amateur radio operators for many of them. Amateur FM repeater systems throughout the country are surely stepping links to our future technicians. Unknown to many of the service shop owners are the bright young amateurs, experimenting and learning while building up some of the many amateur FM repeaters that are challenging, and in many cases surpassing, the sophisticated commercial repeaters. Besides the standard satellite receivers, with Touchtone telephone capabilities, and receivers selected by home brew voting systems. Multiple repeater hookups are becoming prevalent and down time on most of these systems is remarkably low.

No matter how you look at it, the future of the communications industry is bright and glowing with promise and opportunities.

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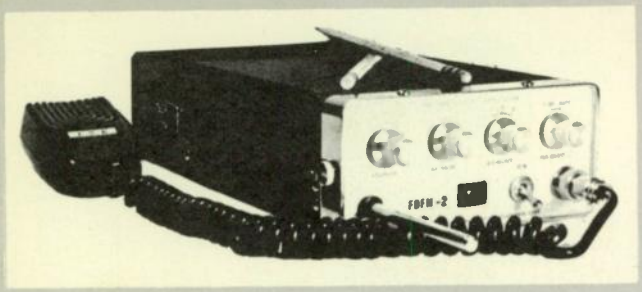

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FM News

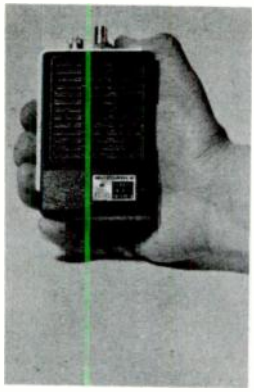
MOTOROLA PUSHES MINIATURIZATION

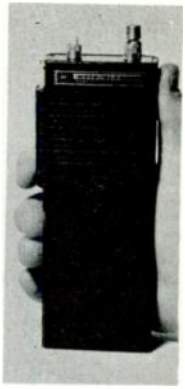
Things are always happening at Motorola. Among the many recent entries into their expanding line of personal communications equipment are two new integrated circuit HT's. The most spectacular of the two is their HT 100, a complete 100 mW transceiver small enough to be hidden by the user's hand. This unit, designed especially for short-range applications, has a rated stability of 0.0015% within a temperature range of −30 to +60°C. Another feature: Like the old HT's, this tiny unit is modular in construction. The transmitter and receiver sections are built around the speaker.

The second unit is the HT 220, the latest evolutionary change to the old HT 200. High-density packaging techniques, use of integrated circuits, and judicious placement of parts has resulted in a Handie-Talkie that is considerably smaller than previous units, though surpassing the older models considerably in performance. The HT 220 is said to have a sensitivity that is superior to the old unit by some 40%.

Weight, too, has been cut by 40%. This was achieved by the replacement of some 50 components with only two monolithic integrated circuits. The nickel—cadmium battery that powers the HT 220 weighs only 21 ounces, yet it can power the unit for approximately 10 hours under normal operating conditions.

Motorola made more news this month, without releasing any hot new product, when the retirement of company president Dan Noble was announced. Mr. Noble will retire in 1972, to be succeeded by Bill Weisz, now vice president.





If you want additional information about Motorola's new products, write Motorola, Inc., 1301 Algonquin Rd., Schaumburg, Illinois 60172. If you want to drop a card to congratulate Bill Weisz, address it to him personally and mail it to Motorola, Inc., 4501 West August Blvd., Chicago, Illinois 60651. Remember, it never hurts to tell them you read about it in *FM* Magazine.

POPULAR ELECTRONICS To Run FM Story

FM and repeaters reached a new level of recognition this month, when the editor of Popular Science, Oliver Ferrell, asked FM's staff to prepare an article about FM repeaters for the 1970 edition of the PE Communications Handbook. Editor Ferrell cited *FM*'s growth and the ever-increasing interest in the exciting world of VHF FM repeaters.

A general-interest article is now being prepared according to Ferrell's requirements. But in an effort to make the

(Continued)

piece as universally encompassing as possible — while staying within the imposed space limitations — *FM*'s staff is soliciting photographs of interesting, unusual, or particularly well designed repeater systems. If you want the world to see what a wonderful system you have, start snapping. All pictures should be 8 × 10 inches, glossy, and packaged to withstand the severe environment typical of the post office. Mail them to the *FM* Editorial Office. We'll try to see that the most appealing (from practically any standpoint) are published in the PE annual handbook (along with credits for you and your group, of course).

IEEE CALLS FOR PAPERS for December VTG Conference

A call for papers has been issued for the 20th annual IEEE Vehicular Technology Group Conference, which is scheduled for December 4 and 5 in Columbus, Ohio. The call was announced by Dr. Robert E. Fenton of Ohio State University in a letter to FM Magazine.

According to Dr. Fenton, who will serve as technical program chairman, the sessions will highlight such specific topics as air, ground, and marine mobile communications.

Only papers which have not been previously presented or published should be submitted. Authors should submit both a 50-word abstract and an abridgment of 800—1000 words by August 1, 1969, to Dr. R. E. Fenton, Department of Electrical Engineering, Ohio State University, Columbus, Ohio.

Authors who would like some editorial help in presentation or formatting are invited to send rough outlines or text to Editor, FM Magazine, 4861 Ramona Place, Ontario, California. There is no charge for the editorial assistance, and the credits stay with the author. The editorial offer is made only to subscribers of *FM*, and for the purpose of encouraging dissemination of valuable technical information.

Papers needing editorial help must be received by *FM* before June 1 so that the manuscripts can be returned to the authors for final typing and mailing before the August 1 deadline.

Notice of acceptance will be sent by October 15. The abridgments of all accepted papers will be published in the IEEE Conference Digest. If you've a hankering for recognition and have something of value to contribute to your peers, the IEEE Conference is the ideal outlet.

NEW PORTABLE ANTENNA

LINCOLN, NEBRASKA — A new lightweight knockdown type antenna, claimed to have considerably improved performance and convenience in storage and use, has been introduced by Hy-Gain Electronics Corporation.

The antenna is designed for the new generation of low-band portable (backpack) radio sets. Ten models cover frequencies from 2.0 to 19.0 MHz.

The base of the antenna is supplied with a PL-259 connector for attachment to the radio. The base segment is bendable so that the antenna will be erect while the transceiver is in any operating position. A rigid base segment with 3/8 — 24 thread is also available. The whip section breaks down into either two or three parts, dependent on frequency. The

New Entry in FM Equipmarket!

LOW-COST 2-FREQ PERSONAL RADIO ANNOUNCED

A brand new pint-sized transceiver combining IC's with transistors has just entered the commercial—amateur miniature communications market, and from the specs, it looks like it's going to give the Big Boys some stiff competition. Distributed by Telco, the handheld unit (called *Handicom*) boasts a receiver sensitivity of 0.5 μV and transmitter output power of 1.6W. According to the manufacturer, the Handicom is fully FCC type-accepted. All units are two-frequency, and come with a set of crystals on the operating frequency of the buyer's choice. Telco says the unit sells for $250 and can be supplied wideband or narrowband. Write Telco Communications, 1309 South San Antonio Blvd., Pomona, California, or circle FM Reader Service Card 69 (in which case FM Magazine will get credit for the fact that you saw it here first).

VARITRONICS ADDS NEW UNIT TO LINE

Varitronics, Incorporated, one of the few manufacturers specializing in FM gear for the amateur, announces the FDFM-2S, a "big brother" to the low-power FDFM-2. The 2S is a compact, ruggedly constructed VHF transceiver packed in the same package density as the smaller version. The manufacturer says the 2S comes complete with a high-impedance microphone, built-in speaker, mobile mounting bracket, mike clip, power cables and plugs, and three crystal frequencies. Channel 1 is 146.34 transmit, 146.94 receive; channel 2 is simplex 146.94 MHz. Like the 2, the 2S operates from 12V.

UNIMETRICS ANNOUNCES CRYSTAL-CONTROLLED TRANSISTOR POCKET RECEIVER FOR VHF FM

Unimetrics' new VHF FM pocket receiver has about the appearance of a typical 6-transistor standard-broadcast receiver, but in reality it is an FM receiver capable of crystal controlled monitoring of a specific frequency in the 146—175 MHz range. At the flip of a switch, it becomes a tunable FM receiver covering the complete 150 MHz spectrum. The unit is said to be sensitive and selective, and should make an ideal repeater monitor as well as a band-snooper. Specs available from Unimetrics, Inc., 39 Werman Court, Plainview, N.Y. 11803.

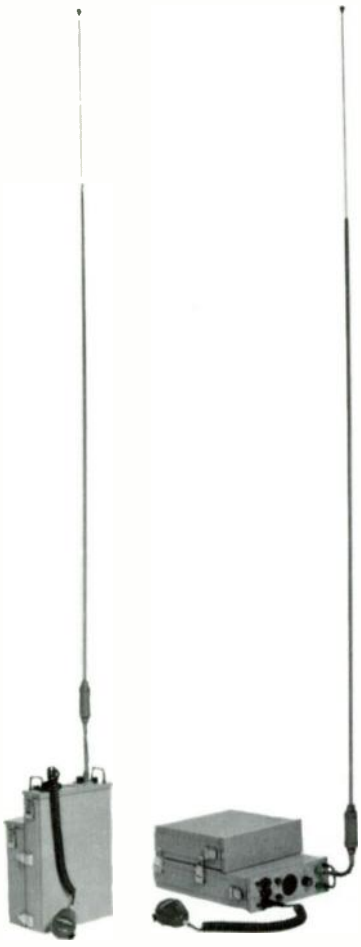
AEROTRON MAKES LIKE CONGLOMERATE

Aerotron, Incorporated announces that it has acquired the amateur radio and Citizen Band filter line from Gavin Instruments, of Somerville, New Jersey. This filter line is designed for use with VHF transmitters (50 and 150 MHz bands) as well as CB equipment in the 11-meter range.

According to spokesmen for Aerotron, The Gavin products will be integrated into Aerotron's Ameco line, and will be manufactured in the company's Raleigh, North Carolina plant. The company says delivery on most models is already being made, and the full complement of Gavin's line will be made available by August of next year.

Hy-Gain Portable (continued)

top whip section telescopes for portability, but is completely extended during operation. Apart from the telescoping



capability, the top section can be altered and locked to adjust the maximum length for top performance at any specific frequency within the range of the loading coil used.

ESSA transmits weather data

Mariners Tune in on VHF FM for 24-hour Scoop—

Few people get closer to weather than those who follow the sea. And few have a greater need for timely information on the state of the atmosphere and ocean — information available from the ESSA weather bureau's Marine Weather Services.

One of a family of specialized, user-oriented weather bureau programs, the marine weather services serve both recreational and commercial sailors with weather reports, forecasts, and warnings.

At the weather bureau forecast offices shown above, a new and expanding service is bringing mariners continuous broadcasts of the latest weather information. These ESSA VHF radio weather transmissions repeat taped messages every 5 — 7 minutes. Tapes are revised and updated periodically, usually every 3 — 6 hours, amended as required to include latest weather information. Messages include weather and radar summaries, wind observations, visibility, sea and lake conditions, and detailed local and area forecasts, as well as information tailored to the needs of boating enthusiasts, swimmers, surfers, fishermen, and others who use the water for work or recreation. When severe weather warnings are in order, routine transmissions are interrupted and the broadcast is devoted to emergency warning operations.

ESSA VHF radio weather transmissions can usually be received up to 40 miles from the antenna site, depending on terrain and the type of receiver used. Where transmitting antennas are on high ground, this range is somewhat extended. Special receivers for tuning the 162.55 MHz transmission frequency are becoming available in an increasing variety of types, from prices as low as $20.

HOW DOES FM STACK UP ?

*by John A. Murphy**

A number of recent articles have extolled the virtues of using commercial wideband FM equipment on the VHF amateur bands. Nearly all of these articles have commented on the extreme sensitivity of the reecivers used in this equipment. However, almost without exception, these receivers have noise figures of around 12 dB. Today's serious VHF hams are not very impressed with a 12 dB noise figure — to put it mildly! Yet performance of the equipment is so good that it seems the receivers must be *quite* sensitive. In order to resolve this apparent contradiction, let's review some of the fundamentals of frequency modulation.

HOW DOES FM STACK UP?

Frequency modulation systems were developed as the result of a train of reasoning somewhat along these lines: The nature of noise is such that it consists primarily of amplitude rather than frequency variations. Thus, it should be easier to detect a change (i.e., modulation) of a carrier's frequency than of its amplitude. In other words, frequency modulation processes the intelligence we

*The author, a former systems engineer for Motorola, holds a BSEE (Notre Dame), a first class commercial FCC license, and amateur license K5ZBA. A resident of Tulsa (4105 S. Pittsburg St.), he is employed by Midwestern Instruments as an instrumentation designer. He serves on the engineering staffs of Chicago's MAPS and Tulsa's famed repeater organization.

wish to transmit in a way that makes it more readily distinguishable from noise. It can be shown by vector analysis[1] that for the same signal-to-noise ratio, the ratio of the amount of frequency modulation that can be applied to a carrier by intelligence to the amount of modulation caused by noise is much higher than the corresponding ratio for amplitude modulation. This means that for equal rf signal-to-noise ratios, FM produces a much higher signal-to-noise ratio at the detector output.

In practice, FM signals above a certain critical threshold level tend to suppress noise, and a definite calculable improvement in output signal-to-noise ratio results. Below this threshold, mathematical analysis becomes extremely difficult. However, it has been shown that the amount of improvement decreases very rapidly. Thus, when operating below threshold, a change in transmitter power or propagation loss of 3 dB results in a change of *much more* than 3 dB in signal-to-noise ratio at the output. This explains why under marginal conditions signals tend to fluctuate so rapidly from solid copy to zero copy and back again, and why a mobile seems to drop suddenly out of range.

Closely related to the effect of noise suppression is the capture effect. When two signals are on the same frequency, the stronger tends to suppress the weaker, resulting in much less interference than might be expected.

