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November 1969
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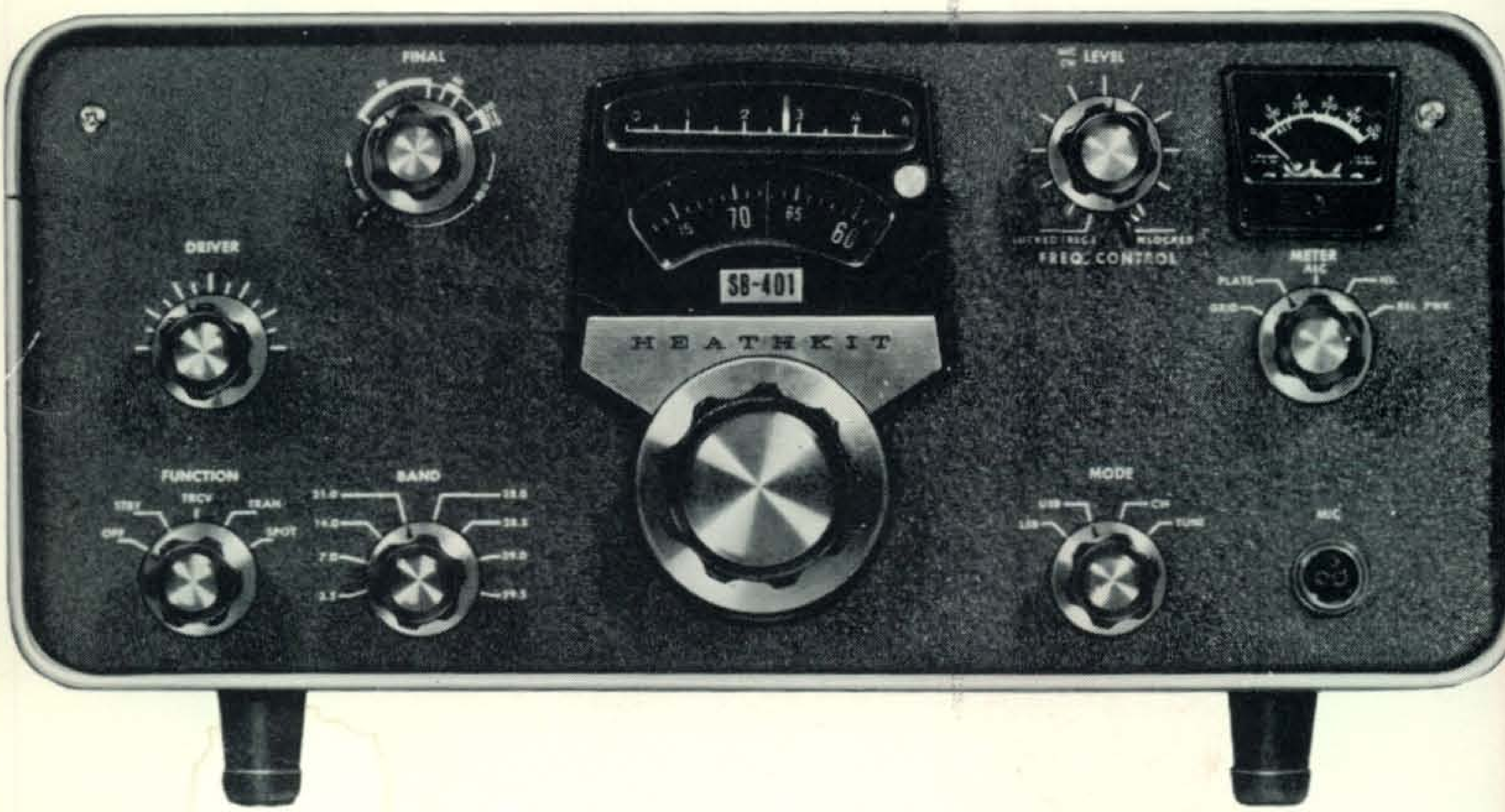
SPECIAL
An in-depth report on sunspots,
the ionosphere, and the mechanics
of radio wave propagation.
The Radio Amateur's Journal

Some Hams Still Prefer A Separate Receiver

And Transmitter...



We're One Of The Few Places You Can Come To

The HEATHKIT® SB-301 amateur band receiver

Performance-Plus Features, Top Dollar Value And Sophisticated, Quality Engineering Have Made The SB-301 The World's Largest Selling Receiver

• 80 through 10 meter coverage on AM, CW and SSB with all crystals furnished • Famous Heath factory assembled and aligned Linear Master Oscillator for truly linear, high stability tuning • Crystal-controlled front end for same rate tuning on all bands • 1 kHz dial calibration — 100 kHz per dial revolution • Less than 50 Hz backlash • Less than 100 Hz drift per hour after warm-up • Bandspread equal to ten feet per megahertz • Tuning dial to knob ratio approximately 4 to 1 • Three speed AGC

Plus These Extra-Performance Features That Put The SB-301 In A Class By Itself

• RTTY position on mode switch — SB-301 is a fully capable RTTY receiver • 15 to 15.3 MHz coverage for WWV reception • Built-in 100 kHz crystal calibrator • Built-in switch selected ANL — a real help if your QTH is in a high noise location • Front panel switching for control of optional 6 and 2 meter plug-in converters — enables complete 80 through 2 meter amateur band coverage • Front panel switch selection of optional AM and CW crystal filters • Circuit board, wiring harness construction make assembly fast and simple

Kit SB-301, Amateur Band Receiver, less speaker, 23 lbs. **$270.00***
SBA-301-1, Optional AM crystal filter (3.75 kHz), 1 lb. **$20.95***
SBA-301-2, Optional CW crystal filter (400 Hz), 1 lb. **$21.95***
Kit SBA-300-3, 6-Meter Plug-in Converter, 2 lbs. . . . **$19.95***
Kit SBA-300-4, 2-Meter Plug-in Converter, 2 lbs. . . . **$19.95***
Kit SB-600, Communications Speaker, 5 lbs. **$19.95***

Look over the specs and find out why thousands of hams have chosen the SB-301 for their shack!

SB-301 PARTIAL SPECIFICATIONS — Frequency range (megahertz): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 15.0 to 15.3, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megahertz. **Frequency stability:** Less than 100 Hz per hour after 20 min. warmup under normal ambient conditions. Less than 100 Hz for ±10% line voltage variation. **Visual dial accuracy:** Within 200 Hz on all bands. **Electric dial accuracy:** Within 400 Hz on all bands after calibration at nearest 100 kHz point. **Backlash:** No more than 50 Hz. **Sensitivity:** Less than 0.3 microvolt for 10 db signal-plus-noise to noise ratio for SSB operation. **Modes of operation:** Switch selected; LSB, USB, CW, AM, RTTY. **Selectivity:** RTTY; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). SSB; 2.1 kHz at 6 db down, 5.0 kHz at 60 db down (crystal filter supplied). AM; 3.75 kHz at 6 db down, 10 kHz at 60 db down (crystal filter available as accessory). CW; 400 Hz at 6 db down, 2.0 kHz at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response:** SSB; 350 to 2450 Hz nominal at 6 db. AM; 200 to 3500 Hz nominal at 6 db. CW; 800 to 1200 Hz nominal at 6 db. **Audio output impedance:** Unbalanced nominal 8 ohm speaker and high impedance headphone. **Audio output power:** ½ watt with less than 8% distortion. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socket. **Crystal calibrator:** 100 kHz crystal. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120/240 V AC, 50/60 Hz, 50 watts. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

The HEATHKIT® SB-401 5-Band SSB Transmitter

Imaginative Engineering and Rugged, Reliable Performance Capabilities Have Made The SB-401 The World's Largest Selling Transmitter

• Ideal power level for barefoot operation — 180 watts PEP SSB, 170 watts CW • Makes a perfect driver for any linear, like the SB-200 • Built-in power supply and small, compact size make it an excellent self-contained desk top transmitter • Famous Heath pre-built & aligned LMO for rock solid frequency control — less than 100 Hz drift per hour after warm-up • ALC for more talk power means better DXing through QRM • Crystal filter sideband generation • Built-in antenna change-over relay • Operates upper or lower sideband • VOX and PTT control • 1 kHz dial calibration — 100 kHz per dial revolution • 500 kHz per band switch position • Maximum TVI protection from completely shielded and isolated circuits • Relative power meter • Clean signal characteristics — carrier and unwanted sideband suppression of 55 dB

The Versatility You Need For DXing, Round Tables, Nets Or Rag-Chews

• Just a flick of a switch to select transceive or independent operation of the SB-401 and SB-301 (or SB-300) combination — no troublesome, time consuming cable changing . . . ideal for cross band work • Can be operated as an independent transmitter with any receiver when the SBA-401-1 crystal group is installed • Fast, clean break-in CW keying • Meter checks grid current, final plate current, ALC maximum modulation, final plate voltage and relative power, all at the flick of a switch.

Kit SB-401, 34 lbs. **$295.00***
SBA-401-1, Crystal Pack, 1 lb. **$29.95***

Check the specs and see the many reasons why you hear the SB-401 on the air more often than any other transmitter!

SB-401 SPECIFICATIONS — Emission: SSB (upper or lower sideband) and CW. **Power input:** 170 watts CW, 180 watts P.E.P. SSB. **Power output:** 100 watts (80-15 meters), 80 watts (10 meters). **Output impedance:** 50 to 75 ohm — less than 2:1 SWR. **Frequency range:** (MHz) 3.5 — 4.0; 7.0 — 7.5; 14.0 — 14.5; 21.0 — 21.5; 28.0 — 28.5; 28.5 — 29.0; 29.0 — 29.5; 29.5 — 30.0. **Frequency stability:** Less than 100 Hz per hr. after 20 min. warmup. **Carrier suppression:** 55 db below peak output. **Unwanted sideband suppression:** 55 db @ 1 kHz. **Intermodulation distortion:** 30 db below peak output (two-tone test). **Keying characteristics:** Break-in CW provided by operating VOX from a keyed tone (Grid block keying). **CW sidetone:** 1000 Hz. **ALC characteristics:** 10 db or greater @ 0.2 ma final grid current. **Noise level:** 40 db below rated carrier. **Visual dial accuracy:** Within 200 Hz (all bands). **Electrical dial accuracy:** Within 400 Hz after calibration at nearest 100 kHz point (all bands). **Backlash:** Less than 50 Hz. **Oscillator feedthrough or mixer products:** 55 db below rated output (except 3910 kHz crossover which is 45 db). **Harmonic radiation:** 35 db below rated output. **Audio input:** High impedance microphone or phone patch. **Audio frequency response:** 350-2450 Hz ±3 db. **Power requirements:** 80 watts STBY, 260 watts key down @ 120/240 V AC, 50/60 Hz. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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POWER / PORTABILITY / PERFORMANCE

HIGH POWERED TEAM

Cygnet Linear Amplifier

1200 watt matching amplifier with self-contained AC power supply

For those times when the quarter kilowatt of the model 270 transceiver isn't quite enough to break through, the Cygnet Amplifier illustrated above provides a 5 times increase in power. Utilizing a grounded grid, super-cathode-drive circuit, both efficiency and linearity are exceptionally high. In a matching cabinet which includes the AC power supply, the 1200-W makes a most attractive companion for your Cygnet transceiver. It plugs directly into the Model 270, and may be adapted easily to the 260 as well as other transceivers.

SPECIFICATIONS: Power Rating: 1200 watts P.E.P. input with voice modulation, 800 watts CW input, 300 watts AM input. • Covers 80,40,20,15, and 10 meters. • Four 6LQ6 tubes operating as grounded grid triodes. • Third order distortion down approximately 30 db. • Pi output tank for 50 or 75 ohm coaxial antenna feed. • Computer grade electrolytic filter capacitors. • Silicon diode rectifiers. • Complete with interconnecting cables, ready to plug into the 270 and operate. • 117 volts, 50-60 cycles input. Available on special order for 208-220-240 volts. • **Dimensions:** 5½ in. high, 13 in. wide, 11 in. deep. Weight: 25 pounds. (Carrying handle included.)

Amateur net: **$295**

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Deluxe *Cygnet* 270 Transceiver

5 BANDS 260 WATTS
for fixed, portable or mobile operation

A complete amateur radio station with built-in AC and DC power supply and loudspeaker. The Cygnet 270 contains all the features required for home station operation, yet it is compact and light enough to make an ideal "traveling companion" on those business or vacation trips.

SPECIFICATIONS: Power Input: 260 watts P.E.P. in SSB voice mode, and 180 watts in CW mode • **Frequency Range:** 3.5-4.0 mc, 7.0-7.3 mc, 14.0-14.35 mc, 21.0-21.45 mc, 28.0-29.7 mc • **C.F. Networks:** Crystal Lattice Filter. Same as used in the Swan 500-C. 2.7 kc band width at 6 db down. 4.6 kc wide at 60 db down. Ultimate rejection exceeds 100 db • **Unwanted** sideband suppressed 50 db. **Carrier** suppressed 60 db. 3rd order distortion down approx. 30 db. • **Audio Response:** flat within 3 db from 300 to 3000 cycles in both transmit and receive modes • **Pi Antenna coupler** for 50 to 75 ohm coaxial cable • **Grid Block CW keying** with off-set transmit frequency • **Solid state VFO circuit** temperature and voltage stabilized • **Receiver sensitivity** better than ½ microvolt at 50 ohms for signal-plus-noise to noise ratio of 10 db • **100 kc Crystal Calibrator** and dial-set control • **S-meter** for receiver, P.A. Cathode meter for transmitter tuning • **Improved** AGC and ALC circuit. Separate **R.F.** and **A.F.** gain controls • **Sideband selector** • Provision for **plug in of VOX** unit, external VFO, headphones, and Cygnet Linear • **Tube compliment:** 12BA6 VFO amp., 12BE6 trans. mixer, 6GK6 driver, 6LQ6 pwr. amp., 6BZ6 rec. R.F., 12BE6 rec. mixer, 12BA6 1st I.F. amp., 12BA6 2nd I.F. amp., 12AX7 prod. det. A.F. amp., 6AQ5 A.F. output, 12AX7 mic. amp., 6JH8 bal. mod., 12AV6 AGC-ALC amp. **Dimensions:** 5½ in. high, 13 in. wide, 11 in. deep. Net weight: 24 lbs.

Amateur net: **$525**

PLUG-IN ACCESSORIES: Model 508 External VFO, Model 510X Crystal oscillator, Model VX-2 VOX unit.

OTHER ACCESSORIES: Model FP-1 Phone Patch, Mobile Mounting Kit, Model 45 Manual Switching 5 band Mobile Antenna, Model 55 Remote Switching 5 band Mobile Antenna.

SEE YOUR SWAN DEALER SOON FOR COMPLETE DATA ON THE SWAN LINE

CQ

NOVEMBER, 1969 VOL. 25, No. 11

The Radio Amateur's Journal

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DEPARTMENTS

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Two rugged Eimac 3-500Z high-mu triodes are featured in Henry Radio's new 2K-3 linear amplifier. Henry designed the amplifier around versatile Eimac power tubes because these popular triodes are ideal for grounded-grid operation at the 2 kW PEP SSB input level, and at the 1 kW DC input level for CW, AM and RTTY. Users of this new Henry rig will enjoy a conservative plate dissipation rating of 1000 watts for year-in, year-out reliability under key-down service. Henry's choice should be your choice. For more information on the 3-500Z and on Eimac's line of power tubes for advanced transmitters, write Eimac Amateur Services Department or contact your nearest Varian/Eimac distributor.