Audio characteristics

The audio system plays a very important part in determining the performance of an FM receiver. The nature of noise and the operation of discriminators are such that, under strong signal conditions, the noise at the discriminator output is preemphasized at the rate of 6 dB per octave. There is four times as much power in a small band of frequencies around 2 kHz as in an identical band around 1 kHz, and four times as much at 4 kHz as at 2 kHz. It is obviously desirable for the audio response to roll off rapidly above 3 kHz to minimize the total noise power at the speaker. Virtually all commercial FM receivers further reduce this noise power by the use of a deemphasis circuit. This is a simple RC low-pass filter with a cutoff of 500 Hz and a rolloff of 6 dB per octave. This rolloff cancels the rising chracteristic of the noise and results in a flat noise spectrum at the speaker. A short trip into the realm of mathematics shows that this results in an 11.8 dB reduction in total noise power.

Preemphasis in the transmitter causes the response of the speech amplifier to rise at 6 dB per octave. This rise is canceled by the receiver's deemphasis circuit, resulting in a flat system response with an 11.8 dB improvement in signal-to-noise ratio. The preemphasis in the transmitter gives us still another advantage. The power contained in speech tends to fall off at approximately 6 dB per octave at frequencies above 500 Hz. The preemphasis tends to flatten out this frequency distribution, permitting the higher frequencies to more fully modulate the transmitter and maintaining the overall signal-to-noise ratio as high as possible.

Figure 1 shows the general shape of the transmitter frequency response, the discriminator output, the receiver frequency response, and the speaker output. If you build your own FM gear, failure to include this frequency shaping will result in poor receiver sensitivity and poor audio quality when used with commercial equipment.

1 See also "THE CASE FOR WIDEBAND," this issue.

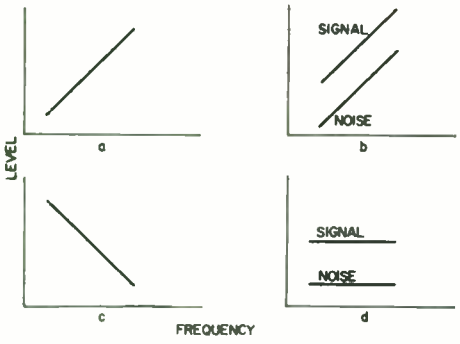


Fig. 1. Signal characteristics — relative level versus frequency. (a) Preemphasized frequency response of transmitter; (b) signal and noise at receiver discriminator; (c) deemphasized frequency response of receiver; (d) signal and noise at speaker.

Sensitivity

While on the subject of receiver characteristics, it might be worthwhile to comment on the methods of rating sensitivity. The Electronic Industries Association defines two sensitivity specifications: the *20 dB quieting* sensitivity and the *12 dB SINAD* sensitivity. The 20 dB quieting sensitivity is the level of unmodulated carrier required at the receiver input to reduce the unsquelched noise at the speaker by 20 dB. This is a very quick and easy test to make and provides a valuable check on the condition of the receiver. However, since this effect of quieting is unique to FM receivers, the test is of little value for comparing sensitivity with other types of receivers.

The 12 dB SINAD sensitivity is the level of carrier modulated 67% by a 1000 Hz tone required to produce a 12 dB ratio of *signal plus noise and distortion* to *noise and distortion*, which EIA calls a minimum usable signal, at the speaker. This test is considerably more time consuming and requires the use of a distortion analyzer. It is, however, applicable to AM and SSB receivers, so it does provide a means of comparing the systems at a level below threshold.

Most commercial FM receivers have a 20 dB quieting sensitivity of 0.5 μV and a 12 dB SINAD sensitivity of 0.35 μV. With a 12 dB noise figure and a 30 kHz bandwidth, that works out to a signal-to-noise ratio in the i-f strip of about 4 dB for 20 dB quieting and about 1 dB for 12 dB SINAD. That's usable, copyable signals with signals only 1 dB out of the noise! *Perhaps there's more to this FM stuff than meets the eye!*

SYSTEMS COMPARISON

When comparing two or more modulation systems, it is not sufficient to simply state that one system is so many decibels better than another; the basis of comparison must be defined. For instance, we could compare AM and SSB on the basis of equal transmitter sideband power — such as a 100W AM station and a 50W SSB station — and find them equal; that is, they both produce exactly the same signal-to-noise ratio at the outputs of their respective receivers. We could compare them on the basis of AM carrier power equal to SSB *peak envelope power* (PEP) and find SSB with a 3 dB advantage. We could use equal PEP for both stations and find a 4.8 dB advantage for SSB, or use equal sideband-power-to-noise ratio and find AM with a 3 dB advantage. The two systems could be compared on the basis of maximum legal power, or using the same final tube and power supply, or any of many other criteria, each yielding a different result. The point is, the basis for the comparison must be clearly defined. What, then, constitutes a "comparable" system?

In the example above, the AM receiver bandwidth is assumed to be twice that of the SSB receiver. This represents another factor which must be taken into consideration. When comparisons are made with FM, still another variable enters the picture: Is the receiver operating above its threshold? If the signal is above the threshold, which occurs around a 10 dB signal-to-noise ratio in the i-f, mathematical analysis is straightforward and performance can be accurately predicted. Below threshold, the analysis becomes very complicated. We can, however, make comparisons at the 12 dB SINAD point, since this sensitivity is given in the manufacturer's specifications. tions.

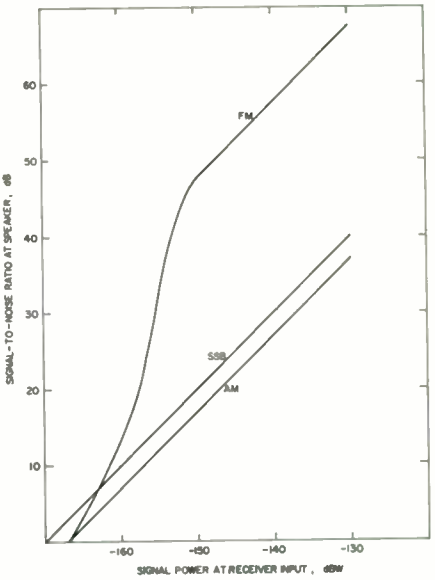


Fig. 2. Signal-to-noise ratio at speaker as a function of signal power at receiver input, theoretical performance curves.

FM vs AM and SSB

It can be shown that for signals above threshold and for equal carrier power, FM has a power advantage in output signal-to-noise ratio of $3M_f^2$, where M_f is the modulation index, defined as the maximum frequency deviation divided by the highest modulating frequency. For the equipment we are discussing, the maximum deviation is 15 kHz and the highest audio frequency is 3 kHz, giving a modulation index of 5 and a power advantage of 75, or 18.8 dB. When we add the 11.8 dB gained by deemphasis we get a total improvement over AM of 30.6 dB.

If we now add an SSB system to the comparison, with a PEP equal to the carrier power of the other two transmitters, we will find that it has twice the sideband power of the AM station and so is 3 dB superior to it and only 27.6 dB worse than the FM system!

We have said that these figures are valid only when the FM signal is at or above threshold. Let's assume that it is right at threshold, and that threshold is a 10 dB signal-to-noise ratio. In the SSB system we have the same signal power in a bandwidth only one-tenth as wide, and therefore containing only one-tenth the noise power. The signal-to-noise ratio in the i-f of the SSB receiver is therefore 10 dB higher, or 20 dB. Since the input and output signal-to-noise ratios are equal in an SSB system, this gives a 20 dB signal-to-noise ratio at the speaker. We have shown that the AM system is 3 dB worse, for a 17 dB signal-to-noise ratio, and the FM system is 27.6 dB better, for a 47.6 dB signal-to-noise ratio. Any one of these signals would give fairly good copy, so the FM system doesn't really buy us that much under these conditions. At first it might seem reasonable to assume that the FM system would yield the same readability over a path loss 27.6 dB greater than the SSB system. But as soon as the path loss increases, the signal drops below threshold and the advantage decreases. In fact, if the path loss increased 27.6 dB, the

receiver would see a signal-to-noise ratio of −17.6 dB and provide zero copy.

It appears that the point to make the most meaningful comparisons is at the level of minimum usable signals, or 12 dB SINAD.

An SSB receiver with reasonably low audio distortion will produce a 12 dB SINAD output with an input signal-to-noise ratio of about 12 dB. We found previously that our FM receiver produces this output with only a 1 dB signal-to-noise ratio at the input. This gives us 11 dB in favor of FM. However, the FM receiver has a bandwidth ten times that of the SSB receiver, giving us 10 dB for SSB — or, after squaring accounts, 1 dB in favor of FM. We said previously that 12 dB SINAD measurements are made with 67% modulation. This means that, for purposes of the measurement only, we must reduce the audio voltage to the SSB transmitter by 33%, which reduces the output power 3.5 dB, giving a grand total of 4.5 dB in favor of FM. The AM system will still be 3 dB worse than the SSB system, so FM comes out 7.5 dB better than AM. In this case we are able to say that FM will provide communications over a path loss 7.5 dB greater than a comparable AM system, where comparable means the same carrier power for the transmitters and the same noise figures for the receivers.

Figure 2 summarizes the above results in the form of a plot of signal-to-noise ratio at the speaker versus rf input to the receiver in −dBW, or decibels below one watt. One microvolt across 50Ω is −137 dBW. Graphs of this sort appear in many text and reference books, but are useful only if it is clearly understood exactly what is being plotted and what assumptions are being made.

Here are the conditions for this particular plot: First, the SSB receiver has a noise bandwidth of 3 kHz; the AM receiver, 6 kHz; and the FM receiver, 30 kHz. Wider bandwidths shift the curves to the right, giving lower signal-to-noise ratios for a given input. Doubling the noise bandwidth of a receiver moves its curve 3 dB to the right.

Second, all transmitters are using 100% modulation. This means that an input power equal to the 12 db SINAD sensitivity gives a signal-to-noise ratio of 15.5 dB, due to increasing the modulation from 67% to 100%. Third, the FM system has an M_f^2 of 5, peak deviation of 15 kHz, and 3 kHz maximum audio frequency. Fourth, the effects of deemphasis in the FM receiver are included. Fifth, this is a plot of signal-to-noise ratio, not a ratio of *signal plus noise* to *noise*. The difference is minor except at very low levels. A 3 dB signal-plus-noise-to-noise ratio is a 0 dB signal-to-noise ratio. Sixth, the noise figure of all three receivers is assumed to be 0 dB. This is, of course, impossible, but it does make a good reference point. The effect of realistic noise figures is to move the curves to the right. A 10 dB noise figure for a particular receiver moves the curve for the receiver 10 dB.

Finally, for those who tend to have a basic distrust of mathematics and "theoretical" advantages, I have verified the seemingly incredible shape of the FM curve with measurements on a typical receiver. It really does happen that way!

With these figures under our mental belts, it is quite easy to modify the results to cover different bases of comparison. Suppose we want a comparison on the basis of identical PEP for all three systems. The PEP of the FM and SSB rigs were the same in our first case, so we need consider only the AM station.

The PEP of an AM transmitter is the carrier power plus the maximum sideband power, or 1.5 times the carrier power. In the previous case, the AM and FM systems had equal carrier power.

For the same PEP, we must decrease the AM station power by one-third, or 1.8 dB. This gives FM an additional 1.8 dB advantage. Thus, for signals above threshold, an FM station with a PEP of 1 kW will provide an output signal-to-noise ratio 32.4 dB superior to an AM station with a PEP of 1 kW. Below threshold, the FM system will provide communications over a path loss 9.3 dB greater than the AM system.

Another comparison of interest is one based on maximum legal power. Our original figures were for FM carrier power, AM carrier power, and SSB PEP all equal. Maximum legal power for AM and FM is 1 kW of rf amplifier input power, restricting the carrier to 1 kW or less, so the figures are the same as before; 30.6 dB difference above threshold and 7.5 dB at 12 dB SINAD. For SSB, however, while the maximum legal power is 1 kW as indicated by the plate voltage and current meters, the output may be considerably higher than the voltampere indication: The voltmeter remains pretty steady, but the ammeter bounces continuously with speech. How then do we relate the meter readings to actual power?

It is a standard practice in the telephone and broadcast industries to test audio amplifiers for distortion with a sine wave that produces a meter indication approximately three times as high as speech peaks. If we use this criterion for our SSB transmitter, we test it for distortion and rate its PEP at three times the maximum plate current indicated on speech peaks. With constant plate voltage, that amounts to three times the power, or 3 kW PEP. With SSB PEP adjusted to equal FM carrier power, we find differences of 27.6 dB above threshold and 4.5 dB at 12 dB SINAD. If we now increase the SSB PEP by a factor of 3, or 4.8 dB, we find FM superior by only 11 dB above threshold, and SSB superior by about 0.3 dB at 12 dB SINAD.

All of the figures presented here are based on receiver bandwidths of 3 kHz for SSB, 6 kHz for AM, and 30 kHz for FM. The bandwidths assumed for SSB and FM are reasonably typical of the equipment in use by amateurs today. Many VHF AM receivers, however, have noise bandwidths of perhaps 60 kHz or more, giving FM another 10 dB or more advantage. Equal noise figures for all receivers are also assumed — and this point deserves some discussion.

Homebrew receivers are usually designed and optimized by cut-and-try techniques for maximum sensitivity, and may have noise figures of 2 or 3 dB on 2 meters. Commercially manufactured amateur receivers are designed for a compromise between maximum sensitivity and repeatable results on the production lines. A manufacturer cannot hand-pick components for optimum performance and sell his product at a competitive price. The designer of FM receivers for commercial two-way radio users has still another problem. His receiver must have as few spurious responses and be as clobberproof as possible. His equipment is often used in proximity to 40 or 50 high-power transmitters and with the crystal-controlled channelized operation, the user cannot shift frequency a few kilohertz to avoid interference caused by these transmitters. Since maximum sensitivity and maximum rejection of "spurs" does not occur under the same conditions, we find even the latest solid-state

receivers with 12 dB noise figures, FET front ends and all!

Figure 3 is the same type of plot as Fig. 2, modified to include the effects of "real-world" receivers. In this graph, the FM receiver has a sensitivity of 0.5 μV for 20 dB quieting, the SSB receiver requires 0.5 μV for 10 dB *signal plus noise*-to-*noise* ratio, and the AM rig requires 1 μV for 10 dB *signal plus noise*-to-*noise* ratio. These figures are taken from the specifications of currently available amateur equipment. It can be seen from the graph that with equal carrier power FM has an advantage over AM of about 39 dB above threshold and 15 dB at the 12 dB SINAD point.

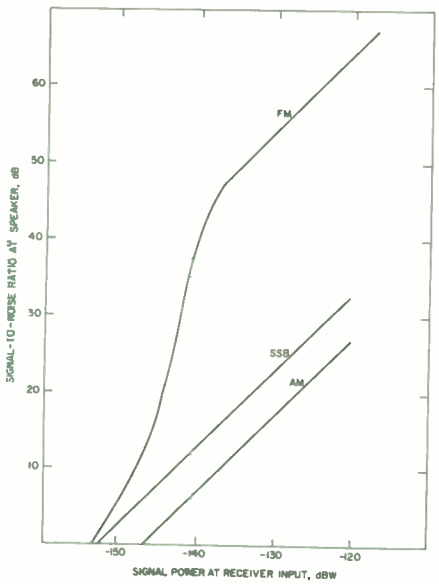


Fig. 3. Measured characteristics of actual FM, SSB, and AM receivers. Compare with plots of Figure 2.

CONCLUSIONS

We started this discussion wondering how a receiver with a 12 dB noise figure could be considered extremely sensitive. We have found that wideband FM systems process the signal in a way that makes it more readily distinguishable from noise. But the secret of success is not purely in the mode of transmission. The FM mode is generally superior to the other modes when the receiver tuned to the FM signal is designed for FM reception.

In essence, we could make this generalization: An AM receiver will hear AM and SSB signals far better than it will hear FM. FM enjoyed a short burst of popularity after the war, but the mode fell rapidly from favor because amateurs found it inferior to AM. *They were transmitting via FM* (to take advantage of the minimum modulator requirements) *and receiving on their AM equipment* (because of the high cost and general unavailability of commercial units). So they could not get exposed to the real benefits of the mode.

But now the situation is different. No currently used mode can compare with the communications capability of a properly tuned FM transmitter operating in conjunction with a properly adjusted FM receiver. Tomorrow, SSB and FM may be combined into a digital regeneration type of system, with performance surpassing all the schemes in vogue now. But today, FM is clearly THE MODE!

K5ZBA

ED. NOTE: When the manuscript for this article came in, I was prejudiced against it and had decided to reject it before reading the first paragraph. But I DID read the first paragraph. And the first page. And I kept on reading till I had digested the entire text. This article is a rarity. It is informative, interesting, objective. It is a refreshing cut above the mode-versus-mode thing, and it should be Required Reading for every serious FM'er.

THE CASE FOR WIDEBAND

*by Earl Lagergren**

In the August 1968 issue of *FM*, Bob Kelty extolled the virtues of narrowband FM[1]. The present article will attempt to explain the operational differences between wideband and narrowband FM from a communications—engineering point of view. First, the engineering criteria by which wideband may be considered superior to narrowband FM will be explained; and second, the validity of the points noted in Kelty's article will be examined.

A steady sinusoidal waveform in the form of a carrier can be expressed as a vector rotating in a plane. A vector is a convenient tool used by engineers to show the magnitude and phase angle of a signal. The length of the vector represents the amplitude of the voltage, and the angle made with the horizontal axis is representative of the phase angle. Vectors can be plotted to show some very important and indisputable factors concerning FM as a mode of communications.

In Fig. 1, the vector V_n represents the ever-present voltage caused by noise. This unwanted signal may be the result

1 **The Case for Narrowband,** Robert Kelty, **FM,** August 1968, page 13.

*The author holds a BSEE as well as first-class commercial and amateur Extra licenses.

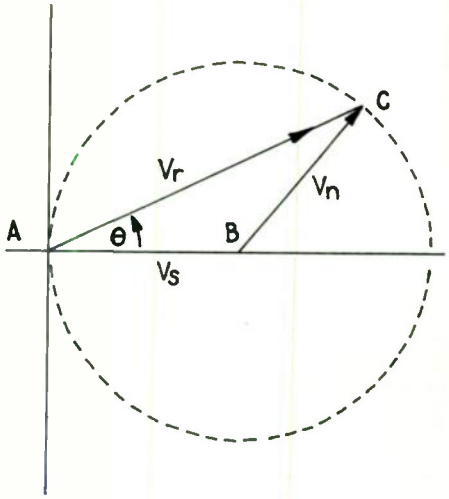
of static; automotive ignition; or receiver front-end, thermal, or mixer noise (or any combination of these). Since the noise must be added to the desired signal vectorially to determine the level of the resultant signal V_r received by the dedector, the "toe" of the noise vector is placed on the "head" of the signal-voltage vector V_S. Then V_S rotates about point *B*. To make the explanation easier without affecting the analysis, V_S is made the reference vector so that it does not rotate. In other words, V_S is rotating, but the analysis is not compromised if it is assumed that V_S is observed under a strobe light — so it appears that V_S remains stationary along the horizontal axis.

Now let us assume that the desired incoming signal either decreases in strength to approach the noise level (as would be the case with a marginal mobile) or the noise increases to equal the level of the received signal (as would be the case with inadvertent exposure to electromagnetic radiation from any number of sources). For the purpose of this analysis then, the desired signal is equal in amplitude to the undesired noise voltage.

From Fig. 1, it can be seen that as V_S rotates around point *B*, the resultant signal V_r seen by the receiver will rotate along the dotted circle. The FM detector in the receiver will see a signal that varies in both amplitude and phase.

The singularly important factor to consider is that the maximum phase modulation induced by the noise is plus and minus 90 degrees — slightly more than one radian. Since the maximum phase deviation is equal to the modulation index of a frequency-modulated wave, we may thus draw the following conclusion about FM as a communications mode:

To reduce interference (or capturing) of the desired signal by the undesired signal (noise), the following criteria must be met: (1) The amplitude of the desired signal must be equal to or greater than the undesired signal; (2) the receiver must be insensitive to amplitude variations; and (3) the modulation index of the desired signal must be a very high ratio (preferably on the order of 5:1).



The modulation index equals *carrier deviation* divided by the *modulating frequency;* thus, with the typical audio frequency response limit of 3 kHz for voice channels, the minimum deviation should be 12–15 kHz.

From the foregoing, it may seem that wideband FM is superior to narrowband FM all the time. This is *almost* true. But not quite. In cases where the signal is actually below the threshold (at the lowest squelch setting), the signal-to-noise ratio of a narrowband FM signal is higher than that of a wideband FM signal. However, since signals this weak are typically intolerably distorted and incapable of being processed intelligibly through a repater, it is better to use wideband FM. Moreover, once the signal is above the noise threshold, the signal-to-noise ratio of the wideband signal becomes greater than that of the narrowband FM signal. Since this will

hold true for the majority of time and in the majority of individual cases (and in virtually all cases involving repeaters), the use of wideband FM seems a clear best choice for typical amateur communications at 6 meters and above.

The previous discussion assumes that limiting takes place in the receiver. If the signals are not limiting, the analysis becomes extremely difficult. The receiver should actually limit on noise alone; if it does not, system performance will be degraded.

The first point made in Kelty's article was that commercial services went to FM because of spectrum savings coupled with eradication of Loctal tubes — his implication being that FM is the more modern mode. I would like to point out that either mode may be used with equally modern components, and wideband FM is neither oldfashioned nor outmoded. All of the three recent-appearing solid-state amateur FM transceivers are supplied as wideband in the standard models.[2]

Kelty's second point was that sensitivity increases as a result of narrowband operation; also, that the squelch is more positive, the sound indefinably sharper. As illustrated previously, the signal-to-noise ratio improves markedly with wideband FM because of the inherently superior noise rejection *if the signal is stronger than the threshold noise level.* A properly designed squelch will operate equally well in either case, and both will close during overdeviation.

With regard to fidelity, the two major causes of distortion in FM systems are the inherent anomalies associated with the classes of device operation (A, AB, B, C), and linearity of the modulators and discriminators. A discriminator is designed to give maximum output with reasonably low distortion for a specific maximum deviation level. With either narrowband or wideband, reducing deviation reduces distortion because the discriminator's nonlinearity decreases as the signal frequency approaches the discriminator center frequency. This is not to say that either system has an inherent advantage with respect to distortion, for both should exhibit roughly the same in communications use, all other factors being equal. The comment that narrowband transmitters produce less splatter and noise makes no sense without stating the receiving conditions. Wideband transmitters used with wideband receivers using wideband filters (and transmitting on wideband-spaced channels) will generate no more noise and splatter than narrowband transmitters (with concomitant narrowband contingencies).

Another advantage of wideband — which is often a key factor — is that frequency control requirements can be relaxed. Especially in mobiles, crystal ovens are an abomination on a par with horizontal polarization. Also, many of us like to use walkie-talkies, where it is difficult to maintain good narrowband frequency stability under adverse physical shocks and temperature cycling. A little drift on narrowband can make a weak signal disappear; the effect of the same drift on wideband may be imperceptible. Therefore, for the reasons presented above — and because most amateurs presently use wideband FM — I suggest that 12 kHz be used as a standard deviation value for usual simplex/repeater operation. Depending on the locale, it may be desirable to use narrowband on UHF control links (for spectrum conservation), though outside

2 FDFM units, Varitronics, Incorporated, 4109 North 39th Street, Phoenix, Arizona; ICE units, International Communications and Electronics, 1917 NW Military Hwy., San Antonio, Texas; VHF Assoc. units, CW Electronic Sales, 1237 16th Street, Denver, Colorado; and the Handicom, from Telco, 1309 South San Antonio Boulevard, Pomona, California.

Simple Squelch Circuit for the Motorola Pocket Pager

*by Roy Welch and Lenox Carruth**

With the increasing interest in the use of FM repeaters and the availability of high quality, low cost FM equipment, there has been a demand for information to convert this equipment to a form suitable for amateur use. This article describes the addition of a simple squelch circuit to the Motorola HO3ANC-1100AQ VHF paging receiver. This series of receivers used two resonant reeds for selective calling and had a push-to-listen switch which was pressed to receive a message after the signal tone was heard.

The conversion is straightforward and designed to use as many of the original parts as possible. Reference to the original schematic, included here as Fig. 1, will simplify the conversion. Begin by removing the two resonant reeds which are held in the case by two screws. These two screws also hold the reed amplifier board in the case. The eight wires which go to the reeds from the reed amplifier board should be carefully unsoldered from the board and removed. The push-to-listen switch should now be removed from the case and the wires going to it cut near the switch. The blue and the yellow wires should be connected together. Remove the brown, light green, light blue, gray, and white wires which went to the switch and connect the red, tan, and pink wires as shown in the modified schematic, Fig. 2.

Next, remove the reed amplifier board from the case and remove the following components: C51, C52, C53, R48, R63, R64, and CR5. Now, remove CR6 and CR8 and replace them with silicon small-signal diodes with their polarities reversed as shown in Fig. 2. Remove the gray wire and connect the 5.6K resistor as shown in the schematic. This resistor can be a ½-watt type and will fit on the foil side of the board if care is used to provide clearance for the board mounting frame. A jumper wire can be used to connect to the collector of Q13 if the resistor is connected to the proper side of C71. Now, notice the color code which indicates the polarity of C77 and

*Both authors are residents of Dallas, Texas. Roy, whose address is 9968 Greenfield Drive, holds amateur license W5SLL. Lenox, 9660 Leaside Drive, holds amateur license WA5OVG.