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Ted Henry needed a rugged linear triode. So he came to us.

ZERO BIAS

EARLY this year *CQ* DX Editor John Attaway, K4IIF filed with FCC a petition that the Extra Class exclusive segments 7.000-7.025 mc and 14.000-14.025 mc *not* be expanded as scheduled on November 22, 1969 and suggested that a 10 kc exclusive segment would be more appropriate on these bands. The petition was filed by John as an individual, and not by *CQ* itself, although we were in total agreement with the proposal.

In an order adopted on Sept. 24, 1969, the FCC rules on John's proposal (RM-1393), as well as two other proposals, RM-1357 by Neil W. Petlock, and RM-1493 by Emery T. Mitton related to Extra Class c.w. requirements and the 50 mc band, respectively.

Although all three proposed Rule Makings were denied in the Order, John's proposal was evidently used as the framework for the FCC's decision to withhold implementation of its previously announced plans to further expand the exclusive Extra Class c.w. segments by another 25 kc on November 22. As the Order reads: "The exclusive telegraphy sub-bands for the Amateur Extra Class licensees are relatively lightly used compared to the telegraphy usage of the balance of the band by the other Classes of operators. Therefore, further expansion is not justifiable as a productive incentive to qualify for the Extra Class at this time."

We're pleased to see that the men who write and enforce the rules have once again shown their ability to be reasonable and flexible in meeting a problem.

Copies of the complete Report and Order are available from *CQ* (s.a.s.e. please).

Alien Operators—More Progress

With Senator Barry Goldwater at the helm, the progress of S-1466—sometimes known as the Alien Operators Bill—has been sure and methodical. The Bill was originally sparked by George Pataki, ex-YO2BO and his determination to see an error which was unwittingly written into the Reciprocal Privilege Bill some years ago corrected to allow aliens to operate amateur equipment in the U.S. Under present law, a vacationer from one of the 41 foreign countries which the U.S. has negotiated Reciprocal Agreements can operate unhindered in the U.S. amateur bands. An alien, or political refugee to the U.S., even if he has begun the naturalization process is now denied the same privilege.

The latest corrective legislation to be introduced is S-1466, and is *sponsored* not only by Sen. Goldwater, but the following 21 Senators: Sen. Fannin (Ariz.), Sen. Murphy (Cal.), Sen. Cranston (Cal.), Sen. Dominick (Col.), Sen. Inouyi (Hawaii), Sen. Fong (Hawaii), Sen. Bayhr (Ind.), Sen. Dole (Kans.), Sen. Metcalf (Mont.), Sen. Curtis (Neb.), Sen. Hruska (Neb.), Sen. Bible (Nev.), Sen. McYntyre (N.H.), Sen. Javits (N.Y.), Sen. Packwood (Ore.), Sen. Pell, (R.I.), Sen. Thurmond (S. Car.), Sen. Barker (Tenn.), Sen. Tower (Tex.), Sen. Bennett (Utah), Sen. Randolph (W. Va.).

Of the eight Federal agencies which have been called on to report and advise on S-1466, seven have replied favorably, and one is still due to report. When the final agency report is in, committee hearings will be held, probably before the end of the year, and barring any major upset, the odds appear to favor passage of S-1466 sometime this session.

Your letters to your U.S. Senators, urging support of S-1466 can only help assure passage when the vote comes.

Australis-OSCAR 5 Launch Imminent

Sometime before the end of November Australis-OSCAR 5 is likely to be launched piggyback with a weather satellite. Amateurs are urged to check W1AW for the launch announcement. Orbital and operational parameters are as outlined in previous articles in Aug. *CQ*, p. 63, and Sept. *CQ*, p. 22, and Oct. *CQ*, p. 49. Anyone with 2 or 10 meter gear would do well to keep an ear pitched for OSCAR's familiar HI, but beware; this satellite business has been known to completely absorb many an avid ham!

73, Dick, K2MGA

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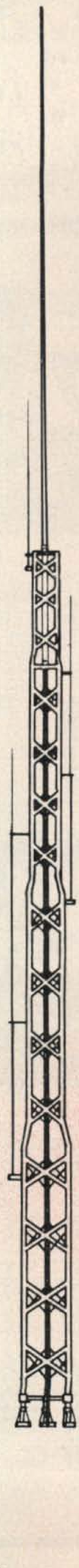

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SCRATCHI

Feenix, Ariz.

Deer Hon. Ed:

Any time you being asked to get involved with hams, Hon. Ed., just thinking twice about it. Hokendoke Hackensaki but they being a mixed up bunch of peeple.

Before you getting eggscited and getting off on wrong foot, let me telling you I not talking about radio amchoor hams. No—I talking about acting-on-stage type hams.

There is group of them heer in Feenix who having theater not too far from Hon. Brother Itchi's ranch. They calling themselves Ye Old Bar-X and Corral Dinner Thearter. They buying old barn and fixing it up with stage and stuff and even a kitchen to serving meals. For five bux you can come eat and see a play at the same time.

I getting involved on acct. the feller who usually handles liteing problems for them are on vacation back East. See what I meen, Hon. Ed.— what kinda nut leeves Arizona in wintertime to go back East for a vacation?

Anyhow, I attending rehersals and pushing switches to making lites go brite and dim and vice versa. The play are called Southern Belles are Ringing—or sumthing like that. It all about life on the old plantayshun midst the peech trees and magnolia blossoms.

Rehersals going very well except for one Hon. Old Grayhaired Lady. Evidentally she major stockholder in Ye Old Bar-X and Corral D.T. so she having chance to be in each play. She's eighty if she's a day—and she's a day— and she's sorta deff to boot.

Her problem is that she can't remembering her lines from one minute to the next. The Hon. Director are teering his hair out, so I suggesting I fixing up little xmitter/reseever deel so the prompter can speak into mike and Hon. O.G.L. can then heering with the reseever and little earpiece.

The Hon. Director and Hon. Old Grayhaired Lady are agreeing, so I geting tiny FM

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radio with earpiece and making FM xmitter of reelshort range so prompter can giving lines to Hon. O. G. L. from offstage whenever she forgetting them—which is most of the time.

Everything working peechy-hunky in rehearsals. Tiny FM reseever hidden under shawl Hon. O. G. L. is wearing. She heering the cues when she forgetting, and play are reely 1/c.

Everything staying peechy-hunky on opening nite, too, in the first act. It being in second act when suddenly Hon. O. G. L. missing one cue, then another. She also looking kinda wildly. Knowing sumthing wrong, I rushing to FM xmitter, and checking it, but it seems to be ok. Howsumever, what being said in mike not being heard by Hon. O. G. L.

She heering sumthing, tho. Each time it her turn to speak, she saying sumthing. For awhile it sounding like Hon. Shakespeare. Audience getting reel big charge out of it.

On a hunch I turning on spare FM reseever I having. Hah!! Sure enuf, local FM stayshun are broadcasting Romeo and Juliet. Evidentally Hon. O. G. L. moving shawl over the tuning knob on the reseever and tuning in a reel FM stayshun.

Short time later she doing it again, and this time are tuning in to local boxng match. Now the play are reely getting funny. The other actors on stage not knowing what to do at first, but they seeing that the audience are enjoying the play, and laffing like furies, so they going along with the gag.

Boxing match going off the air it followed by a network program—"Why Did You Marry Your Wife." At this point rating of the play going from G—for family entertainment —to M—for mature audiences only.

Now everybuddy having great old time. Actors laffing so hard they can hardly speak there lines, and the audience are practically rolling in the aisles.

No telling how long play going on that way except that Hon. Old Grayhaired Lady moving her shawl again and tuning in program of recorded music. This put a damper on things reel quicklike so the stage manager are running down the curtain, and cast are all taking there curtain calls, and the play over.

At first I thinking that Scratchi are going to be blamed for the reseever being tuned off the prompter's freakwency, but that not the case. Hon. O. G. L. so delighted with the way the play going, that she wanted to do the same

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thing that next performance. As usual, Ye Old Bar-X and Corral Theater record on tape every first-nite performance. So, they having everything on tape and they can listen and find out what went on.

Now, all they gotta do is to figyouring out sum way to cueing Hon. O. G. L. on what she said that opening nite performance. That meens they gotta find sum way to keeping that reseever tuned to one freakwency.

Notice I saying "they" gotta figyouring it out. Not me. I having enuf of that crazy bunch of hams. Maybe the play go on, and all that stuff, but so must my skeds with reel normal type amchoors.

Respectively yours,
Hashafisti Scratchi

OUR READERS SAY

CQ on Tape

Editor, *CQ:*

Our contact with the blind community indicates to us that many blind persons are unaware of the fact that *CQ* is available to them on tape from Science for the Blind. This is true in spite of the fact that we have tried to notify them through notices in braille periodicals and by direct mail to our own mailing list.

Perhaps you and your readers can help. We would be grateful if you could print this letter in your "Letters to the Editor" and request that anyone who knows a blind person mention to him or her the fact that we have *CQ* available.

Perhaps you would also be willing to place a small note in a few, or all, issues of *CQ* which might read something like the following:

CQ is available to the blind and physically handicapped on magnetic tape from SCIENCE FOR THE BLIND, 221 Rock Hill Rd., Bala Cynwyd, Pa. 19004. It is read onto tape by volunteer readers with the publisher's permission and is intended solely for the use of the blind and handicapped.

We have sincerely appreciated the cooperation *CQ* has given us with this project. We have included excerpts from it in our *Radio Digest*, and have had an enthusiastic response from the 100 blind persons who receive it. We feel that this enthusiasm would be shared by a significant number of others if they knew about our service. Our thanks for your help.

Mrs. L. Fuller, Assoc. Dir.
Science for the Blind
Bala-Cynwyd, Pa. 19004

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Free Map

Editor, *CQ:*

Our radio club recently had printed a large number of sets of maps used to determine average monthly sunrise and sunset times anyplace in North America.

The maps are useful for any work involving approximate sunrise and sunset times such as 160 meter propagation studies.

To get rid of the excess quantity of maps, a set of twelve (one for each month) maps with instruction sheet will be sent free of charge to all *CQ* readers requesting them.

Donald Erickson
6059 Essex Street
Riverside, Calif. 92504

Liberal Lexicon

Editor, *CQ:*

Articles about integrated circuits might mean more if you included a glossary. Nand and nor and stuff like that. Not to mention truth tables.

Sounds like a lot of Boole to me.

Joe Russo, K9TCU
Godfrey, Ill. 62035

Announcements

Data-Net

Data-Net is an association of amateurs and non-amateurs with an interest in the unidentified flying object (UFO) phenomena. They publish a monthly news-letter called the *Data-Net Report*. For information on Data-Net's on-the-air activities and membership contact Michel M. Jaffe, WB6RPL, 624 Farley St., Mountain View, Calif. 94040.

Kingston, Oklahoma

The annual Texoma Hamarama will once again be held at Lake Texoma State Lodge on Nov. 14-16, 1969. Registration is $2.00 per person. Plenty of activities for all including the annual joint meeting of the QCWA. There is plenty of camping and travel spaces available. For lodge or cabin accommodations, write or call directly to the Lake Texoma Lodge, Kingston, Okla. 73439. Phone 405-564-2311. Mail registration for the Hamarama to Texoma Hamarama, P.O. Box 246, Kingston, Okla. 73439.

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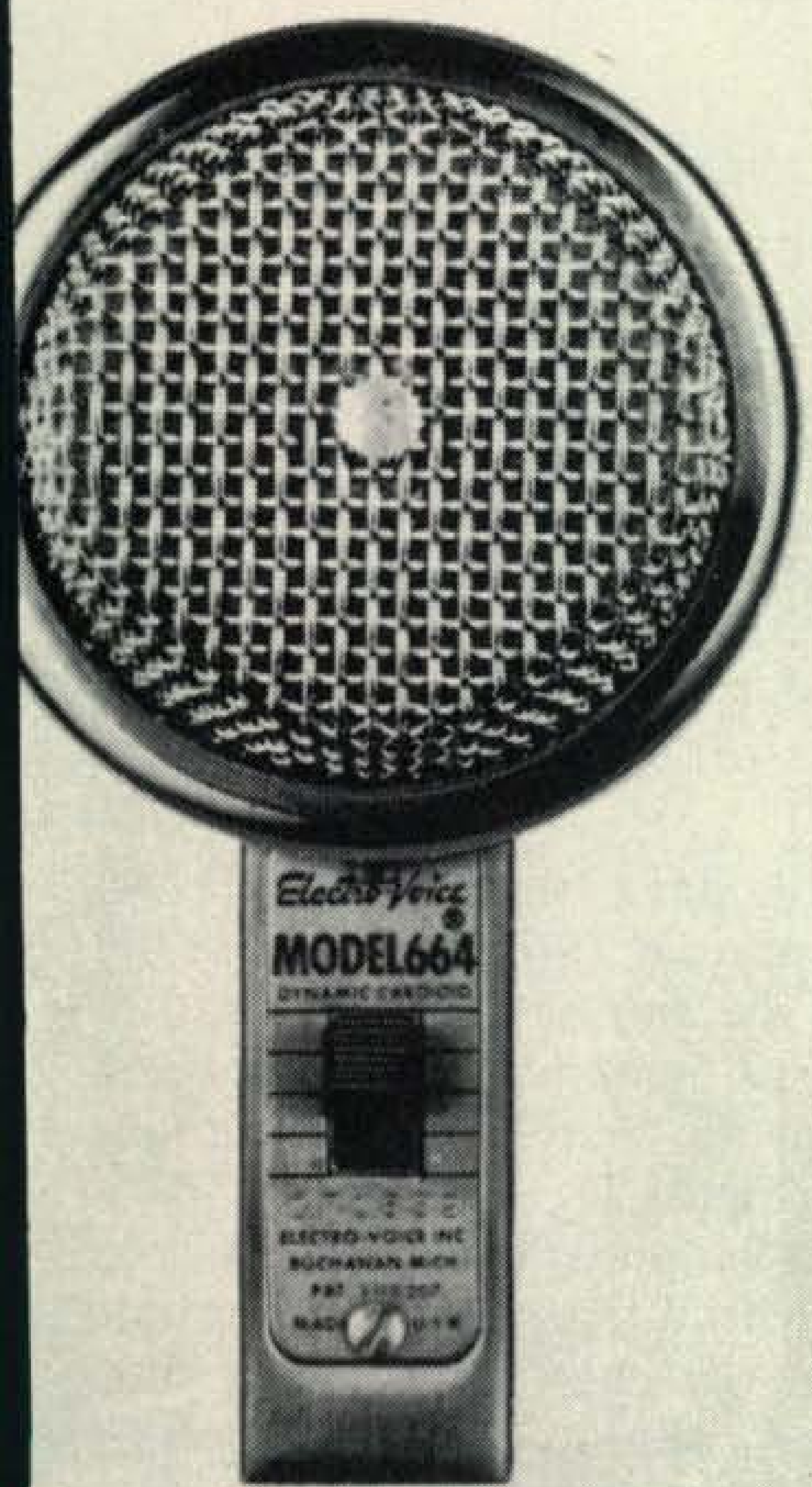

Electro-Voice
MODEL664

What are all these other holes for?