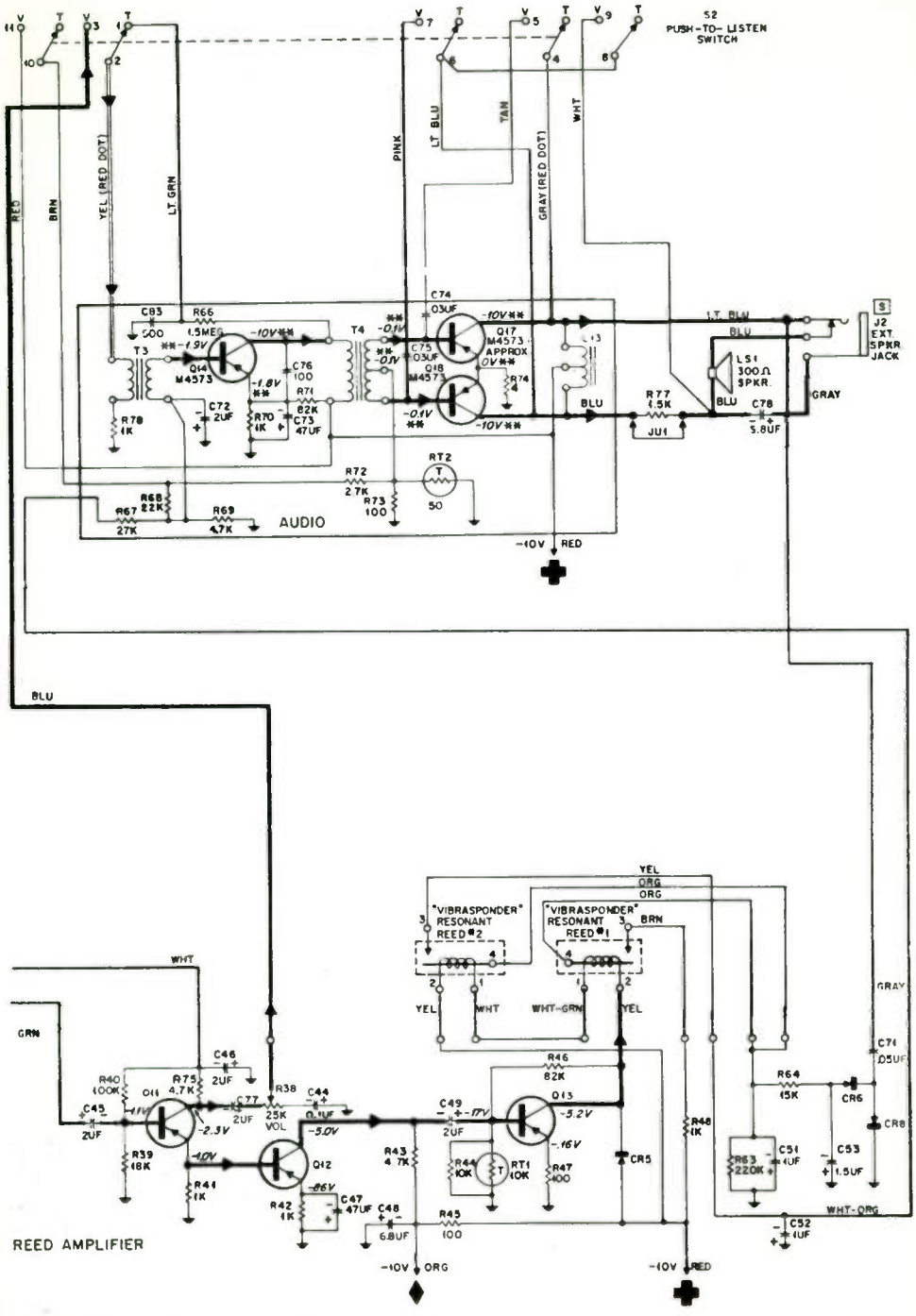


Fig. 1. Original schematic of audio and reed amplifier portion of pocket paging receiver.

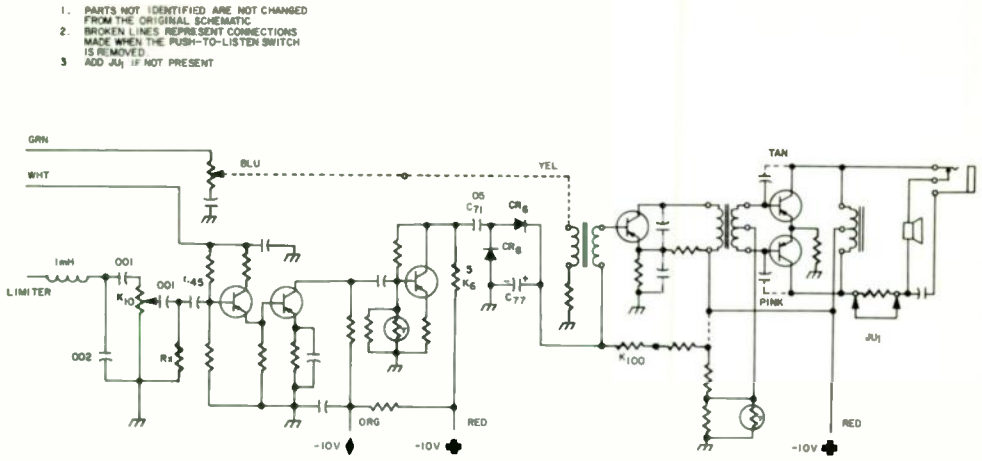


Fig. 2. Modified schematic. Parts not identified are not changed from the original schematic. Broken lines represent connections made when the push-to-listen switch is removed.

then carefully remove it. Solder C77 in the place where C53 was located. The white—orange wire can be connected to the junction of CR6 and C77 and used to connect to the audio board. Remove the green lead from C45 and connect it to the terminal of R38 formerly occupied by C77.

The filter network can be built on the back of a small 10K Trimpot and three wires can be used to connect this assembly to the reed amplifier board and limiter module. The lead to the limiter module is connected at the junction of C37 and R32 as shown in Fig. 3. The value of R_x should be determined experimentally to provide for the squelch threshold to be in the center of the range of the squelch control. This value will generally be in the range from 500 to 3000Ω, depending upon the particular receiver. The squelch filter assembly can be wrapped with tape or heat-shrinkable tubing and placed in the area formerly occupied by the two resonant reeds. The squelch pot will only need to be set once.

The L-shaped audio board must now be pulled far enough out of the receiver frame to remove C72, R67, and R69. The combination of R68 and the 100K ½-watt resistor can be replaced by a single resistor in some models of the receiver.

But in my case one of the leads of R68 was fairly long and I did not have anything smaller than a ½-watt resistor, so I cut the long lead of R68 and placed the 100K resistor in series with it.

The 100K resistor will fit parallel to the board in the corner of the L. Now, replace the audio board and install jumper JU1 across R77 if it is not already present. Resistor R77 is located on a small board which is glued to the rear of the speaker.

ED. NOTE: The authors say that a parts kit is available for $3 (plus postage). The kit contains a subminiature potentiometer and all parts except R_X. Order from Tom Gentry, K5VOU, 929 Warfield Way, Richardson, Texas.

The paging receivers are available from Spectronics, Inc., 1009 Garfield Avenue, Oak Park, Illinois. $50 postpaid. But be sure to include your call, as Spectronics sells only to amateurs.

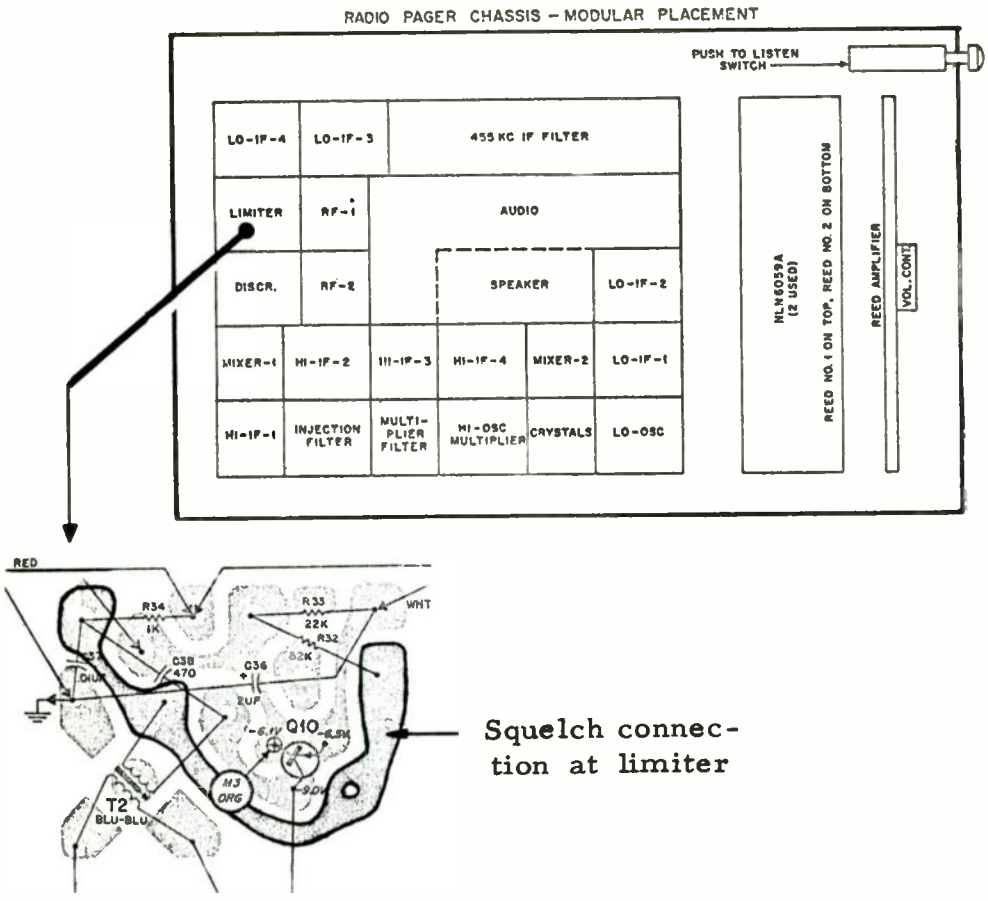


Fig. 3. Sketch showing layout of limiter module and "map" of VHF pager modules.

Replace the reed amplifier board and the radio should be ready to operate. The squelch pot should be set to some convenient value. After setting the squelch pot the radio can be closed. Do not tighten the retaining screws too tight as this will distort the front of the case.

For operation in strong signal areas no external antenna is needed, but in weaker signal areas a 19-inch length of stranded and insulated hookup wire makes an excellent antenna. This receiver has excellent sensitivity and, with the addition of this squelch circuit, makes a very good monitor receiver for amateur use.

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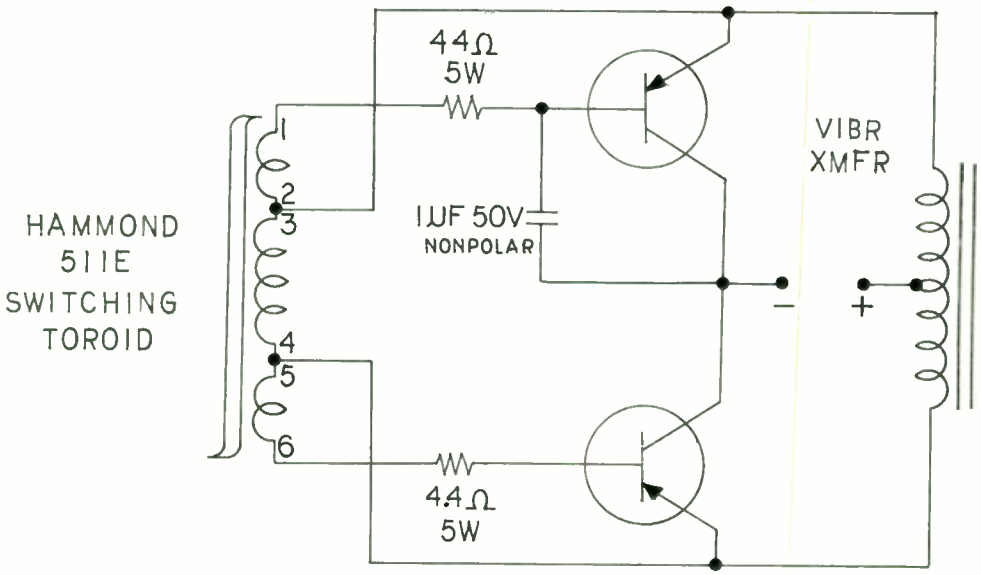
PLUG-IN SOLID-STATE VIBRATOR ELIMINATOR

*by Vern Epp**



Have you ever thought how nice it would be to have a transistor power supply on your vibrator-powered mobile? Maybe you just never got around to it because of the work involved, or perhaps you simply haven't been able to find a transformer with the proper characteristics. Well, here is the answer.

Since with this approach the vibrator transformer is still used, the conversion is greatly simplified and the resale value of your equipment is actually enhanced.

The circuit shown produces a 200 Hz square wave without spikes, so vibrator hash is minimized. The switching toroid is manufactured by Hammond, in Canada. There is undoubtedly a suitable American replacement, but if you cannot find one readily, a postcard to Hammond should bring rapid results.

The entire unit was mounted on a cut-down vibrator so that the existing pins could be used. Thus, the rig was not changed. The philosophy of this approach was to keep everything as unmodified as possible so that if trouble developed in the circuit, the transistor supply could be unplugged and the old vibrator reinserted in its original position.

Use conventional engineering practices when you build your transistor replacement. For example, you are likely to be disappointed if you don't mount the transistors on an adequate heatsink. The efficiency of the transistors appears to be slightly better than the original vibrator arrangement. The unit produces slightly more dc voltage than it used to.

I have used the vibrator eliminator for about a year and have experienced no problems. The unit should work in mobiles with transmitters up to about 25W output. And it can be adapted to virtually any mobile unit.

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FM Outlook

ARRL repeater committee member in the "know"

FM has been eating some words on its criticism of the ARRL's repeater advisory committee — and in this case, we are glad we were wrong. It is still true that few of the ARRL's appointees are key people or knowledgeable experts when it comes to FM repeaters. But in one case, at least, the appointee is sincere — with the result that he could do more good for the FM community than if he were an expert. Gil Boelke informs **FM** that Harry Lang (VE3ADO) readily admits that he is in no position to singlehandedly recommend FM repeater licensing changes. He has, therefore, adopted the policy of consulting with known experts in his area before making any comments to the ARRL. Lang is said to be a progressive amateur who is active, willing to learn, and ready to participate in anything that might benefit amateur radio. It is **FM**'s belief that if all ARRL appointees would react in the manner that Lang has reacted, the ARRL committee could be a very worthwhile and instrumental tool in the shaping of FCC philosophy. If any other FM readers learn anything noteworthy about the ARRL or its committee with regard to rulemaking, pass it along to the rest of us.

FM Reviews get unexpected results

One of the reviews written by the **FM** staff appears to have had some effect on a few manufacturers. Antenna Specialists has turned out a mobile antenna whose upper and lower sections fit concentrically and a bit more snugly. A review published last year made note of the lack of singularity in appearance and of the bad fit from the central piece to the upper and lower sections.

George Riggins, of Riggins Electronic Sales, 2331 San Anseline, Long Beach, California 90815, states that some changes were also made in the Larsen line. The review acclaimed the Larsen antenna's performance, but commented on the "ugliness" of it when mated to the black-ball mount. Now, unless the customer requests otherwise, all of the Larsen base sections for the Antenna Specialists type of mount "screw down against the body, doing away with the black ball." Riggins, incidentally, is the Western States distributor for Larsen, Radio Specialties, and Dynacoustic Labs.

FM outlook (Continued)

Editorial Liberties

Those of you who subscribe to 73 Magazine should make it a point to read Kayla Bloom's swan song in the April issue; it's called **Editorial Liberties.** If you don't subscribe, buy a copy somewhere or bum one from a buddy the way you do with **FM.**

Rules said to be FCC leak

The scary rumors about rulemaking — passed along to us in the March issue by Regional Editor Gordon Pugh — are getting even more frightening. They're shaping up to be uncomfortably factual. Reliable sources, however, say that FCC people are looking for comments and reactions. The rumors were lamented as FCC "leaks" but they may in fact have been an intentional flag — run up the pole to see how we salute.

Amperex feedback

Amperex says the February **FM** article on their new UHF in-line amplifier created "quite a stir in the communications industry." The queries were so overwhelming in number that Amperex had to print up form letters in response. In essence, the letter states that their product is still in the developmental stage. No market date has yet been set.

FM Repeater Handbook

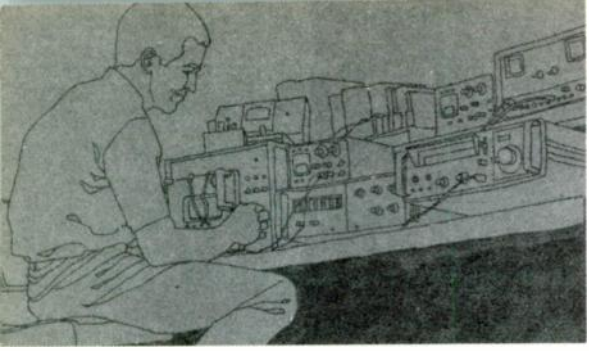
Editors & Engineers has been snowed, too. Editor Bob Welborn says he's getting "a steady stream of inquiries about the **Radio Amateur's FM Repeater Handbook,"** which is not yet off the presses. About the earliest publication date, he now says, will be July. And this first printing will be hard-bound only. Welborn did not state the handbook's selling price.

American League of Repeater Associations

All offices of **FM** are being swamped with dollar bills from readers enlisting in the American League of Repeater Associations. The response is necessary and fully appreciated. But money sent to **FM** offices causes delay, red tape, and unnecessary expense. Be sure to mail your dollar to Paul Hudson, Box 452, Don Mills, Ontario, Canada. Paul is coordinating this group and its activities until a permanent chairman is elected. There are too many new members daily to attempt a directory at this time. But in a month (or possibly two), **FM** will publish a complete membership roster for the ALRA. If your group has not appointed a representative member, don't wait — for the ALRA will be **FM**'s repeater advisory committee. The prime requirement for full membership is association with a repeater that is either operating or under construction.

Repeater directory

A new repeater directory is currently being prepared. If you have last-minute changes or additions, send them **immediately** to 4861 Ramona Place, Ontario, California 91762.



FM SERVICE CENTER

*by Don Chase**

GENERAL ELECTRIC

GE *Progress Line* mobiles with transistor power supplies— If the power supply quits when operating at full output but operates normally at light loading, check the high-B+ filter capacitor. Low capacity allows the power amplifier surge current to stop the transistors from oscillating.

* * *

A recent trouble with a GE *TPL* receiver was traced to the first oscillator crystal. The crystal can was slightly larger than normally supplied. A slight pressure on the case of the radio moved the oscillator cover, causing a short between the crystal can and the thermostat — and a burned-up resistor in the audio —squelch board!

* * *

The item of this column on filing down the bases of 6146 tubes as a means to replace 2E26's resulted in quite a bit of mail. One ham uses "dikes" to nibble off the unwanted phenolic. He correctly pointed out the danger of vibration damage to the tubes. Other methods used include using high-wattage soldering irons (200 watts or more) and burning the unwanted material away. Okay fellows, choose any way you wish. The key word is *careful!*

Sometimes a receiver will be difficult to align because of aged capacitors. In some of the sets twenty years or so old, it is a good idea to visit the local parts house and grab a sackful of bypass capacitors. And try to use the same ground lugs as the manufacturer did — ground loops could make the problem worse!

* * *

The GE *Voice Commander* is subject to a few troubles all its own. The most common trouble is cracks and breaks in the printed-circuit audio—squelch board. Bend the board slightly and force a little epoxy cement into the break with a hypodermic needle. (Possession of syringes is illegal in some states. Ask your family doctor.) Fix the break in the conductor by bridging the break with a short wire. To finish the job, allow a small amount of epoxy to flow over the board in the area of the break.

* * *

Aside from breaks in the board, the most usual troubles in the audio — squelch circuit are leaky C6 (the input coupling capacitor for the noise amplifier), and low capacity in C7 (the emitter bypass capacitor for the noise amplifier). I usually replace C7 with a 0.5 μF capacitor instead of the normal 0.1 or 0.047, and the squelch seems to work smoother.

*Don Chase is regional editor of **FM**. He holds an amateur license (WØDKU) as well as a first-class commercial. Don owns and operates his own two-way business in Wichita, Kansas. If you have service problems, send SASE directly to him at FM Service Center, 4543 South Elizabeth, Wichita, Kansas 67217.

* * *

Moving to the low i-f and discriminator board, the most common failures are (1) a leaky or shorted Q4 (second limiter transistor) and (2) an open or intermittent L3 (a miniature 15 mH inductor). The symptoms given by the transistor will be weak and distorted audio. L3 being open shows up as continuous squelch noise.

* * *

A small push-to-talk relay on the *Voice Commander III* often gives troubles of intermittent keying. Bend the holding bracket slightly and slip the plastic cover off. Careful examination usually shows that one or both leads from the coil are broken. Solder across the break, but check the coil bobbin for loose fit to the core. A few drops of epoxy will prevent recurrence.

* * *

Early model GE *TPL* receivers gave trouble with solder joints mounting subassemblies onto the main boards. Under conditions of vibration, almost any solder joint can be the culprit. After resoldering every joint, stuff a small amount of polyurethane foam between the boards.

* * *

A low-cost (60¢) replacement for the *TPL*'s rf amplifier transistor is the *RCA 40235*, but to use it, you must pull the rf assembly from the frame. On the bottom of the assembly, you will see a red and a brown wire from the rf amplifier to solder points H11 and H12 (under the first oscillator board). Interchange the connections. If maximum sensitivity is needed, adjust the value of R2 (normally about 3900Ω) for 1 mA collector current. The sensitivity normally runs in the vicinity of 0.4—0.5 μV — and with adjustment of bias for optimum, it can run in the 0.25—0.3 μV range.

* * *

Also with the *TPL*, watch the location of the circuit-breaker/solenoid block. The circuit breaker is a thermal type, and heat under the hood will make it open without apparent cause.

* * *

It has truly been said, if you have battery, generator, or voltage regulator trouble, the first place it will show up is the two-way radio. Most sets will operate satisfactorily from about 11 to 16V, but they will almost invariably work best from 12 to 14V. Low voltage usually gives weak audio, some distortion, and erratic squelch operation. High voltage can do all this plus other things — like blown diodes, shorted filter capacitors and drastically shortened life for your transmitter tubes.

MOTOROLA

A common cause of excessive dynamotor whine on the *80D* transmitter is the filter capacitor between B− and chassis ground. Watch the polarity; the positive lead is the chassis.

* * *

It is amazing, the number of different chassis designated *80D*. In many of the transmitters, distortion in the audio can be traced to high *power factor* in the electrolytic capacitors of the power supply. Squealing in some models has been traced to corrosion on a light bulb used as a B+ fuse.

* * *

A common source of complaint with *80D* receivers is the length of the squelch tail. The grid of the dc amplifier and squelch tube typically has two 0.05 μF capacitors to chassis. The capacitance at this point can be reduced to as little as 0.001 μF with the possibility of some squelch chop on signals with heavy modulation as a tradeoff.

* * *

Don't be concerned if the silver plating of the miniature cavities in the *Sensicon* receivers is discolored or black. The black is silver oxide or silver sulfide and is just as good a conductor as bright, shiny silver.

* * *

The *Unichannel* and *G* lines of receivers tend to be "sensitive" about antenna impedance. The first rf amplifier tubes will be stable if connected to a single generator, but if the antenna is not resonant, the receiver may self-oscillate. The best cure is to fix the antenna, but a temporary fix is to connect a 120K resistor from screen to chassis ground.

* * *

Chesney

The artist who produced all the schematics for the April issue was Dave Chesney, of Glendale, Calif. His name was somehow omitted from the credits. He warrants mention not only because of the overall accuracy of his work, but because of the phenomenal volume he produced within a very short time frame.

ERRATA

IC IDENTIFIER

Tom Woore tells of editorial errors that crept into his January article, "Integrated Circuit Repeater Identifier": On page 19 of that issue, lines 8 and 9 of the second column should read:

expressions for the dits is BCD+BCD +ABDC+ABCE+ABCE+ABCD. On page 22, top right integrated circuit of top figure, a line should extend between pads 3 and 5 (pins 10 and 12 of chip).

FM Magazine has been the recipient of calls and correspondence from readers who want to know where the circuit boards can be obtained. Tom Woore furnished a new layout of the board, and FM Magazine had a quantity of the boards produced. These silvered printed circuit boards can be obtained by writing FM Magazine, 4861 Ramona Place, Ontario, California 91762. Send $5 for each board.

IC SYNTHESIZER

Gil Boelke spotted a few errors in the edited version of his article on a 400-channel synthesizer (April 1969), but it was too late to incorporate the changes in that issue.

In Fig. 1, the inputs to the TPL receiver and the TPL multiplier PA should be 46 MHz and 24 MHz, respectively, rather than 4.6 and 2.4 as incorrectly shown.

In Fig. 3, the second block in the diagram (the block following the reference oscillator) should have read "divide by 400" rather than "divide by 2500."

In Fig. 8, the 3.6V output from the voltage regulator was inadvertently grounded. The lead shown going to ground should have been a .05 bypass capacitor. Our artist slept through this one.

In Fig. 10, a meaningless "6 — 1 MHz" is shown at the right of the lower right broken-line box. That label belongs to the input lines to the divide-by-n block.

On the same page as Fig. 10, in the text on the right-hand column, a line was omitted between lines 3 and 4. If you can write small enough, cram in the following:

from 800 to 799. If A_1 and A_2 were both preset, the ratio is reduced by a 1

In Fig. 12, R_{10} (lower left-hand corner) should be 2.2K (not 22K).

In Fig. 13, the output lead at the extreme right of the sketch should read

OUTPUT TO PHASE DETECTOR

rather than OUT TO DETECTOR.

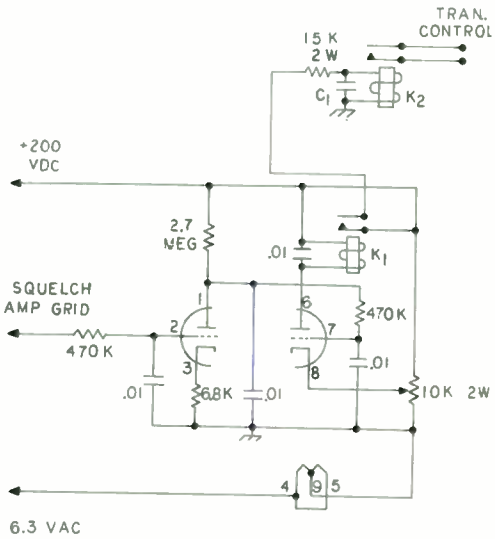
In Fig. 19, in the upper right-hand corner, place a 100Ω resistor in series with the +9V lead feeding Q_1. Then, between the resistor and the transistor, on the same lead, connect a 100 μF electrolytic capacitor (whose negative end will attach to ground).

QUICKIE CTS DECODER

Louis J. La Bonte states that an error appeared in his article, "Quickie CTS Decoder," March 1969. The resistor that goes from B+ to the vibrasponder should be in the neighborhood of 15 megohms instead of 1.5 megohms as printed.

COR "HOLD-ON"

by Wayne Wicks



The General Electric carrier-operated relay circuit can be modified to "hang in there" when weak signals would ordinarily tend to cause motorboating. As shown in the schematic, the only extra parts required are a relay, a capacitor, and a resistor. The effect of the complete circuit is that the repeater will stay on the air long enough for another station to pick it up. Also, when a mobile vascillates between threshold and below threshold, the repeater will keep transmitting even though the signal may drop momentarily below COR-activation level.

This arrangement will give much more mileage to the relays in the transmitter and receiver at the repeater site.

WA2KEC

LETTERS

RULEMAKING

I would like to make some comments on your proposed rulemaking for repeaters. On your statement that applications should be accompanied with information on how the equipment will furnish compliance with certain rules: I don't think this is necessary as it is not required of other amateur licenses and it is just as easy to break the rules with equipment used by individuals on the air as it is with a repeater. If the FCC has certain minimum requirements for repeater operation they should be stated in the rules and each amateur should be obligated to abide by these rules whether he submits additional information on how he is going to do it or not. A person could describe an elaborate system on his application but actually he might use anything. It is up to the FCC to make the rules and the amateur to abide by them without the additional information.

I believe details on control, access, logging, etc. should be left open so as to make it possible to make improvements with the state of the art.

I think the present rules are satisfactory if the logging requirements were changed.

I operate a repeater station in Bloomington, Ill. with about 25 stations using it. It is carrier operated and on 146.34 to 146.94. I have sent you these comments for your consideration so you might present the thoughts of more repeater operators.

Thank you,
Glenn Hill WA9ICK
902 Sheridan Road
Normal, Ill. 61761

Dear Mr. Sessions:

To begin with, I would like to say that FM is doing a great job on keeping us informed about FM repeaters. Many of us here in New Mexico have read and discussed with interest your proposed repeater rules. And we have become upset over the rumored FCC repeater rules changes.