Short Wave Radio and the Ionosphere

BY GEORGE JACOBS, W3ASK & STANLEY LEINWOLL*

This article discusses the formation of electrified, or ionized regions in the earth's upper atmosphere which reflect high frequency radio waves over long distances. In this, one of the most comprehensive articles on this subject to appear in a radio amateur publication, the authors discuss how the ionosphere was discovered, how it is formed and measured, its structure and variations, and how it makes possible shortwave radio communications.

SHORT wave radio communication is possible because there exists, in the earth's upper atmosphere, a region consisting of several electrified layers which are capable of bending high frequency[1] radio waves and returning them to earth at great distances.

The electrified characteristics of these layers, which are collectively referred to as the *ionosphere,* are subject to wide variations. This is so because the ionosphere is formed by ultraviolet radiation from the sun, and the intensity of this radiation changes radically with time, and geographical location.

The amount of radiation illuminating the ionosphere varies hourly, seasonally and geographically, depending upon the relationship between the sun and the earth. In addition, year-to-year changes, over an approximate 11-year cycle, occur in the ionosphere's capability to reflect radio waves. These changes result from the difference in the number of sunspots seen on the face of the sun.

Sunspots are stormy areas on the solar surface which produce considerable ultraviolet radiation.

When the sun's surface is covered with a great number of spots, the ionosphere is electrically strong and shortwave radio conditions are generally very good; when the number of sunspots diminish, conditions become poorer.

The present sunspot cycle, the 20th observed since accurate records have been kept,[2] reached its maximum in November 1968. Since then, the number of spots on the sun has been decreasing steadily. This decline is expected to continue until the present cycle reaches its minimum value, sometime during 1975.

Since the ionosphere plays such a vital role in long distance high frequency radio communication it is desirable at this point to go into greater detail about its characteristics as well as the factors that influence changes in its behavior. Once this has been accomplished, the reader will be better equipped to interpret the changes that will be taking place in the amateur bands over the next five years or so.

The Ionosphere

In 1901, Marconi successfully completed one of the most historic experiments ever conducted ...the transmission of a radio signal, without wires, across two thousand miles of ocean.[3]

*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I. N.Y. 11050.

[1]Wavelength (expressed in meters) and frequency (expressed in kilocycles) are related by the following:

$$Frequency = \frac{300{,}000}{Wavelength}$$

[2]Sunspots were sighted visually by the Chinese more than 2000 years ago. Galileo, inventor of the telescope, viewed sunspots for the first time telescopically in 1611. Accurate sunspot records, however, based on daily telescopic observations were not begun until 1749.

[3]Guglielmo Marconi, an Italian scientist, was the first to conceive the idea of a signalling system employing wireless waves. After several successes during the late 1890's, including transmission across the English Channel, Marconi set out to do what, at that time, seemed impossible...bridge the Atlantic by wireless. At the town of Poldu, in Cornwall, England he erected a large spark transmitter and an elevated transmitting antenna of his own design. He then sailed to Newfoundland with his two assistants, Kemp and Paget, and set up a receiving station on Signal Hill, near the city of St. Johns. At

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Prior to Marconi's experiment, it had generally been believed that radio propagation was restricted to line of sight. However, the German physicist, Heinrich Hertz had demonstrated that radio waves travelled in straight lines, but that their direction of travel could be altered by interposing an electrically conducting obstacle in their path.

A year after Marconi's initial success, two scientists, Arthur Kennelly in the United States, and Oliver Heaviside, in Great Britian, suggested in independent scientific papers[4] that the earth's upper atmosphere consisted of an electrically conducting region. It was this region, they theorized, that acted as an obstacle, and deflected Marconi's signals across the Atlantic Ocean. They reasoned that such a region was probably produced by solar radiation, but two decades were to pass before the existence of this region, called the ether during the early days or radio was verified experimentally.

The electrified region was discovered in 1924 by a British scientist, Edward Appleton.[5] He and his co-workers found conclusive evidence of its existence by measuring the angle of arrival of radio signals from a nearby transmitter. The angle of arrival was such that the signals could have arrived from only one direction... by reflection from an area in the earth's atmosphere about 100 miles high. Kennelly and Heaviside's visionary theory of twenty-two years earlier had been verified. For his pioneering work in the field of radio wave propagation, Edward Appleton was subsequently Knighted by the British Empire.

In 1925, Briet and Tuve, two American physicists demonstrated the existance of a reflecting region high above the earth's surface in an even more striking manner. By transmitting short bursts of radio energy vertically, they were able to detect, using suitable measuring and receiving equipment, the presence of an echo which had been reflected and returned to earth by the ionosphere.[6]

12:30 P.M. on December 12, 1901, using a kiteborn antenna, three faint clicks were heard in the receiver's earphone; it was the Morse letter "S", the pre-arranged signal being transmitted from Poldu nearly 2,000 miles away. The Atlantic had been bridged by radio!

[4]Heaviside made his visionary comments in the 9th Edition of the *Encyclopedia Britannica* (page 215, Vol. 33; 1902). At about the same time Kennelly's appeared in the *Electrical World and Engineering Magazine* (page 473, Vol. 15; 1902).

[5]The existance of the electrified region was first reported by E. V. Appleton and M. A. Barnett in the scientific publication *Nature* (page 334, Vol 115; 1925).

[6]This method for estimating the height of the conducting layer in the earth's atmosphere was first suggested by G. Breit and M. A. Tuve in Nature (page 357, Vol. 116; 1925).

By determining the time that had elapsed between transmission of the pulse and reflection of the echo, and knowing that the radio wave travelled with the speed of light, they were able to deduce the height of the reflecting medium with considerable accuracy.

Later, by varying the frequency of the transmitted pulses over a wide range they discovered that above a certain critical frequency the reflecting region would no longer return the signals to earth.

Extensive studies, using the Briet-Tuve technique, made at several locations throughout the world, soon showed that the critical frequency varied hourly, seasonally, and geographically. This implied strongly that the reflecting layer was under solar influence.

Further evidence linking ionospheric behavior with the characteristics of solar radiation was obtained in 1927 when a sharp decrease in the critical frequency was observed during a total eclipse of the sun. Figure 1 shows graphically how the critical frequency varied as the eclipse progressed.

It was concluded, from this historic experiment, that the primary solar agent responsible for forming the ionosphere was ultraviolet radiation.

This observation has been verified further during each eclipse of the sun that has occurred since 1927.

Measuring the Ionosphere

The rapid development of long-distance radio communication stimulated intensive investigation of the ionosphere throughout the 1930's. The need to solve newly developing communication problems required the establishment of more modern engineering techniques that would meet the demands for uninterrupted use of the ionosphere for reliable world-wide communication.

Equipped with pulse-sounding equipment, ionospheric measuring stations began to spring up in all areas of the world. From a mere hand-

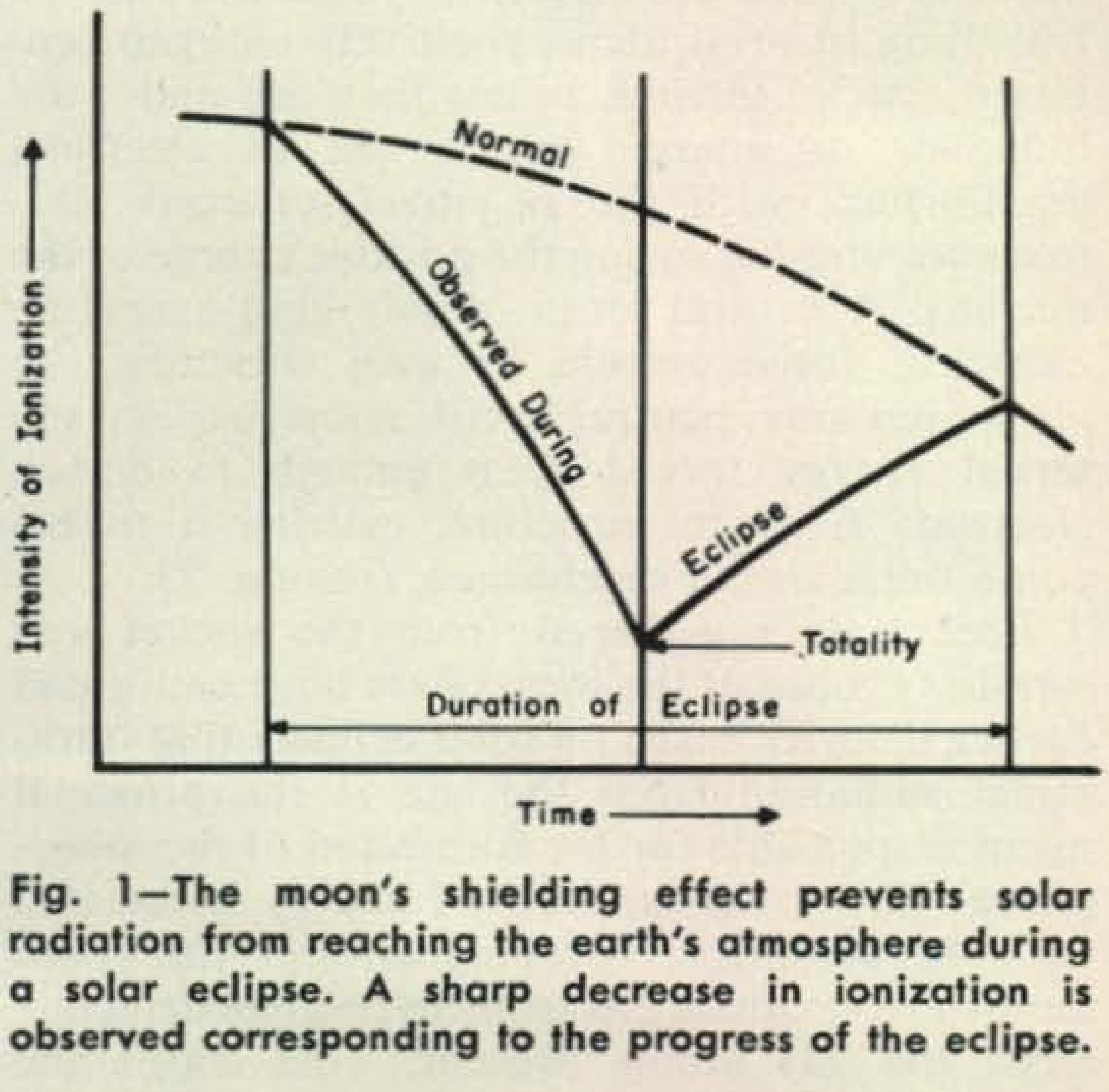

Fig. 1—The moon's shielding effect prevents solar radiation from reaching the earth's atmosphere during a solar eclipse. A sharp decrease in ionization is observed corresponding to the progress of the eclipse.

ful in the 1930's, nearly 250 such stations are now charting the ionosphere hourly at more than 70 locations throughout the world.

While the technique is much the same, the equipment used today is far more sophisticated than that used by Breit and Tuve thirty-five years ago. Modern equipment, called ionosondes, are fully automatic, and present photographic records of critical frequency. Using methods developed by mathematicians and physicists, it is possible to scale the value of critical frequency for any particular time, and convert it to corresponding values which indicate the electron content of the ionosphere and the height of the reflecting layer above the earth's surface.

Ionospheric information obtained from ionospheric soundings is published regularly by several scientific organizations in various countries. In the United States, the Institute for Telecommunication Sciences (ITS), a division of the Environmental Science Services Administration (ESSA), publishes this information.

Extensive data concerning the characteristics and structure of the ionosphere have been gathered over the past forty-five years by the use of pulse probing techniques. Over the past decade, such measurements have been augmented by measurements made by rockets and earth satellites.

Girdling the entire earth several times a day, artificial earth satellites provide the means for extensive investigation of the ionized regions of the upper atmosphere, being able to penetrate deep into areas impossible to reach with ground-based probing equipment.

Formation of the Ionosphere

The earth's upper atmosphere is composed mainly of oxygen and nitrogen and their compounds, with small amounts of hydrogen, helium, and several other gases. These gases, like all material are composed of atoms made up of negatively charged electrons assumed to be travelling in orbit about positively charged centers or nuclei. Atoms, unless they are under the influence of energy forces, are in electrical equilibrium, with the negatively-charged electrons counter-balancing the positive charge of the nucleus. A neutral atom of this kind exerts no electrical force outside its own structure. An atom remains neutral until subjected to external energy forces great enough to detach electrons from its structure, causing it to become unbalanced, or charged. (see fig. 2).

Recent data gathered from the rocket and satellite probes of the ionosphere have confirmed earlier theories based on solar eclipses that ultraviolet radiation from the sun is the principal agent responsible for the formation of the ionosphere. The great amount of energy associated with this radiation, sweeping through the upper atmosphere, causes electrons to become detached from the gas atoms present. This leaves the

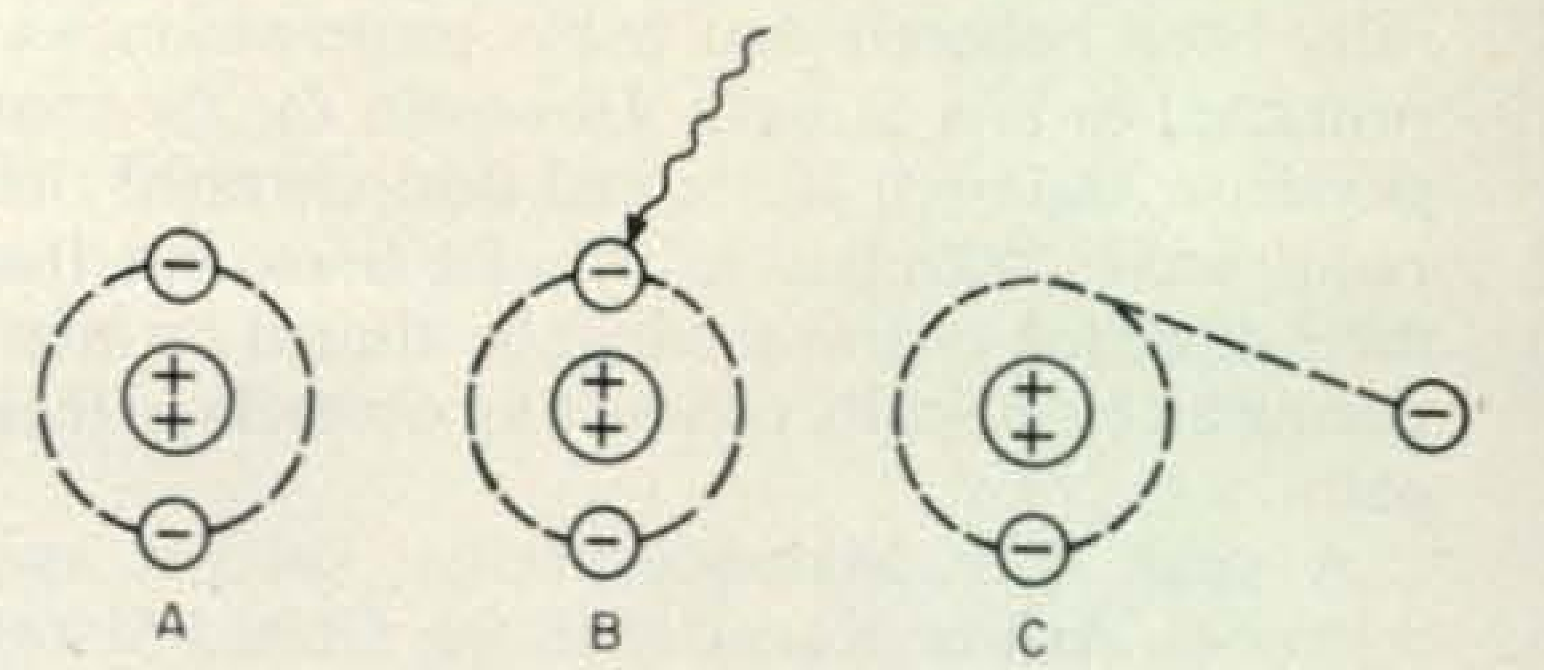

Fig. 2—Diagram illustrating how ionization is produced by energy from ultraviolet radiation. In A, the atom is in electrical equilibrium; in B, the high energy ultraviolet radiation strikes an electron; in C, the free electron is "torn out" of the atom by energy from the ultraviolet radiation. The resulting unbalanced atom is called an ion.

originally neutral gas atoms unbalanced, with an excess of positive charge. Such unbalanced atoms are called ions, and the process by which they are formed is called *ionization*.