As president of the VHF-FM Society of New Mexico, and as owner of the Sandia Crest (Albuquerque) Repeater, WA5JDZ, I would like to comment both on your suggestions and the rumored FCC suggestions. As the rules presently stand, there are many nuisances: logging, 3-minute identification, etc. However, these are just annoying when compared to your report of FCC thoughts in the March 1969 issue. The frequency and power limitations, frequency assignments, and prohibition of crossband operation will probably kill most of the repeater operations. However, there are a few other points which are disturbing.

One is the proposal for mandatory tone access (or even whistle-on access). This may be great in areas such as New York, Chicago, or Los Angeles. However, in relatively remote and sparsely populated areas (such as New Mexico) it is almost unworkable. In New Mexico, there are probably only 30 or so active FM'ers in the entire state. Most of the FM activity is conducted through the repeaters due to the scattered population. Many will hike or camp in remote areas carrying only a small talkie. May God help the ham with car trouble or a broken leg in the middle of nowhere if he lost his access whistle — certainly no one else will. For the past month, not a weekend has gone by that the FM hams have not spent most of their time searching for someone. Equipment used is usually 1-2 watt talkies where there is no space to install a tone oscillator, and whistles are easily lost. Please, try not to make tone access mandatory, but rather make it optional.

Another point is licensing repeaters only to clubs. There are many advantages to club operation, but why make it impossible for an individual to own and operate a repeater? A requirement such as this can be easily circumvented by throwing together a "club" of three or four members. I cannot believe that club-only ownership as a requirement is of great benefit to amateur radio. Amateur stations have traditionally been individual efforts, with clubs being formed to pool resources and exchange information. If an amateur wishes to make an individual effort out of a repeater, more power to him!

Again, I would like to say that *FM* fills a gap in amateur radio which has long needed filling. Keep up the good work.

Sincerely,
Philip H. Dater, M.D.
WA5JDZ
9006 Crestwood, N.E.
Albuquerque, N.M. 87112

You have the wrong idea. A whistle-on device is precisely what the name implies. You don't need A whistle. You need TO whistle. Just pucker up and whistle, and the repeater comes on. It stays on until people quit using the repeater. Ten minutes or so without a carrier and the repeater shuts down. To start it again — just whistle!

Dear Ken:

Re ur article in March, 1969 FM Magazine on Motorola ID numbers. There exists a series of Motorola rigs designed for railroad remote use, identified as R3-GGB, R43-GGV, and R43-GGT. These rigs are identical with the corresponding trunk model series, except they have a multipin connector on the front, which provides connections to the rig for power and control. At least one railway system is trading this gear out at the present time, and some of the gear should be coming available.

Hank Greeb W8CHT
6580 Dry Ridge Road
Cincinnati, Ohio 45239
April 10, 1969

Dear Mr. Sessions:

We would like to offer some opinions and background information on the repeater activity in our area. Our operations in this area are a bit different, and therefore we would like to offer some modifications to your proposed rule changes.

It appears to us that most of the repeaters mentioned in your magazine are of the easily accessible type.

Our repeaters are located on top of three mountains in the state. WA5DMQ is located on top of Capitan mountain at 10,000 ft. WA5JDZ is located on top of Sandia mountain, at 10,000 ft. WA5KUI is located on top of Alamo peak, at 8,000 ft. Changing a small item such as a fuse at the Capitan site takes a six-hour round trip in *good* weather. This site is located 65 airline miles from the town of Roswell, New Mexico, its control point, and the last 16 miles (to the top of the mountain) are over a purposely unimproved road. (There are also numerous commercial repeaters installed on top of the mountain, and this keeps curious people away from the mountaintop and the transmitter shacks.)

There is no commercial power available for 20 miles so this repeater is powered by diesel generators.

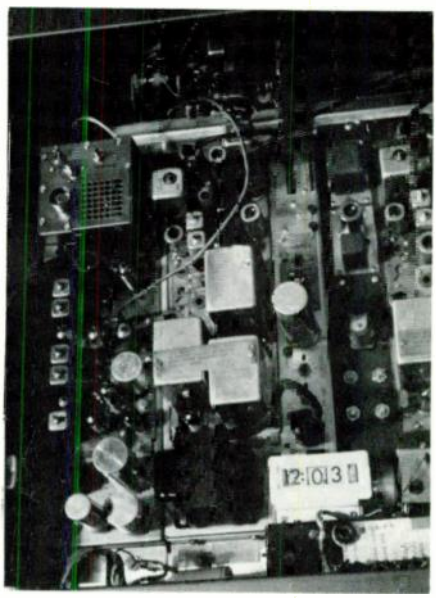
Three repeaters are linked in-band to provide coverage from El Paso, Texas, to Los Alamos, New Mexico in the northern part of the state. Total coverage area is roughly a rectangle approximately 200 miles east-to-west by 250 miles north-to-south.

Having given you an idea of our operations in New Mexico, we would like to offer our opinions of the rule changes proposed in your January issue.

Item 1 — Primary control of the Capitan repeater is 449.5 MHz. for initial tone-up and shutdown. All three repeaters in the state also have in-band control for auxiliary. We do not feel that it is in the best interest of all groups concerned to require mandatory tone (i.e., whistle) control to bring up the repeater each time a station desires to use the system. Also, visiting mobiles would not know whether a whistle or other tone device would be required to bring up a repeater, and hence would not know whether repeaters were operating on the frequencies they had available. If a tone or other signaling device is necessary at an individual repeater location, due to locally heavy traffic in the area, the group or individual controlling the repeater should install this device in the repeater equipment as part of good operating practice.

Item 2 — The proposed requirement of logging in at the transmitter site would make logging these repeaters impossible due to the distances and time element involved. Under our present logging system for the three repeaters, two tape decks, (one in Roswell, and one in Albuquerque) each log the first seven seconds of each transmission. The date is put on tape each morning. Therefore we submit that logging the repeaters from the control site should be sufficient to comply with requirements.1

Item 3 — We see no us in the requirement for logging power and frequency each and every time



the repeater is activated. In the first place, to log this from our meters on the transmitter would be impossible, again due to the distance involved. Secondly, repeaters are not subject to operator adjustment each time they are activated and this information will not be constantly changing. The power and frequency are logged initially, and that should be sufficient.2

Item 4 — "Monitor Stations" and repeater control. We feel that any licensed amateur using a

1 FM recommends that log be completed at the repeater site but only during those times when the equipment is being maintained.

repeater should be able to turn it off if he finds that it is being used improperly or that it is causing interference.

Item 5 — The ID's for our three repeaters are transmitted in sequence, and take a total of 20 seconds. This, together with your proposed two-minute ID requirement, would leave little time for communication3.

In closing, one thing is still not clear to us. Exactly where did this 3-minute ID requirement originate? We would appreciate an explanation of this in a future issue. We assume that from your article in the January issue, you are not sure of the source of this interpretation either, so a clarification would probably benefit everyone concerned.4

T. Warren Smith, President
El Capitan VHF Amateur
Radio Club
2306 Carver Drive
Roswell, New Mexico 88201

2 FM recommends logging power and frequency only when there has been a change, and only when visiting the repeater site.

3 This would seem to be a problem peculiar to the El Capitan club. FCC says ID every 3 minutes (of air time, we assume). FM agrees this is good. A fast-play tape puts out an ident in less than 2 seconds. Three-such idents would take 5—6 seconds. Admittedly, such rapid playback is uncopyable but an interested listener could record the superfast cw ident and play it back at reduced speed. Thus, legality is served and the system is not plagued by long idents. We pity the poor users of El Capitan if they must be subjected to a half-minute of identification every 3 minutes.

4 Repeater 3-minute rule is FCC directive and has been published in FM, CQ, and probably other national magazines several times over the past year. See, for example, the FCC's own article, "FCC Speaks Out On Reporters," FM, July 1968. As to question of where rule originated, suggest you contact Mr. James Burr, FCC, Washington, D.C. He's the one who told us.

Ken and Mike:

Seems the ARRL wasn't really trying to get people on the repeater committee who know what the score is. Your remarks (March 1969) parallel ours. Nominee from the Pueblo area (who didn't make it) was Charles Chambers (KOYFR), club repeater chairman and longtime booster of VHF FM activity.

I agree with most of your (repeater rulemaking) proposals and will be eagerly awaiting revisions and updating with others' comments.

Wilbur C. "Sparky" Lee
WØANO
Pueblo, Colorado

FM Magazine:

1 — Identification is usually the responsibility of the station using the frequency for communications; maybe some arrangement for that responsibility to rest with the station hitting the repeater input? . . . possibly ID'ing the beast every 10 or 15 in hispeed (100 wpm) cw as insurance (both ID's would naturally have to be mandatory).

2 — FCC may say no crossbanding? They already say crossband is okay and repeating is okay (Joe ham repeating 20 SSB to 220 MHz AM in his own shack) so the whole issue seems to be confined to remote-operated repeaters. Does this mean that they will also hold W6GDO's remote operations to this new rule system? (I'm not picking on Jon; just using him as representative of a class of operation).

3 — How about control above 220 MHz, unless on the normal input freq? (.34 to .94 could be controlled from either above 220 MHz. or from .34).

4 — Let's steal an idea from some other services — a repeater with facility for operation as a base station (know of any repeater which doesn't) only has to be ID'ed when operating as a base, not when repeating mobiles. Also, the log only MUST show sign on and sign off times for the station and the operator(s) on duty. Might we (who are probably pinching pennies and who are advancing the state of the art) get similar consideration?

5 — Licenses only to clubs? Must a club have more than one or two members? (Who said hams aren't inventive?)

6 — All repeaters to be tone-encoded?

It makes good engineering practice to have a tone control system (why not nationally uniform Touchtone codes).

7 — AND THE MOST IMPORTANT OF ALL. We don't have any definitions from the FCC yet, so we can't really argue effectively. Such as, is a whistle-on system tone-encoded?

Al Klein W2PMX
MOBILETALK, INC.
36 Emerson Place
Valley Stream, N.Y. 11580

Ken

. . . I agree 100% with you that the ARRL still doesn't realize the FM potential. One visible bit of evidence that FM is not "just another special interest group" is that no special interest group before has ever achieved the level of magazine dedicated to it that is represented by *FM*. My view of *FM*'s future is that almost every active ham will become an FM'er *in addition to* whatever phase of the hobby he now enjoys. This is becoming evident now in our area. DX'ers, traffic-handlers, experimenters — all of them are represented on FM. Furthermore, they are *still* DX'ers, traffic-handlers, and experimenters!

Congratulations on *FM*. It is shaping up beautifully, both as a magazine, a medium of FM communications, and in its editorial responsibility.

Gil Boelke W2EUP
505 Main Street
West Seneca, NY 14224

Ken

I looked over the March 1969 issue today and read your comments about the ARRL's choices for the repeater advisory committee. In answer to my letter to Mr. Huntoon (of the ARRL), I was told that the committee was "an internal affair of the ARRL" and I should not feel concerned. Well, as long as all activities of this committee *stay* within the ARRL, I agree. But if the ARRL makes recommendations to the FCC based on this committee, it is no longer an internal affair of ARRL.

Don Chase WØDKU
Wichita, Kansas

Ken

The March issue is very interesting. I cannot agree with your feelings about Jay O'Brien (WA6GDO) being disinterested in repeaters in spite of his position as appointed ARRL repeater advisory committee member. Jay is one of the most enthusiastic repeater supporters in the Sacramento Valley. He has done more for amateur FM in this area than any other person. It is not uncommon to hear Jay mobiling here or there to assist others with repeater difficulties. Jay engineered and built a full-duplex 450 MHz repeater on Mt. Vaca connected to a .94 remote base station. He engineered and helped build the Grass Valley remote base (a private .34-to-.94 machine). I think you have the wrong impression of Mr. O'Brien and I am sure you will change your opinion if you come up to Sacramento and take a look at what he is doing for FM repeaters.

Louis J. La Bonte
K6KDU
932 Dornajo Way #4
Sacramento, California 95825

You may be right, but we're still inclined to doubt it. You cited all the merits of Mr. O'Brien and pointed out how he helps in "repeater" projects. But as far as we could tell, those repeater projects were in reality private repeaters, or merely remote base stations. To be effective, a committee intending to make recommendations about repeaters should be composed of people who are themselves dedicated to serving others. This means they should be involved with open repeaters — facilities devoted free of charge to the use of all amateurs. Jay O'Brien was extremely upset when FM Magazine accidentally published his "secret" frequencies, and he stipulated pointedly that his facilities are NOT to be considered as open repeaters. It is the opinion of the editor that recommendations coming from exclusive "remoters" will be concerned with such aspects as keeping frequencies clear of unauthorized operators, tone-coding all systems, etc. But we hope we'll be proved wrong. A letter from Jay stating his philosophy would be most welcome, and would undoubtedly be read by all serious FM repeater advocates.

A NOTE TO THE .34-TO-.94 BOYS

Through reading a few past issues of FM, I find that you two-meter fellows think you have all the problems. You may be greatly surprised to find that in this part of the country, we six-meter operators are also having trouble with two-meter activity. Does it sound impossible? No, we do not have receivers that broad. Our trouble doesn't stem from just one repeater system but a combination of two or three.

System one is a simple .34-to-.94 repeater which doesn't give anyone any trouble, at least directly. System two is located a short distance from system one. System two operates with an output frequency of 52.525 MHz, and an approximate power of 30 watts (on several frequencies, one in the six-meter band and 2 or 3 in the two-meter band). One of the two-meter frequencies is 146.34, no less.

This means, as you probably have guessed, that those stations using .34 to access the .34-.94 repeater in system one, are also accessing the .34 to 52.525 repeater in system two. Since all activity in our area was and is on 52.525 and we have made great investments in receiver crystals, and since we wished to remain compatible with activity in other areas on six meters, we had no alternative but to expand our coverage by some means.

Our goal has been set, and we are in the process of building a 52.76 to 52.524 MHz repeater. The system will be located at an elevation of 1900 ft, running 25 watts of power.