If the ultraviolet energy is removed, the detached electrons recombine with the ions to again form atoms in electrical equilibrium. This process, the opposite of ionization, is called *recombination*. Recombination takes place during the night hours when the ionosphere is cut off from the sun's direct radiation.

It is of interest to note that although ultraviolet radiation from the sun is considered the principal ionizing agent, there is recent evidence indicating that other types of solar radiation, such as X-rays and cosmic rays, also play a role. Some degree of ionization is also produced by meteors entering the earth's atmosphere.

Structure of the Ionosphere

As ultraviolet radiation sweeps into the earth's atmosphere from above, it first produces ionization of the rarefied gases it encounters. As the radiation penetrates deeper into the atmosphere it encounters greater densities of gases and the amount of ionization increases. Penetrating further, it produces more and more ionization, but the radiation is also attenuated because it is giving up energy in the ionization process. Finally, the radiation penetrates to a level where its energy is completely dissipated and the ionization process stops. Thus, there is formed a region of maximum ionization, with intensity falling off, above and below it.

The details of the formation of an ionized region in the earth's atmosphere are shown in fig. 3.

The range of ultraviolet radiation from the sun comprises a relatively wide band of frequencies. Since the gases comprising the upper atmosphere respond to different frequencies in the ultraviolet spectrum, there is a tendency for ionization to occur at several different levels, or layers, between approximately 30 to beyond 400 miles above the surface of the earth.

While these ionized regions are usually re-

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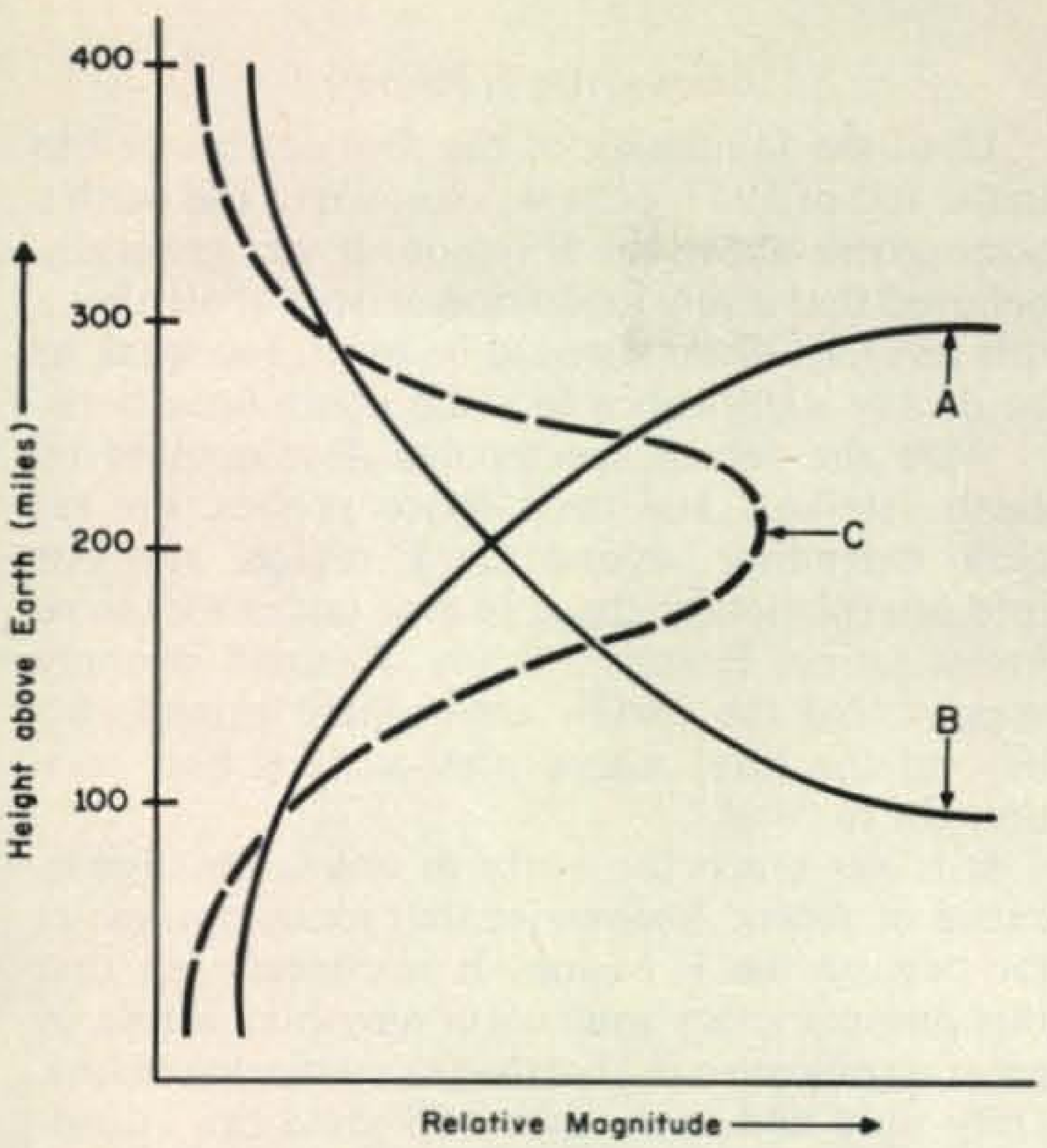

Fig. 3—The formation of an ionized layer by single-frequency ultraviolet radiation. At A, the intensity of ultraviolet radiation increases with height. At B, the molecular density of gas decreases with height. At C, the intensity of ionization varies with altitude.

ferred to as "layers", they are not completely separated one from the other. Each region, or layer, overlaps to some extent, forming a continuous but non-uniformly area with at least four levels of peak intensity, designated D, E, F_1 and F_2.

The allocation of letters to designate the various regions of the ionosphere was initiated by Sir Edward Appleton upon his discovery of the Kennelly-Heaviside layer in 1924. He allocated the letter E to this layer after the symbol generally used to designate an electric vector. In 1925, when he discovered another ionized region at a greater altitude, he used the term F to designate the electric vector reflected from it. Shortly later he assigned the letter D to the electric vector he found to be reflected from another distinct region located below the E layer. This, as he has said, left several letters at the disposal of future workers for allocation to other layers which they might discover either above or below the three layers identified by him. Sir Robert Watson-Watt, an early co-worker of Appleton and one of the original developers of radar, gave the name ionosphere to this entire region, and it has been adopted internationally.

The height and characteristics of these layers change from day to night and season to season. Several of these changes are illustrated in fig. 4. A brief description of each layer follows:

The D Layer

The D layer is the lowest region of pronounced ionization. It extends from about 30 to 55 miles above the earth's surface and exists mainly during the daylight hours. Although it is the ionized region nearest the earth, there is less presently known about it than any other region of the ionosphere.

The amount of ionization in this region is very low compared to the other layers. It reaches maximum intensity at noon when the sun is highest in the sky, and disappears almost completely shortly after sunset. During ionospheric storms, the D layer absorbs radio energy, preventing radio signals from reaching the upper layers of the ionosphere.

The E Layer

The upper boundary of the D layer blends into another distinct region called the E layer which occurs mainly during the daylight hours at heights between 50 and 75 miles. While the height of the E layer may vary somewhat from season to season, it remains practically constant throughout the day.

The intensity of ionization in the E region is considerably greater than in the D layer, and follows closely the sun's position in the sky. Maximum ionization occurs near noon when the sun is most directly overhead. As soon as the sun sets, almost complete recombination takes place, and the E layer practically disappears during the hours of darkness.

The F Layers

The F layers are the most important regions of the ionosphere insofar as long-distance short-wave radio communication is concerned. During the daylight hours, there are two well-defined regions: the F_1 layer, which begins slightly above the upper boundary of the E layer at about 90

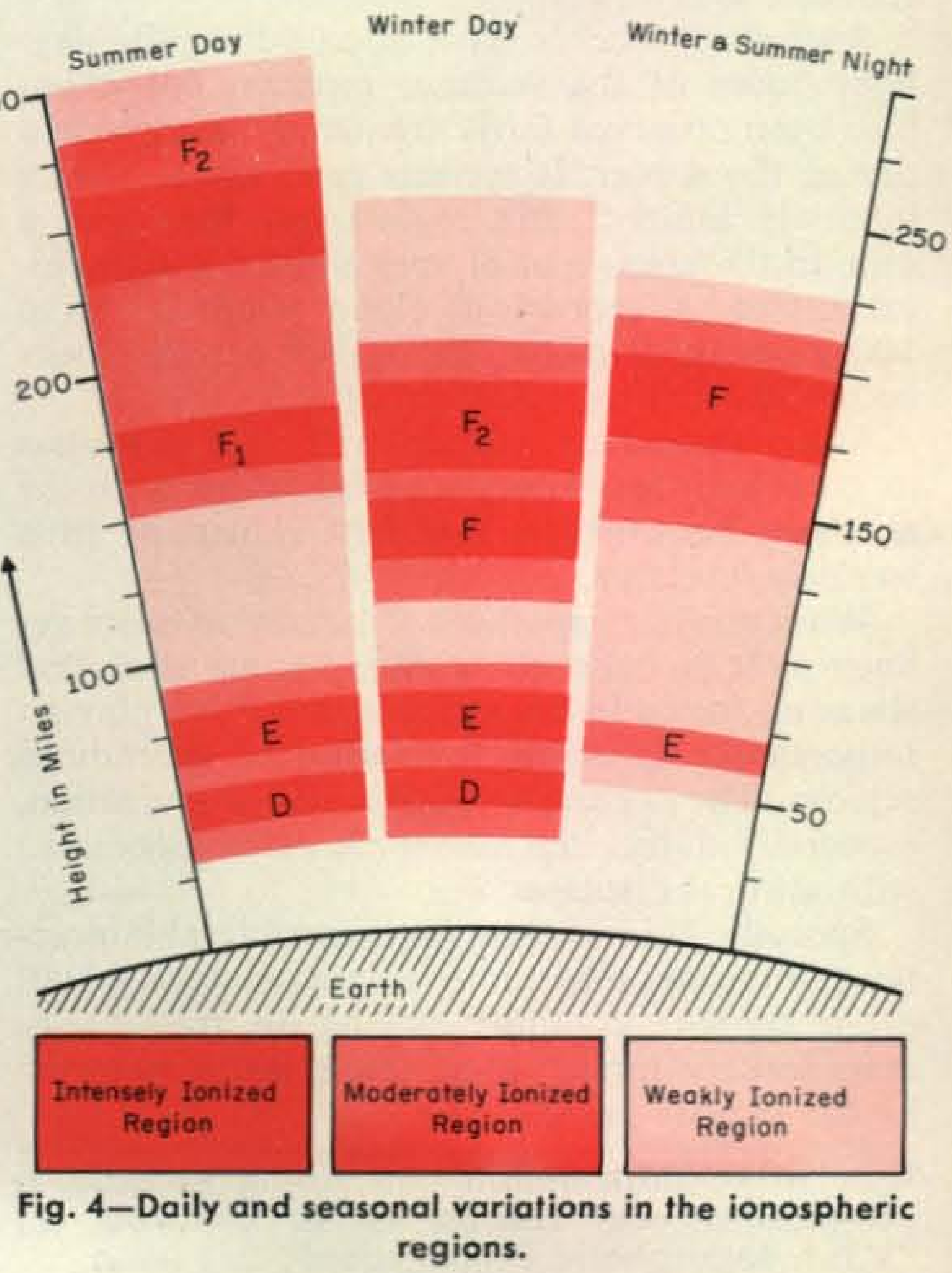

Fig. 4—Daily and seasonal variations in the ionospheric regions.

miles, and extends up to about 150 miles, and the F_2 layer, whose height varies seasonally, ranging up to about 200 miles during the winter and close to 300 miles during the summer.

Although more highly ionized, the F_1 layer behaves very much like the E layer. Maximum ionization occurs near noon when the sun is more directly overhead, and the layer disappears during the hours of darkness.

Unlike the other layers, ionization in the F_2 region exists at all times. This region is the most highly ionized and most important of the ionospheric layers.

During the nighttime hours, the F_2 layer height varies approximately between 150 and 250 miles. Because the recombination rate in this region is relatively slow, the layer exists around the clock. Were it not for this fact, long-distance short-wave radio communication would be virtually impossible during the hours of darkness.

The intensity of ionization in the F_2 region is in an almost continuous state of flux, with hourly, seasonal, geographical and cyclical changes taking place in a somewhat complicated manner.

The Sporadic-E Layer

In addition to the regular D, E and F regions of the ionosphere, there exists an ionized region which occurs sporadically. Unlike the regular layers, it comes and goes irregularly, and its causes are not yet fully known. The height of the layer is variable, but is most commonly about 60 miles high. Since this is about the same height as the regular E layer, it is called the sporadic E-layer.

Sporadic-E occurs most often during the daylight hours of the summer months, but it has also been observed fairly frequently at night and during the winter. It appears generally as a very intensely ionized, thin region, less than half a mile in thickness and of very limited geographical extent. A sporadic-E cloud might be 50 to 100 miles in diameter, lasting for several hours before dissipating.

Many sporadic-E clouds drift with velocities as great as a few hundred miles an hour. In the northern hemisphere, the drift is usually in a westerly direction.

What produces sporadic-E ionization is not yet known. It is believed at the present time that shearing forces in the upper atmosphere play an important role in the formation of sporadic-E regions. The occurance of sporadic-E ionization, especially during the winter, is often associated with auroral displays.

Sporadic-E ionization is of considerable practical importance to radio amateurs since it will often support communications on frequencies considerably higher than those being reflected by the regular layers.[7]

[7]For more information concerning sporadic-E propagation see: Jacobs, G. & Leinwoll, S., "V.h.f. Ionospheric Propagation", this issue.

Above the F Region

Until the launching of the first earth satellite in the fall of 1957, little was known of the earth's atmosphere above the F region. It was generally believed that if any ionization existed at all above this level, its density would be much too weak to be of any significance to radio communications.

With the recent spectacular development of earth satellites and deep space probes, the region, extending beyond the F region, and out into interplanetary space is now under extensive investigation. Results already obtained strongly suggest that the earth's atmosphere extends far beyond the level where previously it had been thought to "end."

It is yet much too early to assess the significance of recent discoveries that ionization exists far beyond the F region. It is conceivable that this interplanetary ionization may play a role of great significance in short-wave communications. Only time and more data will yield the knowledge necessary to determine what this role might be.

Regular Ionospheric Variations

Since the existance of the ionosphere depends on solar radiation, it is evident that changes in the position of the earth with respect to the sun (rotation and revolution) as well as changes in the patterns of solar radiation, will influence the variations which take place in the ionosphere.

The regular variations of the sun, those which are more or less predictable and can be anticipated, can be divided into the following categories:

1. Diurnal
2. Seasonal
3. Geographical
4. Cyclical

Diurnal Variation

The diurnal variation, or the hour-to-hour changes in the various layers of the ionosphere, is caused by the rotation of the earth about its axis. This rotation not only is responsible for variations in the amount of sunlight reaching the earth, resulting in night and day, but also causes a corresponding variation in the intensity of ultraviolet radiation reaching the ionosphere at any given point. During the daylight hours, when ultraviolet radiation is strongest, the ionosphere is highly ionized; during the hours of darkness very little radiation reaches the ionosphere from the sun, and the region decreases to a single, relatively weak layer.

As already indicated, diurnal variations in the D, E and F_1 layers of the ionosphere follow a regular pattern, and are principally dependent on the sun's elevation. Ionization in these layers increases from a very low level at sunrise, reaches a maximum at noon, and then decreases towards sunset. For all practical purposes, these layers disappear at night.

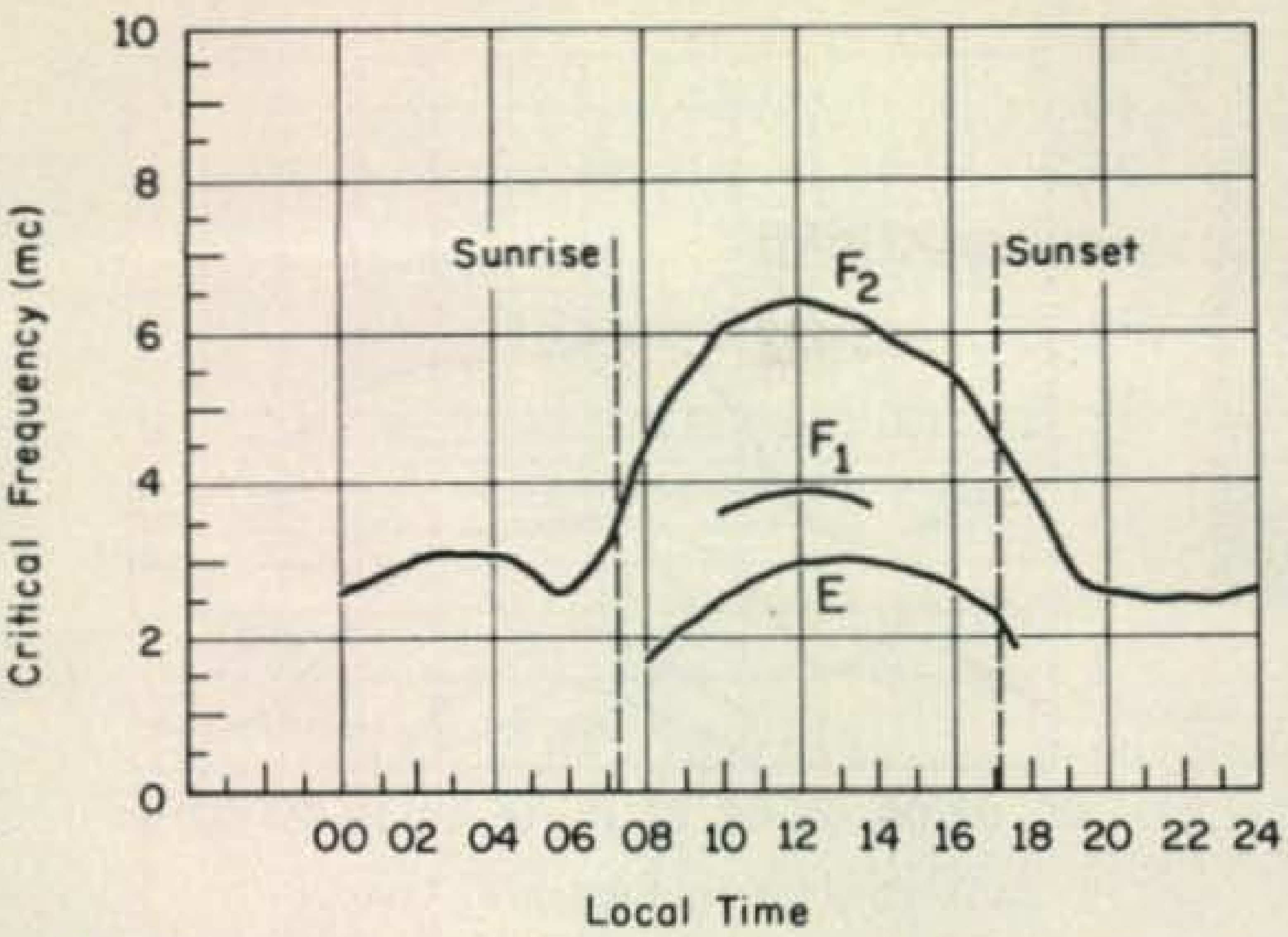

Fig. 5—Typical hour-to-hour changes in the reflection capability of the ionospheric layers.

Typical hour-to-hour changes in the critical frequency for the various layers are shown in fig. 5. From this figure it can be seen that only the F_2 layer is not dependent entirely on the sun's position in the sky.

Ionization in the F_2 region, as shown by the increase in critical frequency, rises steeply at sunrise. Unlike the other layers, maximum ionization is reached a few hours after the sun has reached its zenith, of highest point in the sky. Ionization then decreases, reaching low values during the nighttime hours.

The F_2 layer is the most highly ionized of the regular layers, with considerably higher frequencies capable of being reflected from it. In addition, because of slow recombination rates, it remains in existence throughout the nighttime hours. ·For these reasons, the F_2 layer is of greater importance to long-distance short-wave radio communications that the other layers of the ionosphere. Almost all DX openings take place by reflection from the F_2 layer.

Seasonal Variation

Since the position of any point on earth relative to the sun is constantly changing as the earth moves in its year-long orbit around the sun so, too, do ionospheric properties change.

Ionization in the E layer behaves regularly, being dependent almost entirely on the sun's elevation. Ionization is much stronger in the summer, since the sun is higher in the sky.

During all but the winter months the F_1 layer critical frequency varies in much the same manner as the E layer, being dependent on the sun's elevation. During the winter, however, the F_1 layer usually merges with the F_2 layer, and cannot be separately identified, except in equatorial regions.

The seasonal behavior of the F_2 layer is rather complicated. During the winter months the sun is three million miles closer to the earth than during the summer. As a result, daytime ionization is very intense, and critical frequencies are *high*. During the long hours of winter darkness, on the other hand, the ionosphere has more time to lose its electrical charge, and nighttime critical frequencies dip to very *low* values.

In the summer, a heating effect takes place in the F_2 layer, which expands during the daylight hours, resulting in a much lower ionization density than during the winter. As a result, summer daytime F_2 layer critical frequencies are *lower* than winter values. On the other hand, because of the longer hours of summer daylight recombination does not occur to the extent that it does in the winter. As a result, F_2 layer nighttime critical frequencies during the summer months are significantly *higher* than during the winter months. The difference between day and night critical frequencies is much smaller in the summer than during the winter.

The complex seasonal behavior of the F_2 layer's critical frequency is shown in fig. 6.

Geographical Variation

The intensity of ionizing radiation that strikes the ionosphere varies with latitude, being considerably greater in equatorial regions, where the sun is more directly overhead, than in the northern latitudes.

Critical frequencies for the E and F_1 regions vary directly with the sun's elevation, being highest in equatorial regions and decreasing proportionately north and south of these latitudes.

F_2 layer variations with latitude are again more complex. This is probably due to ionization from other sources, such as X-rays, cosmic rays and meteors. There is also evidence that the earth's magnetic field exerts a considerable influence on the degree of ionization in the F_2 layer.

Although complex, the F_2 layer critical frequency does follow a general pattern of being higher in equatorial regions and lower in the higher latitudes and polar regions. In fig. 7 the latitude variation in the F_2 layer is shown by comparing critical frequency measurements made at three locations of different latitude.

Although not as complex as the latitude varia-

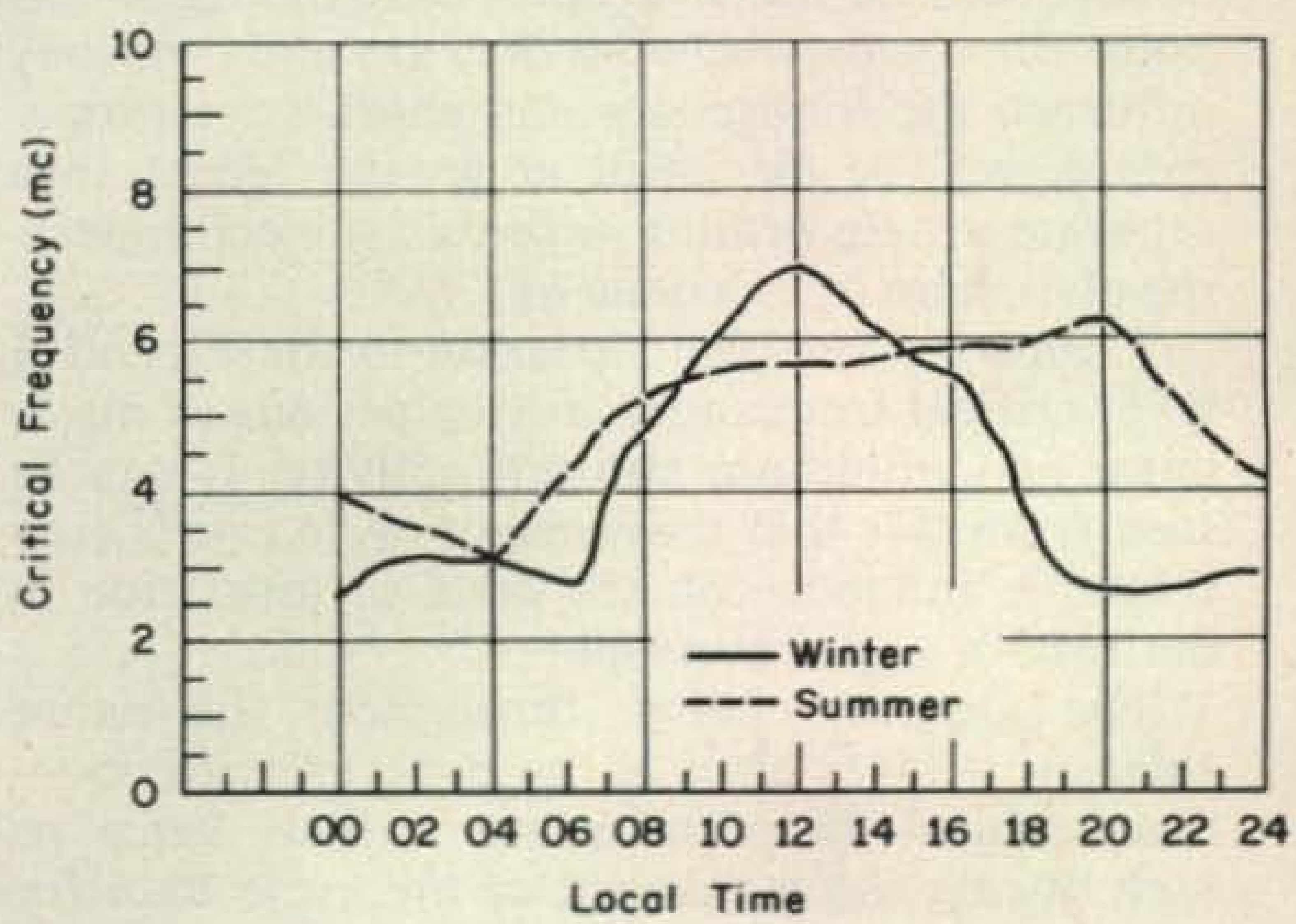

Fig. 6—Typical seasonal variation in the F_2 layer of the ionosphere.

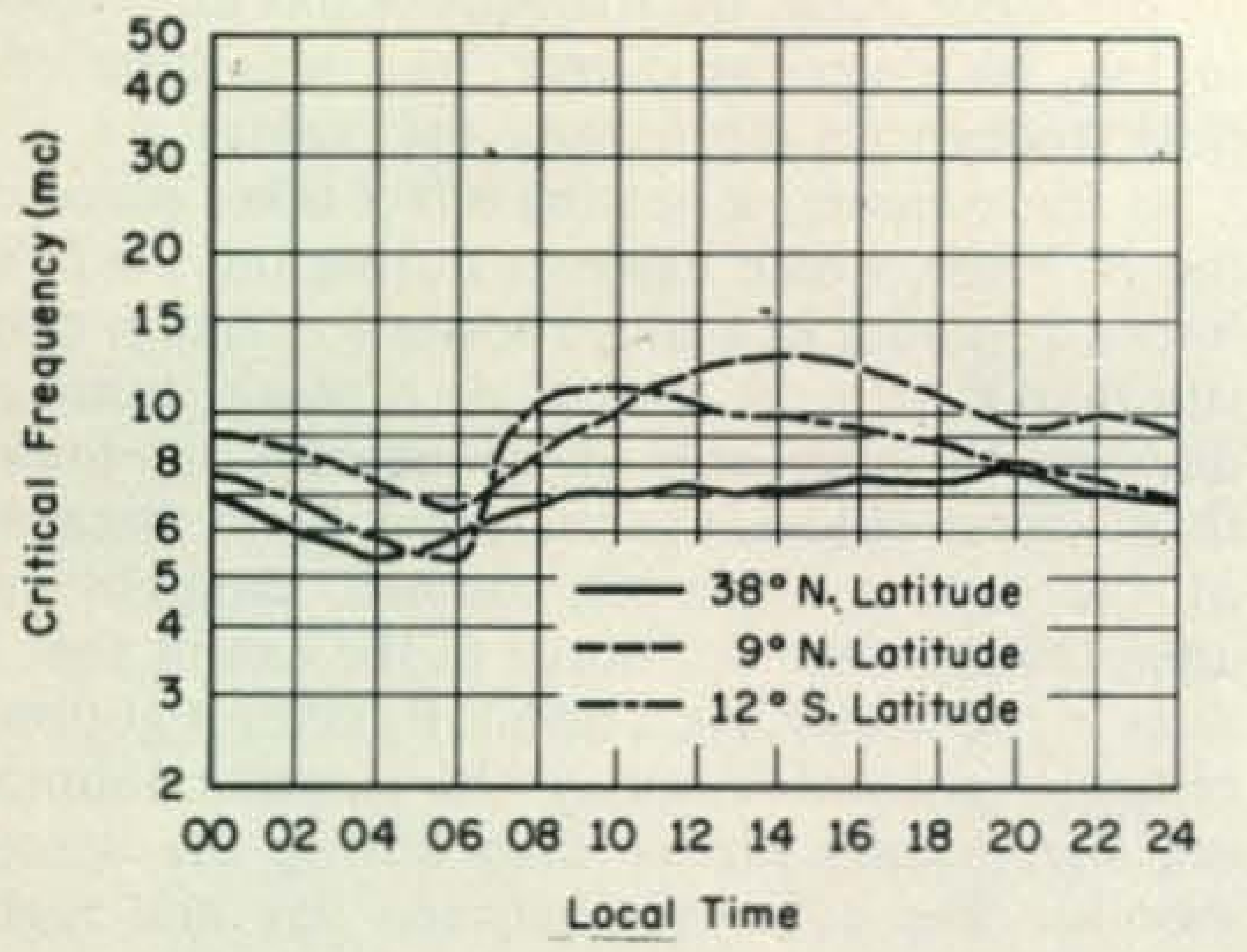

Fig. 7—Latitude variation in F_2 layer critical frequencies. Comparison of measurements made at three locations of different latitude but along the same meridian of longitude; which in this case was 77 degrees west longitude. Measurements were made at the same local standard time during June, 1967.

ion, F_2 layer ionization also differs along meridians of longitude (at the same local time and along the same parallel of latitude). Much of this variation is believed to be due to the influence of the earth's magnetic field. F_2 layer critical frequencies are generally higher in the Asiatic region and Australasia than in Europe, Africa or the Western Hemisphere.