I ask who should complain — we or thee?

R. C. (Dick) Tillotson, WA4SSJ
4 Alpine Drive
Taylors, S.C.

We should. It is the opinion of FM's staff that .34 be reserved as an input to a two-meter repeater. There may be differences of opinion as to what constitutes the national output frequency (.76 or .94), but

on one thing there is no disagreement: 146.34 MHz IS THE NATIONAL TWO-METER INPUT FREQUENCY. Crossband repeaters should be built around inactive channels (preferably both input AND output).

Dear Ken:

I think W7FJM, W7AKE, W7PBY, and many others in Las Vegas should be very proud of their repeater. With the equipment they had available, they have accomplished an almost impossible task. The reworking and changing i-f's of the 30D receivers was a stroke of genius.

During the convention I was able to key up with a full-quieting signal from a horizontal position in my room on the first floor of the Sahara Hotel with an HT 200 Motorola Handie-Talkie. This was true for a couple of days until someone decided to play games and put a "bug" on the air to tie up the input channel. I will not expound here on my thoughts.

As I remember, the distance from the Sahara to the repeater site is something like 23 to 28 miles. The very able president, "Squeak," of the local club, also took nine of us to the mountaintop location of the repeater. Again they are to be commended for their efforts in getting this very excellent site.

Art Housholder
Spectronics, Inc.

CARRIER-OPERATED RELAY KIT

Dynacoustics is currently producing a carrier-operated relay kit which includes a built-in three-minute timer. Terminals are available for connecting COR circuit to receiver. Assembly is contained on a single 2 x 3-inch board, and includes double-pole, double-throw relay. The unit was designed to be used with Dynacoustics' Model 921-A single-tone decoder, but is said to be universally adaptable. Information was supplied by Riggins Electronic Sales, 2331 San Anseline, Long Beach, California 90815.

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FOR SALE

MOTOROLA TLN 6030A – digital base station control unit and mobile control head complete for ham mobile phone patch with manuals and reed. $200. Motorola T1001A (Bird #43) thruline wattmeter new condition with quick connect UHF Patch cable with 2 elements; 2-30MHz/100 watt; 25-60 MHz/250 watts $115. Homebrew Motorola test set with pencil drawn schematic will test all models with phone plug or 11 pin socket, cables included. $40. Motorola (Army) VRC-19 Receiver, hi-band, tuned on channel JR mobile telephone/power 115VAC, butchered DC pack, rest of receiver original with special rack plug included. $20. William R. Hooper, Box 195, Holden, Mass. 01520.

GE BASE – Prog line rack mounted base station $150. with lo-band chassis or $175. with hi-band chassis, 4 freq decks $15. Motorola: 2 freq front end P-8404A for Sensicron A Receiver $25, 41V Base Station 2 freq. on 52-525; $75. 41V hi-band rear mount $35. Bob Coburn R.F.D.-2 Tinkham Lane, Londonderry, N.H. 03053.

BASE TRANSMITTER–hi-band, rack mount, transistorized to driver, final 4CV250R, made by collins, complete with power supply, metering FM mod., 110 vac, 60 cy. $90. One Motorola pack set P33, 5 watt with DC & dry Batt. Supply, tuned to 146. 34 & 94; $50. One prog. line mobile, hi-band, 30 watt, NB, $85 complete. Cavities for 2 meters made to order with or without FET front end, write for quotes. H.W. Pfeiffer, 52 Scotch Pine Dr., Voorheesville, N.Y. – K2LEQ

RCA SENIOR VOLTHOMYST WV97 – less probe – $20. ea., GE TPL 100 watt dual channel with all accessories and cables on 146.94 with manual $425. John Gubernard K2LSX, 220 Mt. Vernon Pl., Apt. 6A, Newark, N.J. 07106.

MOS-FET PREAMP – hi-band, 16 db gain; $10.95 (kit – $6.50) Special kit adds Xmtr. Osc. 3 & 4 to H23DCN/DEN HT., wired – $29.50. Bases: RCA MI 31244 – 450 MHz, $99.50. L44AAB – BY, $99.50. D43GGB with transistor mike, $139.50. GE 4ET 1E1, 2 freq. w/blower, no cabinets, $89.50. Mobile with accessories: T44AAV, $44.50. FMTRU 80D, $39.50. CMU 15A, $34.50. T43G & GGV, $89.50. 2 freq. xmit, $94.50. T53GAD, 60 watt, $109.50. U43GGT, 2 freq., $149.50, Handi-Talkie, H23AAM, $52.50. Satisfaction Guaranteed, Quantity discount will be given any order of two or more units. TOPEKA FM ENGINEERING, 3501 Croco Rd., Topeka, KS., 66605. Phone (913) 233-7580.

FM 5000 – International Crystal Co. freq. and deviation meters. Good $100. Fair $60. Oscillators for above, with International crystals on your commercial channel, new $8.00. Used $5.00. I.F. $8.00. Subtract 25% for ten or more. Carrying case holding 18 oscillators $10. Free with any order of 18 or more oscillators. James W. Holloway, 2027 Harton Rd., San Diego, California 92123.

GE 250W BASE – 52.525 Ex. Cond. $175, GE Remote dispatching unit, 117v, $20. Motorola 80D, 12v, 52.525, Ex. Cond. Control Mike, Ant., $55. Link Type 2210-ED2, 150 MHz, 6v comp. $25. 2SCR-300A 40-48 MHz FM Walkie-Talkies, $25. ea-W. Akerly, WA8QHI, 12 E. Douglas St., Bangor, Michigan 49013.

FOR SALE

AUTOMATIC TELEPHONE DIALER – stores 36 telephone numbers. Put lever opposite name, push button. Dials pre-set telephone numbers automatically. $119.50. SINGLE AUTOMATIC DIALER for any single number $59.95 – actuated by push button or remote relay control. INTERNATIONAL DIVERSIFICATION, INC., 4941 Tracy, Kansas City, Missouri 64110. (Free brochures).

MILITARY SURPLUS – directory of surplus military, commercial test gear, four volumes, 1,500 postpaid, Telecommunications Services, Box 4117, Alexandria, Va. 22303.

MOTOROLA – T44A-6 $40 ea. T44AAV $45. J44AAB, L44AAB with PL $125 ea. T1131A $275., D41GGV-20 $40 ea. Quick Call equipment with reeds, all transistor TLN6185-6 decoders $45. ea. Tube type decoders $10 ea. Hang-ups $1.50 ea. Tube type encoders $50 ea. Single tone P-9301A encoders $5 ea. P-9303 decoders $25 ea. Tube type PL encoders $15 ea. Permakay filters TFN6013AW, K9341, TU194 & TU406 $3.50 ea. RCA & GE 6/12v xtal ovens $2 ea. Motorola 2 freq. 12v ovens $4 ea. New Sonar VHF Sentry receivers with xtal supplied $35 ea. complete. International & Sentry crystals available for 146.460, .70, .880, .90, .94 in many Motorola & some GE types. TX $3 wa., Rx $5 ea., 150 & 450 MHz TX strips, OSC. decks and power supplies are also available. Sorry we do not ship. Illinois Communications Co., Inc. 10347 S. Oxford Ave., Chicago Ridge, Illinois 60415 (312) 445-0364, 423-0364.

MEASURMENTS 8OR – SIG. generator, good cond. $200. Measurments 8OR, Sig. Gen., Late model, excellent cond. $295. Autophone, Inc., 1410 Orme Ave., Los Angeles, Ca. 90023.

MOTOROLA T43GGV, – 12 volt mobile with all accessories, on 146.94 or .34-.76 narrow band, $125. Richard Beatie, WA-4ZYU, 1904-114 Ave., Tampa, Fla. 33612.

GE PROG LINE – 30 watt, hi-band, transistor supply, no accessories $90. Bob Coburn, RFD - 2 Tinkham Lane, Londonderry, N.H. 03053.

RCA CMV-3E1 – 12 volt, 60 w, lo-band, crystaled on 52.525 MHz. TS/323 UR freq. meter; LM freq. meter; Gonset G-150; RTTY; Model 19 & TD, Kleinschmidt TT-4A/TG, VC-89A/URA converter, TDA-2 distortion znalzyer, TS-2B/TG test set. S.R. Rosenquest, 1301 Clearfield Drive, Austin Texas 78758.

BIRD 43 – New Panel meters for Bird 43 Line Sections $15; Related gear S.A.S.E. W4API, Box 4095, Arlington, Va. 22204.

P33AAM – Motorola 5 watt Handie-Talkie P33AAM, preamp on receiver. Ready to go on 146.940 MHz. With batteries, like new, $100. D.J. Goodmah, WA8UIT, 3305. De-Sota Ave., Cleveland Heights, OH. 44118.

U43GGT – Motorola T-Power, Nice Shape, over 40 watts out, 2 freq. transmit, with control head, cables, mike and speaker, only $175. Farnsworth base, 8 watts out, dirty but tuned up and operating on 2 meter FM, on $35. Farnsworth base, 12 watts out, clean, real nice unit, $65. Both Farnsworth units are 2 freq. transmit and receive, and are tuned up on .34-.94. John R. Hall WB2UHK, RFD 1, Hornell, N.J. 14843. Phone (607) 342-5818, All units F.O.B.

80D – Motorola with transistor power supply, 4 freq. Send and receive, multi-channel monitoring, with all cables and accessories. Professionally done, no outboards or sub-assemblies. With crystals for 146.94, 147.3 and 147.5 MHz. – $195. James Scott, W9CWH, 706 N. Elmhurst Ave., Mt. Prospect, Illinois 60056.

½ KW AMPLIFIER – Homebrew, with two 4 x150's in tuned plated lines, 8 watts will drive it on the FM freqs. Complete with tubes. No power supply, only $75. Will ship with deposit, write W9JFP Vic Weissbrodt, 4912 West Hoyt Pl., Milwaukee, Wisconsin 53216.

WANTED

GE TPL – or Prog-Line, hi-band equipment, Lampkin FM deviator meter & freq. meter, S.R. Rosenquest, 1301 Clearfield Drive, Austin, Texas 78758.

GE AC SUPPLY – High power base supply, with blower, similar to 4EP4A3. For use with lo-band repeater. Richard Ahrens, W3WJC; 3404 Reading Crest Ave., Reading, PA. 19605. (215) 929-3466.

ELECTRONICS TECHNICIAN – FCC Licensed. To maintain, install, and check out marine electronic equipment on and for yachts, industrial equipment, FM, VHF communications; transistor experience required. Must be a self-starter and professional in attitude and performance. This is a year-round position for an established, growing, communications-oriented company. Send in a short resume or call collect. All replies strictly confidential. RAD-COM, 122 Library Lane, Mamaroneck, N.J. (914) 698-6800.

REPLACEMENT BATTERIES – need cells for the P33 Series Motorola. The older metal cased and the newer plastic cased cells. John Gubernard, K2LSX, 220 Mt. Vernon Pl., Apt. 6A, Newark, N.J. 07106.

SCHEMATIC – Manual or information leading to same for: COMCO AN/VRC-33A or CY-2108A/VRC-33 mobile radios. Uses 13 tube type 400 RAB receiver, 8 tube transmitter strip and vibrator power supply. All correspondence will be answered. J.R. Vander Maaten, 2181 – 65th Ave., Sacramento, CA. 95822. (916) 421-1873.

GE PROGRESS LINE – Hi-band, 4 free decks, both AC and transistorized supplies for med and high power. J.E. Young, 58 Hetcheltown Rd., Scotia, N.Y. 12302.

MOTOROLA PORTABLE – Hi-band or lo-band portable. Also have heath DX40 to swap for FM gear. John R. Hall, WB2UHK, RFD 1, Hornell, New York 14843. Phone-(607) 342-5818.

MOTOROLA MOTRAC or **GE MASTR** or **TPL** lo-band unit (to cover the 36-42 MHz split). Will consider unit with or without accessories, operating or not, but do want a unit with PL or reed-type tone squelch. GE TPL 30, 60, or 100 watt transmitter and power supply capable of covering 36-42 MHz split. Want Motorola PT-200 style handie-talkie (450 MHz) with PL. Want Motorola TU-217 "Vibrasender", code YZ (82.5 Hz) or code ZA (94.8 Hz) and TU-333 "Vibrasponder", code YZ or ZA. Alfred A. De Figio, Box 524, Republic, Pennsylvania 15475. Phone (412) 785-6320.

RCA MODEL CX-9A 915 KHz I-F Alignment oscillator. Gerry Baldauf, 175 Wernersville Blvd., Wernersville, PA. 19565.

MOTOROLA DISPATCHER – 8 watt, hi-band, T-power transceiver. State price and condition. All replies answered. Jack Molnar, WA3ETD, 111 S. Allen St., #45, State College, PA. 16801.

MOTOROLA TU-112, AC POWER SUPPLY. L 44AAB Motorola desk top base station. Also best deal for info on how to use Touch-Tone loop around & blue box multi-frequency. Robert Young, 319 Wyatt Rd., Harrisburg, PA. 17104.

DUPLEXER, for 440 & 446 MHz. Robert Young, 319 Wyatt Rd., Harrisburg, PA. 17104.

MOTOROLA P8501A, Portable test set manual, also osc. decks P8465 for Motorola FMTRU 80D transmitters. George B. Meserole, WA2UCP, 647 – 88th Street Brooklyn, New York 11228.

GE PROGRESS LINE – 12 volt power supply, lo-band, also Motorola PK Filter SK9035A. Contact: Edward Mattheis, WA8MWS, Box 164, Bridgeport, Mich. 48772.

HANDI-TALKIE or Packset operating on 146.940, hi or low power. Looking for trade-let me know what you need. Prefer local deal. Al Klein, 214 E. Mineola Ave., Valley Stream, N.Y. Phone (516) 825-0384.