Cyclical Variation

If diurnal and seasonal variations were the only influences affecting ionospheric behavior, the long-range pattern of critical frequencies would be simple and straightforward to establish, with seasonal values expected to repeat from year to year at the same geographical location.

Unfortunately this is not the case. There is also a cyclical variation, of approximately 11 year duration, which is perhaps the most influential factor affecting the ionosphere. This variation depends on the level of sunspot activity, which is constantly changing throughout an approximate 11-year cycle. The solar cycle influence will be touched upon only lightly at this point since sunspots, what they are and how they influence the ionosphere and short-wave propagation, will be discussed at greater length in a separate article dealing with this subject appearing elsewhere in this issue of *CQ*.[8]

Figure 8 shows the variation in the F_2 and E layer critical frequencies during periods of maximum and minimum sunspot activity. It can be seen from this that the sunspot cycle exerts considerable influence on the level of ionization in the earth's upper atmosphere.

The greatest change throughout the entire solar cycle takes place in the F_2 layer, with noontime critical frequencies more than twice as high during the maximum of the cycle than for minimum periods. The variation during the nighttime hours was about the same with the midnight critical frequency being about two times greater during the peak of the cycle than at sunspot minimum.

The critical frequencies of both the E and F_1 layers also show a close, linear correlation with sunspot numbers, although the variations between the extremes of the cycle are not as pronounced as in the F_2 region.

Up to this point we have discussed the electrical characteristics of the ionosphere in terms of the critical frequency. This is the highest frequency for which an echo is received when a pulse of radio energy is sent vertically into the ionosphere. In another article in this special issue of *CQ* it will be shown that frequencies used for communication between any two points (oblique propagation as compared to vertical pulse transmission) bear a direct relationship to the critical frequency.[9] ■

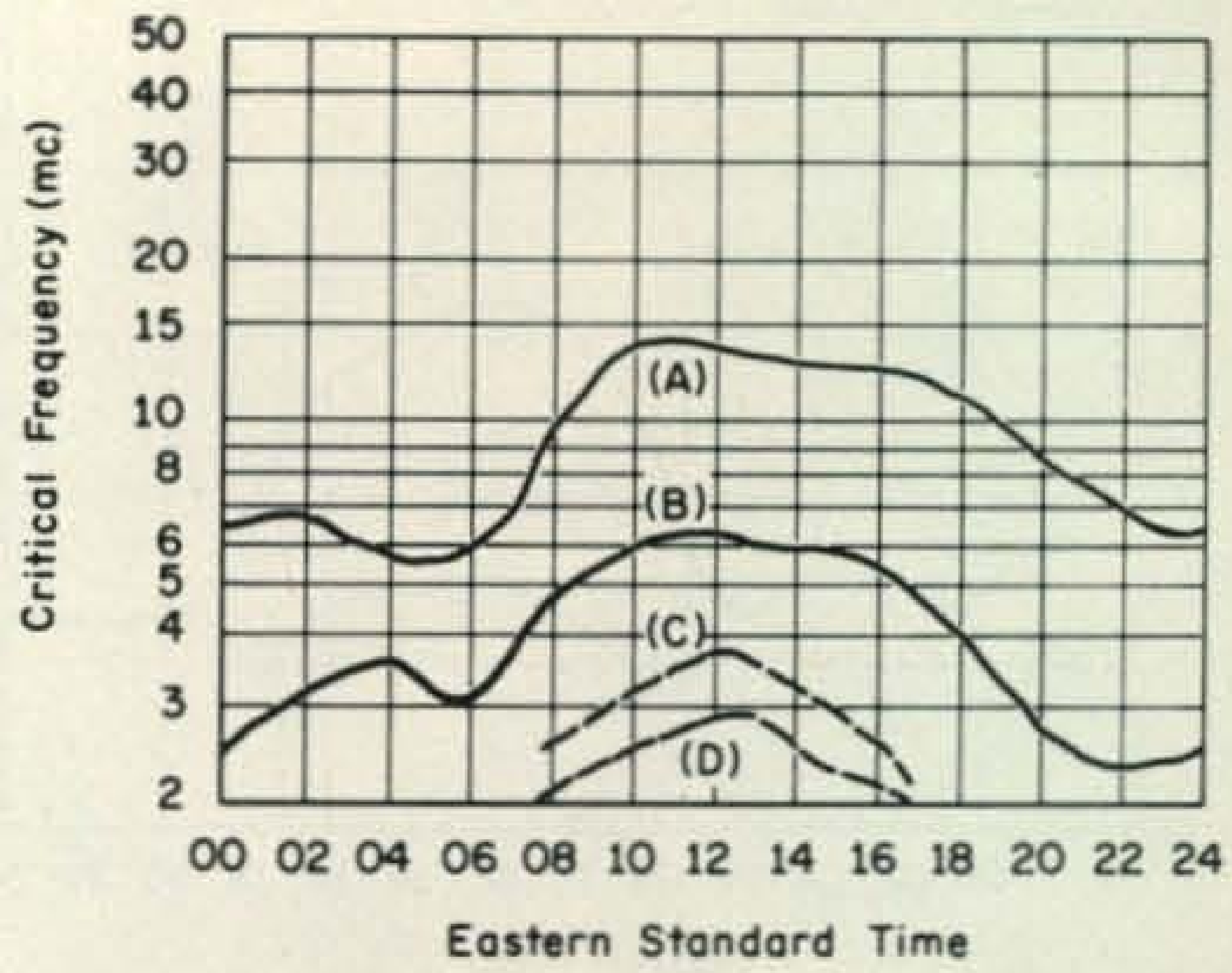

Fig. 8—Comparison of diurnal variation in *E* (dashed curves) and F_2 layer (solid curves) critical frequencies during maximum and minimum sunspot activity. The data shown in the curves marked A were measured near Washington, D. C. during December 1957 when a sunspot number of 200 was recorded. The data shown in curves B were recorded during December 1964 when the sunspot number was 11.

[8]See Jacobs, G. & Leinwoll, S., "A Sunspot Story-Cycle 20: The Declining Years", p. 44.

[9]See, Jacobs, G. & Leinwoll, S., "Optimizing Short Wave Radio Communications," p. 25.

"The main interest here is operating."

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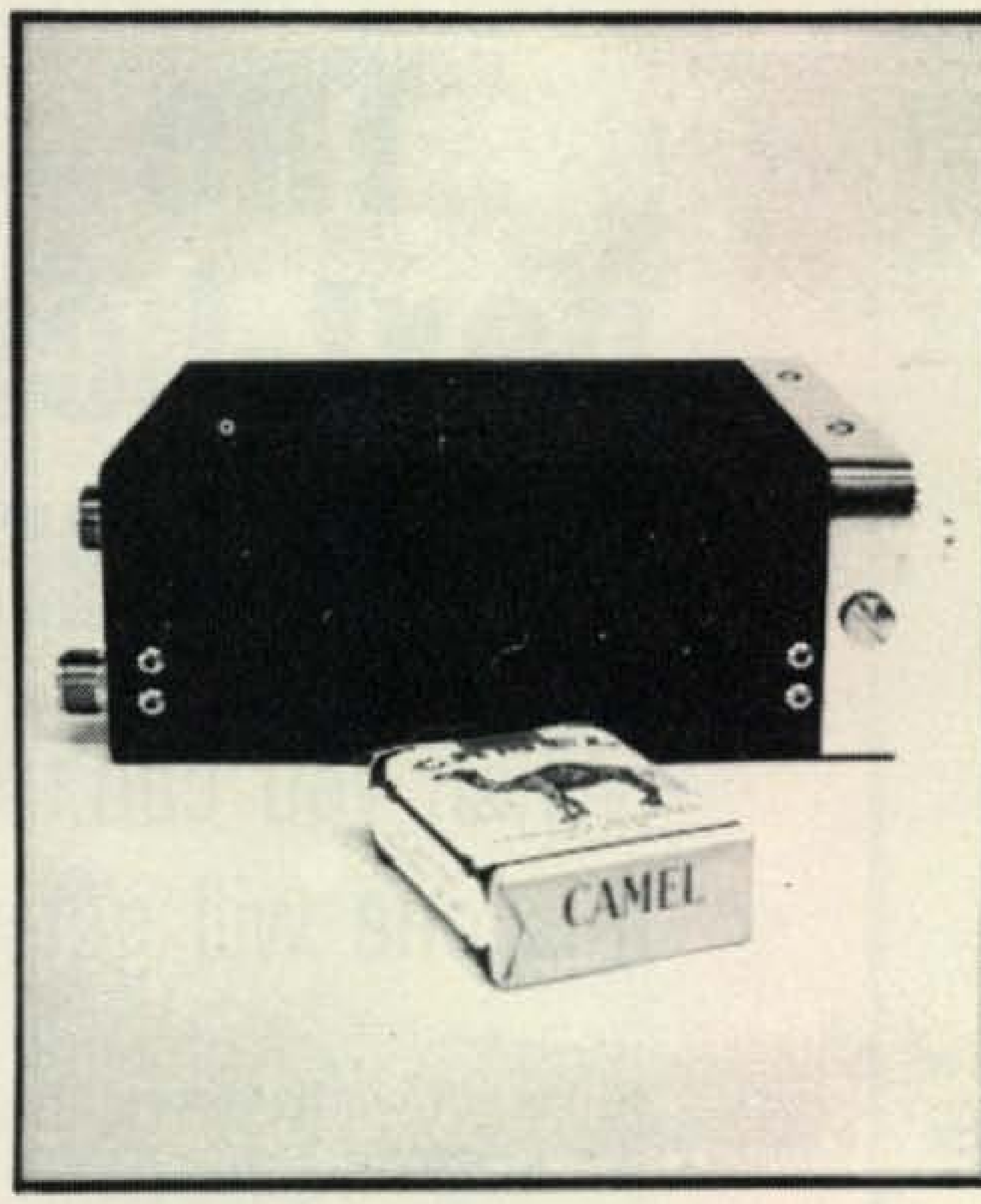
WANTED



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Optimizing Short Wave Communications

BY GEORGE JACOBS, W3ASK & STANLEY LEINWOLL*

In "Short Wave Radio And The Ionosphere", appearing on page 16 of this issue of CQ, the authors discussed the physical characteristics of the ionosphere, its formation, structure and variations. In this article they discuss the role of the ionosphere in short wave communications from a practical point of view, pointing out the relationship between such factors as maximum usable frequency, signal absorption and optimum antenna design.

A FAIRLY wide range of short wave frequencies, when transmitted vertically, will be returned to earth by the ionosphere. The highest frequency so returned by each of the layers of the ionosphere is called the *critical frequency* for that layer. "Short Wave Radio And The Ionosphere," appearing on page 16 of this special issue of *CQ* discusses the importance of the critical frequency in determining the physical characteristics of the ionosphere. Although the critical frequency is invaluable for this purpose, it is not useful for long-distance communication, since it is returned to earth near the transmitter. To enable it to cover the great distances required in radio communication, the radio wave must leave the transmitting antenna at an angle such that the wave will strike the ionosphere obliquely, or at a slant.

The proper slant, or radiation angle, as well as the optimum frequency to use over a particular path depends on many factors, including the height of the reflecting layer, the extent to which it is electrified, and the distance between the transmitting and receiving locations. There is also a direct relationship between the critical frequency at the point the wave enters the ionosphere, and the optimum frequency for the path.

A knowledge of the relationships that exist among critical frequency, layer height, radiation angle, path length, etc., are fundamental to understanding the principles of long distance short wave communication via the ionosphere.

This article explains, in a simplified manner, how some of these factors are related to each other, and how relationships may be used to determine which specific frequency bands will be most useful over any given circuit at any time of day or night.

*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I. N.Y. 11050.

To begin with, there is a simple trigonometric relationship that exists among the critical frequency measured at vertical incidence, the height of the ionosphere at which reflection takes place, and the optimum radiation angle and frequency required for long-distance transmission. This relationship is expressed by the following equation:

$$f = \frac{f_o}{\sin a} = f_o \csc a \quad . \ . \ . \ . \ (1)$$

where:

f_o is the critical frequency; f is the signal frequency for oblique transmission; and a is the radiation angle for oblique transmission.

The mathematics expressed in equation 1 is shown pictorially in fig. 1.

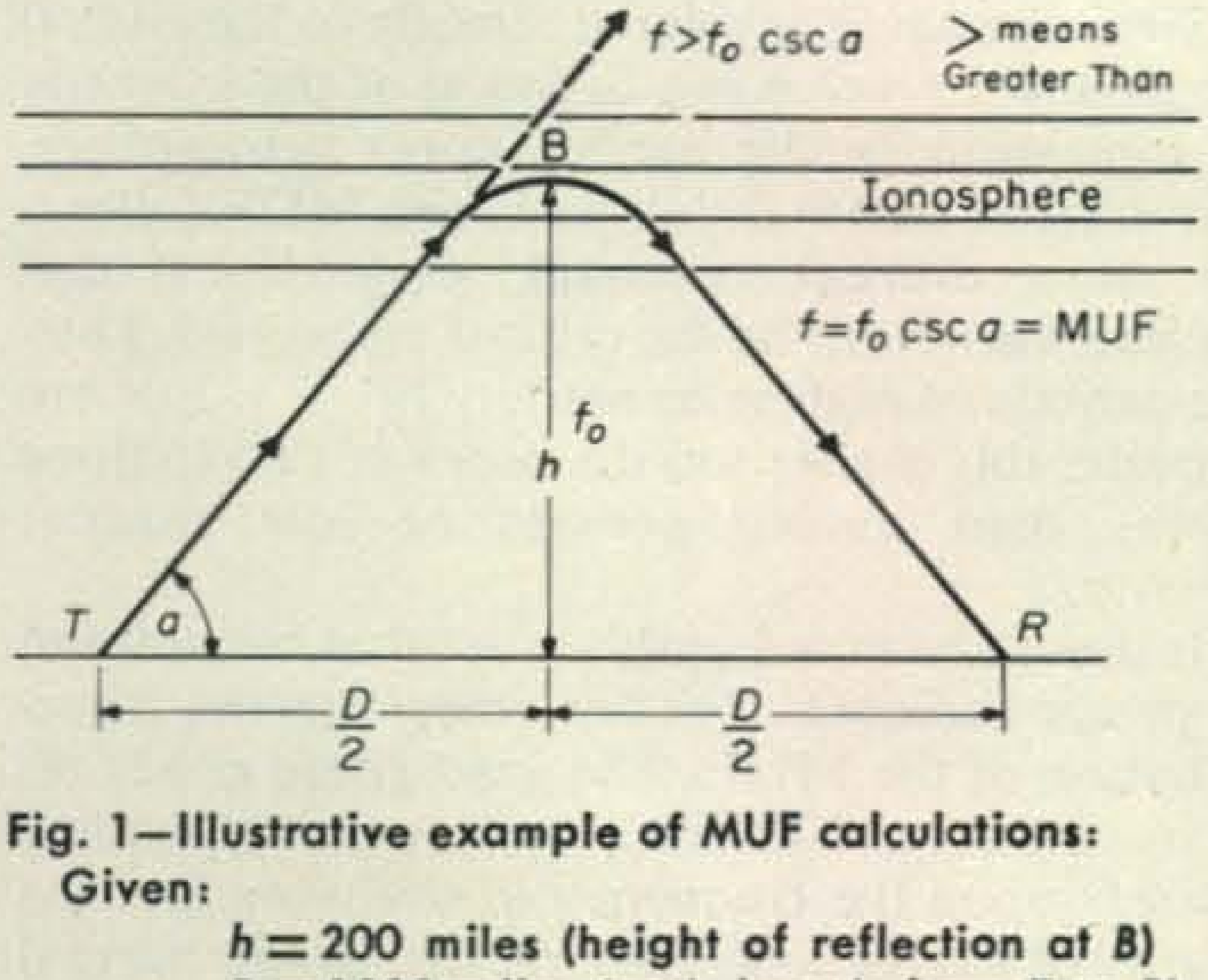

Fig. 1—Illustrative example of MUF calculations:
Given:
$h = 200$ miles (height of reflection at B)
$D = 1000$ miles (path length from T to R)
$f = 5$ mc (critical frequency measured at vertical incidence)
Then: (From equations 2 and 3, see text)
MUF = 13.3 mc
Radiation Angle (a) = 22 degrees.
Illustration not drawn to scale.

Using geometrical relationships shown in fig. 1, equation 1 can be modified as follows to permit an even more direct solution for the optimum frequency required for long-distance transmission:

$$f = f_o \sqrt{\frac{D^2}{4 h^2} + 1} \quad . \; . \; . \; . \; . \quad (2)$$

where:

> f_o is the critical frequency; f is the signal frequency that will give optimum long-distance transmission over a path length of D; and h is the height at which ionospheric reflection takes place. (D and h must be given in the same units, either miles or kilometers).

The significance of equations 1 and 2 is, that given the critical frequency and height of the ionosphere, and knowing the distance between the transmitting and receiving locations, it is possible to determine the best frequency to use for the transmission. This frequency, f in equations 1 and 2, is called the *Maximum Usable Frequency*, or MUF.

For a radio wave to be reflected between two distant points via the ionosphere, its frequency must be equal to, or less than the MUF. As the operating frequency is raised towards the MUF, the signal will be received with increasing signal strength. When the frequency *exceeds* the MUF, ionization at the point of reflection will not be strong enough to bend the wave back to earth at the receiving location, and it will continue on through the ionosphere into space. To insure satisfactory communications between two distant points, the operating frequency must be as near to the MUF as possible, but should never exceed it.

MUF Calculation

Since the MUF is related directly to the critical frequency, its value is a function of the intensity of ionization in the earth's upper atmosphere. For a given transmission path, the MUF follows the same diurnal, seasonal, geographical and cyclical variations as the critical frequency. During periods of high solar activity MUF values are considerably higher (on the order of two to three times) than during periods of low sunspot activity.

It should be noted at this point that the amount of power radiated does not enter into the determination of the MUF. The ionosphere either returns or does not return a radio wave depending entirely upon the frequency of the wave and the degree of ionization. This applies to the normal case of a truly reflected wave and does not apply to the case of "scatter" reflections from the ionosphere that may occur under certain abnormal conditions, or when powers on the order of hundreds of kilowatts are radiated. Under these last two conditions, radiated power will enter into the determination of the MUF, but these are conditions that are not generally encountered in amateur radio communications.

Because the MUF is such an important quality in radio communications, relatively straightforward graphical methods have been devised for calculating its values for transmission paths of any distance, without the necessity for resorting to mathematics.

Contour charts containing world-wide values of predicted critical frequencies, MUF values calculated for a standard distance of 4000 kilometers (2400 miles), and appropriate graphs for determining from these values the MUF for any distance, are published monthly by the Environmental Science Services Administration (ESSA), U.S. Dept. of Commerce, Boulder, Colorado. They are entitled *Basic Radio Propagation Predictions,* and are obtainable from the Supt. Of Documents, U.S. Govt. Printing Office, Washington, D.C. 20402 at an annual subscription rate of $2.75.

Ionospheric Absorption

So far we have discussed the characteristics of the ionosphere as a reflector of radio waves. Ionization, however, not only bends a radio wave, it causes energy to be absorbed from it as well. Ionospheric absorption is one of the main reasons the signal strength of a radio wave is reduced as is passes through the ionosphere.

As a radio wave enters the ionosphere, it imparts energy to the electrons that exist in this electrified region. The electrons are set into motion by the transfer of energy, and thus convey the radio wave through the ionized region. While moving through the ionosphere, electrons vibrating in rhythm with the radio wave collide with much larger gas molecules and with ions which are also present in this region. As a result of such collisions, the electrons lose some of the energy imparted to them by the radio wave. In effect, this lost energy is not propagated, and the amount of energy in the radio wave when it emerges from the ionosphere is less than when it entered, resulting in decreased signal strength.

Exactly how much energy is lost as the radio wave propagates through the ionosphere depends on the number of collisions per second between electrons and molecules of gas. This quality, in turn, depends on the radio wave's frequency, as well as the number of electrons and molecules present. As the wave frequency increases, the wavelength decreases[1], and the number of collisions between electrons and gas molecules also decrease. The *higher* the frequency, the *less* the absorption.

---

[1]Frequency (expressed in kilocycles) and wavelength (expressed in meters) are related by the following:

$$Frequency = \frac{300{,}000}{Wavelength}$$

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The amount of ionospheric absorption varies inversely as the square of the wave frequency. If the wave frequency is doubled, ionospheric absorption will decrease by a factor of four. For example, the absorption on 28 mc (10 meter band) is one-fourth the intensity of the absorption found on 14 mc (20 meter band). When both bands are open at the same time, it will require considerably more power on 20 meters to equal the strength of the 10 meter transmission over the same path. This accounts for the strong signals often possible on the 10 and 6 meter bands, even when using relatively low power.

Since the MUF is the highest frequency that can be used on a circuit, and since ionospheric absorption decreases rapidly with an increase in frequency, this type of absorption is *minimum* near the MUF.

Ionospheric absorption depends upon the intensity of ionization in the earth's upper atmosphere. The level of absorption varies greatly throughout the day, season of the year, and geographically, being proportional to the angle that the sun makes with respect to the earth. Absorption is much more intense in equatorial regions, where the sun is more directly overhead, than in the temperate latitudes, and is generally greater during the summer months than in winter.

While absorption takes place in each of the ionospheric layers, it is strongest in the lowest, or *D* layer, where it varies from extremely low values during the hours of darkness to very high values which peak shortly after noon.

As we might expect, the absorption of high frequency radio waves as they pass through the ionosphere varies throughout the solar cycle. During the years of low sunspot count, when ionization is at a minimum, ionospheric absorption is also at a minimum.

Signal strength measurements made during the past two sunspot cycles show that during the daylight hours, ionospheric absorption is between approximately 3 and 10 db *less* during periods of low solar activity than at the cycles peak. The reduction in absorption on the 10 and 15 meter bands is nearer the 3 db figure; the reduction on 20 and 40 meters is nearer 6 db, and the reduction on the 80 and 160 meter bands is approximately 10 db.

During the hours of darkness, when ionospheric absorption normally drops to very low values, there is a reduction of between approximately 3 and 6 db as the sunspot cycle declines from maximum to minimum activity, with the greatest reduction taking place in the lower frequency bands.

The reduction in ionospheric absorption as the solar cycle declines is very significant, for it means that during the coming years of low solar activity the absorption that contributes most to weakening signals will be reduced materially. Consequently, the signal strength of radio waves that will be reflected by the ionosphere during the next several years should be *noticeably stronger* than signals have been during the recent years of high solar activity, especially on the 40, 80 and 160 meter bands.

The LUF

The *Lowest Usable High Frequency*, or LUF is the *lowest* frequency that can be used for satisfactory communication over a particular path at a particular time. The LUF is defined as the frequency at which the received signal strength is *equal* to the *minimum* signal strength required for satisfactory reception.

The strength of the received signal depends upon the power of the transmitter, the gain and directivity of the transmitting and receiving annennas, the path length, and absorption losses.

The minimum level of signal intensity required for satisfactory reception depends upon the noise level at the receiving location and the type of modulation transmitted. Atmospheric noise, or static, is generally the predominent type of noise that the signal must overcome. For satisfactory reception, a manual c.w. signal requires a signal-to-noise ratio of about 3:1, speech grade quality s.s.b., with 10 db carrier suppression and 3 kc bandwidth, requires a ratio of about 7:1; while speech quality d.s.b., with 6 kc bandwidth, requires a signal-to-noise ratio of at least 15:1.

At frequencies *below* the LUF, satisfactory reception will not be possible since the received signal will be lost in the prevailing noise level. As the operating frequency is raised *above* the LUF, the signal-to-noise ratio improves. Optimum conditions occur at the MUF, where both the signal-to-noise ratio and the propagation reliability are maximum.

Unlike the MUF, which is dependent entirely upon ionospheric characteristics, the LUF can be controlled to some degree by adjustments in the effective radiated power, or by changes in the type of modulation transmitted. As a general rule of thumb, the LUF can be *lowered* approximately two megacycles for each 10 db *increase* in effective radiated power, and vice versa.

The LUF is somewhat more difficult to determine than the MUF, since it depends upon so many variables. Graphical techniques for calculating the LUF appear in *Ionospheric Radio Propagation*.[2]

Since ionospheric absorption decreases between approximately 3 and 10 db as the solar cycle declines, the LUF for any particular circuit is expected to be somewhat lower during the coming years of low solar activity than during the recent period of peak sunspot count.

Circuit Analysis Curves

Between the MUF and the LUF there is a range of frequencies over which radio communi-

[2]Available from the Supt. Of Documents, Govt. Printing Office, Washington, D.C. 20402 for $2.75 a copy.

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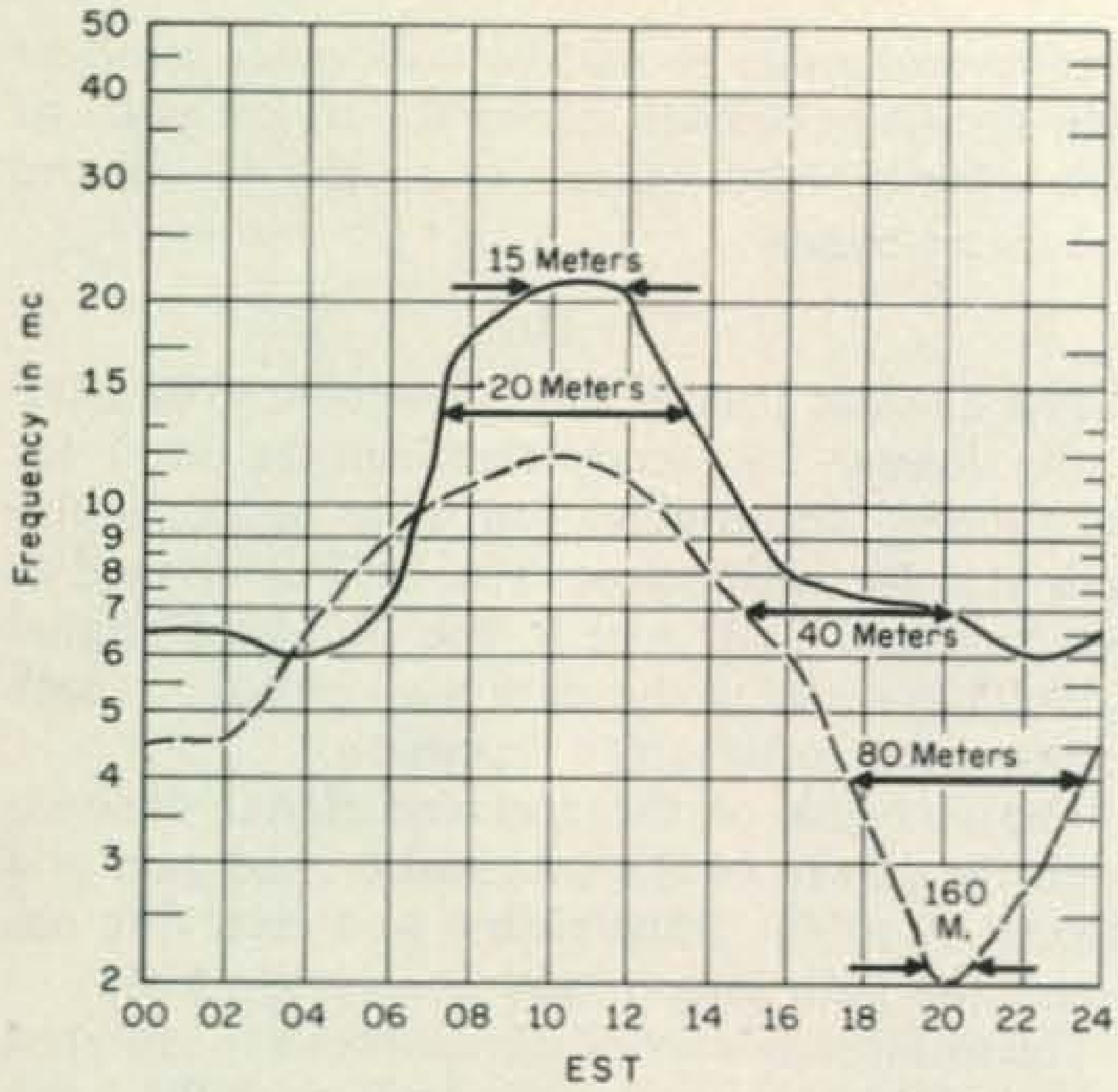


Fig. 2—Circuit analysis curve east coast U.S.A. to western Europe; low sunspot activity (SSN 10); winter season December, 1964. Solid line is MUF, dashed line is LUF. LUF based on 250 watts of c.w. effective radiated power.

cations can be maintained on a particular circuit. The upper limit of this range (the MUF) is determined by the ionization density at the point of reflection, while the lower limit (the LUF) is determined by ionospheric absorption along the path, and noise conditions at the receiving terminal. It is of great operational importance to know both these limits as well as the intervening range of useful frequencies. Such data, plotted conveniently in graphical form, are often referred to as circuit, or propagation analysis curves.