INDUSTRIAL PS-150 two way radio packset information. Need crystal, battery and IF info. Also crystal information on LINK transmitter 1872 and rcvr 1873. Warren, 9017 – 8th Ave., S.W., Seattle WN. 98106.

WANTED Continued

BIRD #43 – Wattmeter, two Motorola H23 DEN hi-band portables, U51GGT lo-band with PL. FM signal generator. State price and condition. W.B. Kincaid, WA4YND, 210 Graeme Drive, Nashville, TN 37214.

GE BASE – Progress line late model 100 watt base station, one (1) lo-band 52.525 MHz, one (1) hi-band 146.940 MHz. Send your price and phone number to: Paul W. Cox, K4LLX, Drawer 160, Asheboro, N.C. 27203.

GE PHONE UNITS – 5 Channel telephone units, Progress UHF units, lo-band progress. VHF Progress mastr, Motrac, late TPL-Motorola or GE 11-Channel units, or any parts or strips to the above. Top wholesale prices paid. Call Bill Miller – (213) 263-4112 or write Autophone, Inc. 1410 Orme Ave., Los Angeles, CA. 90023.

BACK ISSUES – Need issues of FM prior to and including July 1968, George E. Missbach, 3330 Peachtree Rd., N.WL Atlanta, G.A. 30326.

SERVICE EXTENSION CABLE – Type 1474787 for Westinghouse Model FE Railroad base station, or connectors to make same. John Becker, K9WEH – 2435 Birchwood Lane, Willmette, Illinois 60091.

UHF PROG. LINE STRIPS – Richard Beatie, WA4ZYU, 1904 – 114th Avenue, Tampa, Florida 33612.

COMCO 580, 680, 582, 682 GEAR. Complete with head and cables. If reasonably priced and not stripped. Contact: R. Knowles, 146 S. Main St., Freeport, N.Y. 11520.

INSTRUCTION MANUAL, for L44AAB consisting of TU112 power supply, TA 147-TX, and TU193-RX or Zeroxed Schematic of TU112 power supply. Please reply to: Robert Young, 319 Wyatt Rd., Harrisburg, Pennsylvania 17104.

455 KHz PERMAKAY FILTER – used in the W8BCI Two-Meter FM Handie-Talkie. See Dec. '67 'FM' or June '62 QST, Page 37. Need two units. Paul Frankle, 215 Stewart Hall, Angola, Ind. 46703.

MOTOROLA HT-200, Series Handi-Talkie. (H23DCN) 150-170 MHz. 2-freq. preferred but will consider single freq. model. Also interested in low band and 450 versions of the above with "PL". Also looking for single tone encoders and decoders (transistorized) such as "Reach", "Dynacoustic", etc. K3AUD, Alfred A. De Figio, Box 524, Republic, Penn. 15475. Phone – (412) 785-6320.

BENDIX MRT-10 (lo-band) – need info and schematics. Also tips on converting the above to 6 meters. Bob Spain, RD 2, Box 532, Blackwood, N. J. 08012.

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events

CROSSVILLE HAMFEST– The Oak Ridge Radio Operator's Club will sponsor the 20th Annual Crossville Hamfest at the Cumberland Mountain State Park July 26-27. For information, write P.O. Box 291, Oak Ridge, Tenn. 37830.

S. W. MICHIGAN VHF PICNIC – The Annual S.W. Michigan VHF Picnic will be held August 3, 1969 at the Allegan County Park. 13th year with approximately 600 from the Great Lakes in attendance. For more information, write: Walter Akerly, Jr., WA8QHI. Bangor, Michigan 49013.

35TH ANNIVERSARY HAMFEST – Hamfests Radio Club of Chicago, Illinois will present their 35th Anniversary Hamfest on Sunday, August 10, 1969 at Santa Fe Park, 91st and Wolf Road, Willow Springs, Ill., Southwest of Chicago. For info contact: Joseph W. Paradyla, WA9IWU, 5701 South California Ave., Chicago, Ill. 60629.

WIMU HAMFEST – Wyoming, Idaho, Montana and Utah Hamfest. 37th Running. Being held at the Mack's Inn Idaho, 23 miles south of Yellowstone, Montana. August 1, 2, & 3. Contact the President of the South Eastern Idaho FM Radio Association, Robert W. MacGregor, K7UAE for information.

TWO RIVERS 5TH ANNUAL HAMFEST – Sunday, July 27, 1969 at the Balkan Hotel, 801 Coulter Road, McKeesport, Pa. For info contact: M.L. Backstrom, W3DM, 1405 Clearview Ave., McKeesport, Pa. 15131.

NORTH ALABAMA HAMFEST – August 17, 1969 at the John C. Calhoun State Technical and Junior College near Decatur, Alabama. Contact: William L. Matthews, P.O. Box 9, Decatur, Alabama.

Cont. from page 22

of California and the East Coast this probably will not be necessary for a long time to come. It may also prove more practicable to set up a narrowband system where an abundance of narrowband equipment is supplied to a large group of isolated FM'ers in an isolated area.

Until recently, virtually all of the equipment available to amateurs was of the wideband type, using tubes or a combination of tubes and transistors. Now, however, the very latest units becoming available are of the narrowband type. Since it will be extremely desirable to standardize nationally on a rigid deviation level, the question then arises: Where will amateurs obtain solid-state units with technically superior wideband capability? One source of supply is the recent entry of solid-state transceivers mentioned previously. Another source is the traditional one: homebrew. Prices are continually falling on semiconductors, and new gadgets and goodies are appearing almost daily.[3] Regardless of the source, we should bear in mind that FM as an amateur VHF mode has found itself. And as the demand continues to increase, so must the supply!

3 ED. NOTE: A third source, if you're interested in widebanding a narrowband Motorola unit, is Spectronics, Inc., 1009 Garfield Avenue, Oak Park, Illinois. Company Rep Art Housholder tells of a large stock of wideband Permakay filters for Motorola units of all vintages, including the Motrac.

books

GOOD READING FOR THE FM'ER

FIRST-CLASS RADIOTELEPHONE LICENSE HANDBOOK, (2nd Edition)

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TWO-WAY MOBILE RADIO MAINTENANCE, (2nd Edition)

by Jack Darr. Here is a complete and extremely practical field-servicing handbook. It is a valuable guide to planning, installing, and maintaining all types of 2-way mobile radio systems. The author's own first-hand experience gets you right to the heart of how to do the job the quickest and best way. Written in easy-to-understand language; illustrated with many on-the-job photos of 2-way equipment. 256 pages; 5½ x 8½; softbound.

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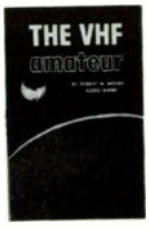

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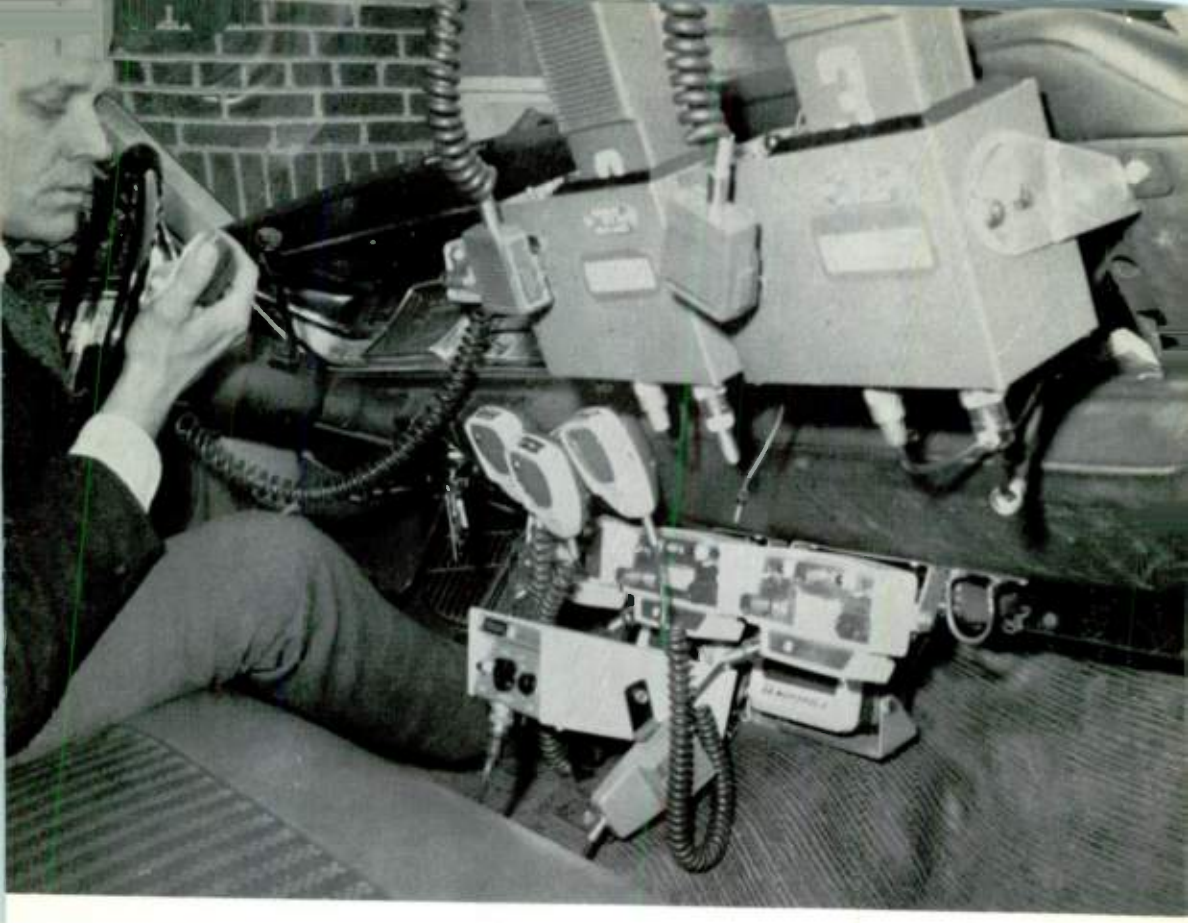

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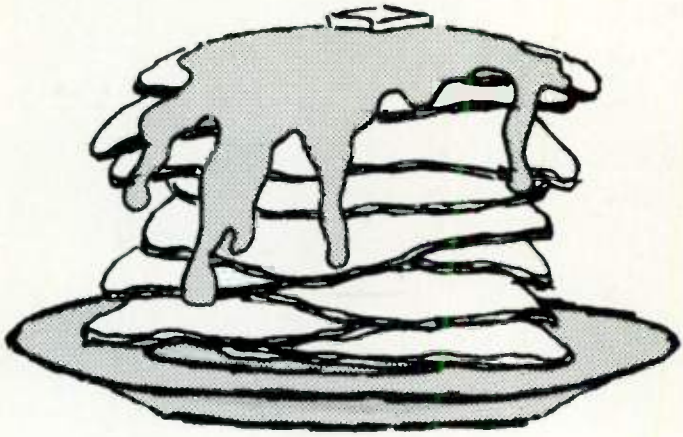

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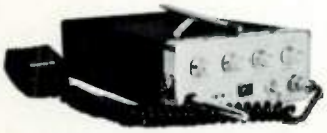

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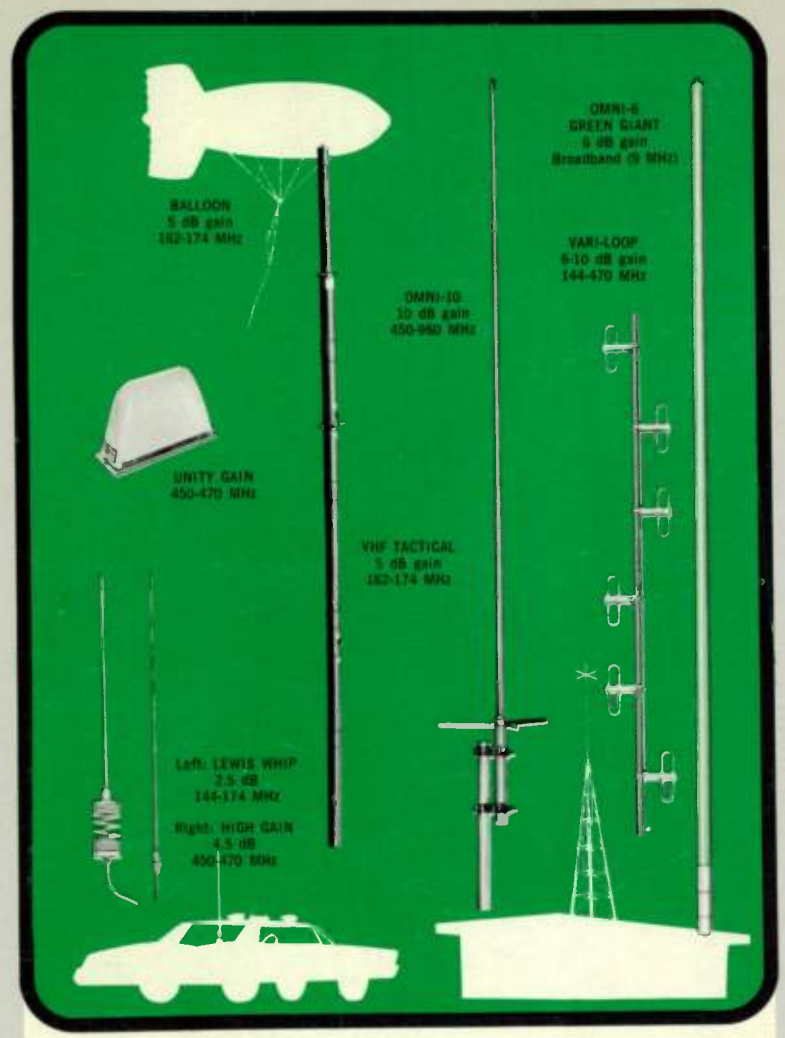

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