Figure 2, a typical circuit analysis curve, represents data for the circuit between the east coast of the U.S.A. and western Europe for a winter period of low solar activity (December, 1964). From this example, it is possible to see at a glance what bands are expected to be open at any time of day. For example, fifteen meter openings are shown between 9 A.M. and 12 noon EST, while forty meter openings are shown between 3 and 8 P.M. EST, etc. The circuit analysis shown in fig. 2 is based on an effective radiated c.w. power of 250 watts.[3]

During periods of time when the LUF *exceeds* the MUF, "blackout" conditions occur, and it becomes very difficult, if not impossible, to maintain communications on the circuit In fig. 2 blackouts occur between 4 and 7 A.M. and 1 and 3 P.M. EST.

Propagation forecasts appearing monthly in *CQ's* PROPAGATION column are based upon the evaluation of nearly 100 different circuit analysis curves of the type in fig. 2.

[3]Effective radiated power, or ERP, is defined as the power supplied to the antenna multiplied by the gain of the antenna in a given direction, relative to the gain of a dipole antenna a half-wavelength above ground.

It can be seen from fig. 2 that unless we are familiar with ionospheric conditions, the chances of maintaining effective radio communicatons are very slim, since haphazard selection of an operating band can easily result in the signal either penetrating the ionosphere and being lost in space, or being completely lost in the noise level. On the other hand, proper band selection based on propagation data will result in reflection of the signal between transmitter and receiver with a minimum loss of energy.

The ability to maintain efficient long distance shortwave communications depends to a great extent on the ability to predict far enough in advance, what conditions in the ionosphere will be, so that adequate plans can be made. Such long range propagation studies are made possible because of the close relationship that is known to exist between ionospheric conditions and smoothed sunspot numbers. Figures 2 and 3 are examples of propagation data observed on the path between the eastern U.S.A. and western Europe during the winter months of previous periods of high and low solar activity data appearing in "A Seven-Year Propagation Forecast For The Amateur Bands"[4] is based on similiar circuit analysis for more than 50 other DX paths.

Optimum Radiation Angle

Figure 4 shows the relationship between radiation angle, or the slant angle that the radio wave must leave the earth, to be reflected a specific distance by the ionosphere. Radiation angles, or wave angles as they are also called, are shown for reflection from an average E layer height of 60 miles, and for normal F layer limits of 150

[4]See Jacobs, G., & Leinwoll, S., "A Seven-Year Propagation Forecast For The Amateur Bands", on page 52 of this special issue of CQ·

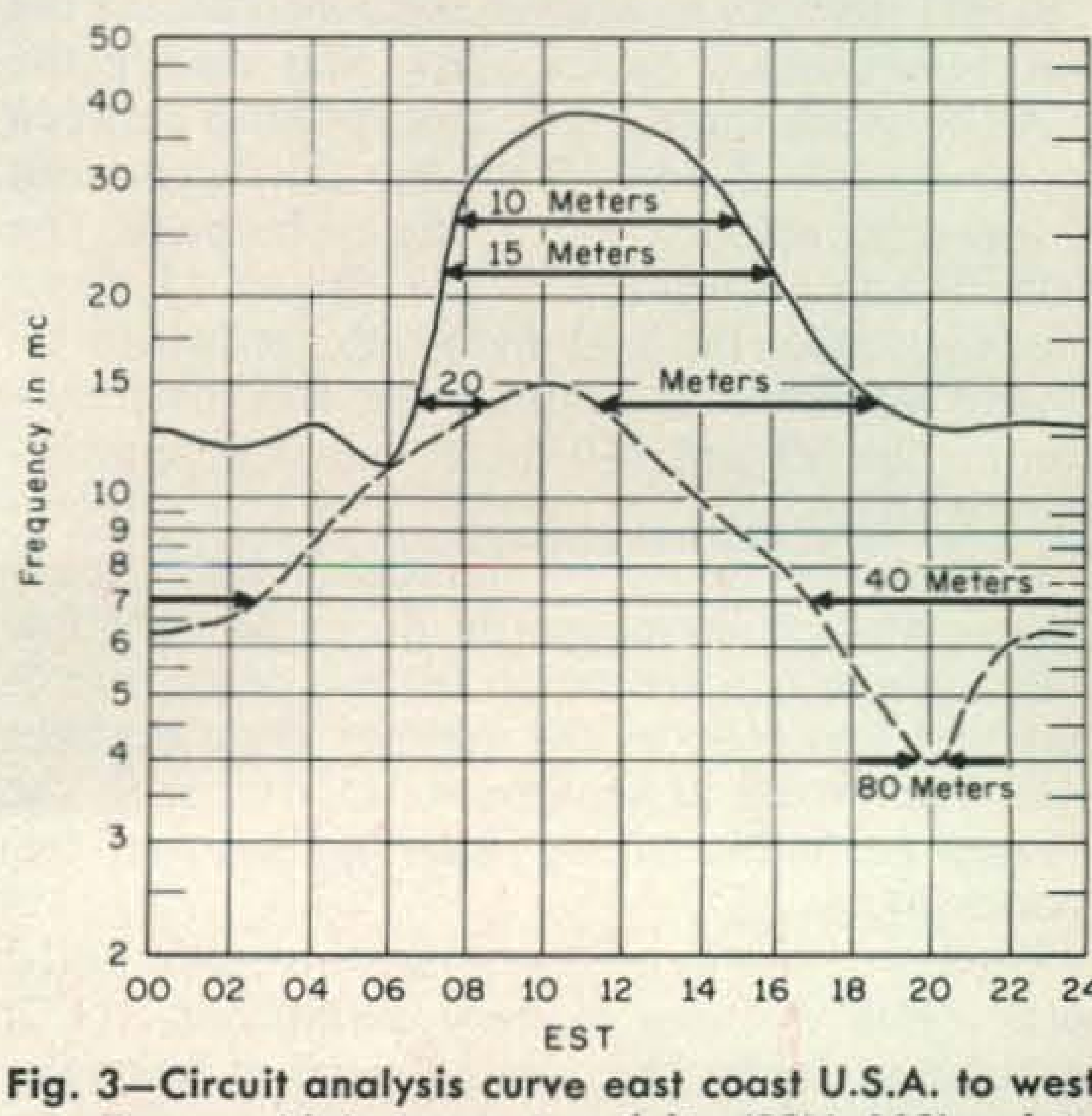


Fig. 3—Circuit analysis curve east coast U.S.A. to western Europe, high sunspot activity (SSN 110); winter season, December 1968. Solid line is MUF, dashed line is LUF. LUF based on 250 watts of c.w. effective radiated power

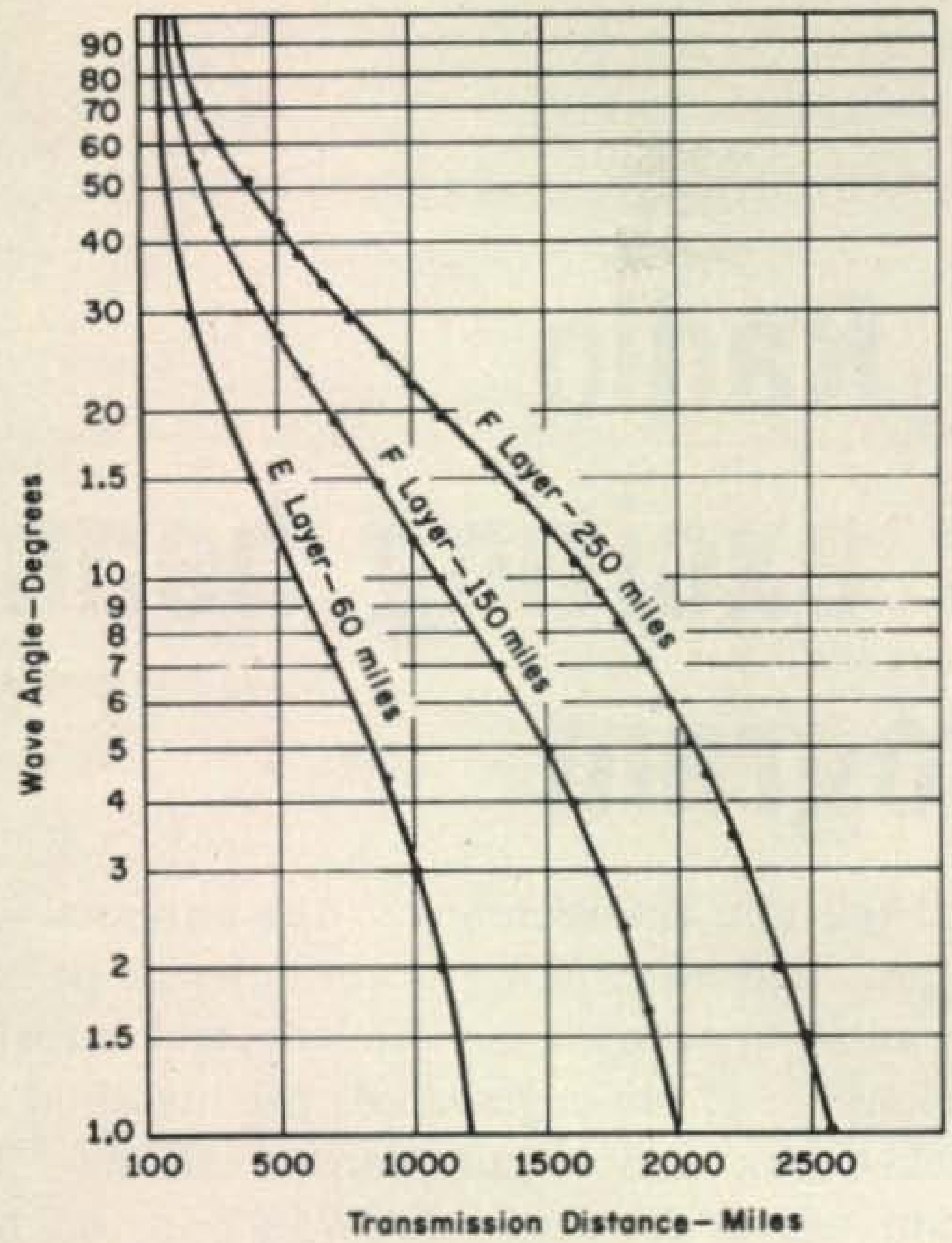


Fig. 4—Relationship between optimum antenna wave angle, transmission distances and height of the E and F layers.

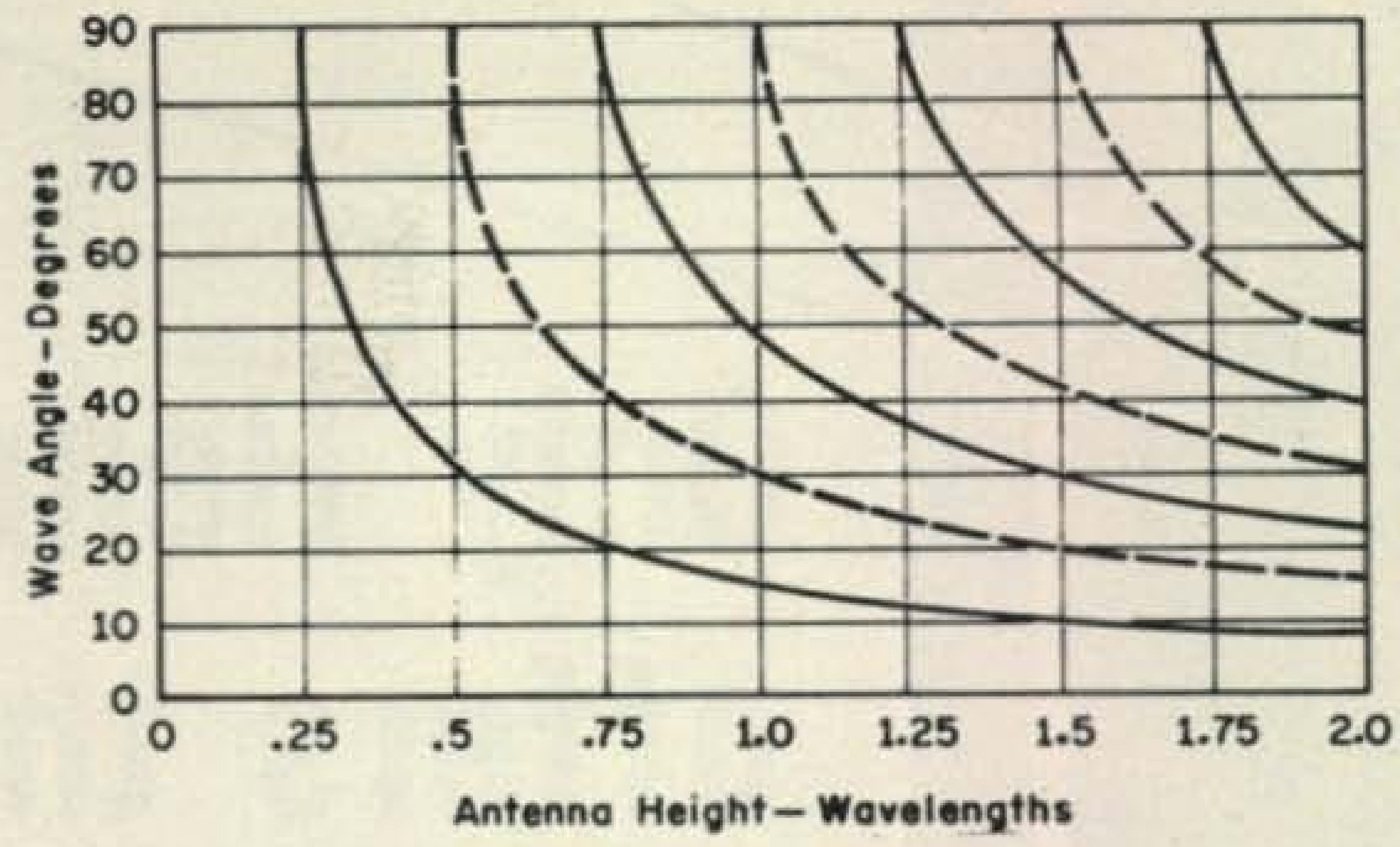


Fig. 5—Antenna radiation angles for various antenna heights above ground. The solid lines are maxima, dashed lines nulls, for all horizontal antennas and for vertical antennas having a length equal to an even mutiple of one-half wavelength. For vertical antennas an odd number of half waves long, the dashed lines are maxima and the solid lines nulls. For example, a horizontal antenna 0.75 wavelengths above ground will have maximum radiation at a wave angle of 20 degrees, minimum radiation at a wave angle of 40 degrees and a second maximum at 90 degrees.

and 250 miles. From fig. 4, assuming one degree as the minimum attainable wave angle, it can be seen that the geometry of skywave propagation is such that one-hop reflection from the E layer is limited to approximately 1200 miles, and one-hop F layer propagation is limited to a maximum distance between approximately 2000 and 2600 miles. Propagation beyond these distances is usually accomplished by multi-hop propagation, or successive reflections between the earth and the ionosphere.

For most efficient shortwave propagation, the radiation angle of the transmitting antenna (and the receiving as well), should be optimized according to the geometry of propagation. For distances less than the one-hop limit, the optimum wave angles can be determined directly from fig. 4. For multi-hop propagation, experience has shown that the *lower* the radiation angle, the more efficiently the wave is propagated.

The radiation angle of an antenna is determined primarily by its electrical height above ground. Figure 5 shows how the wave angle varies with the antenna's height above ground. Basically, the higher the antenna, the lower the wave angle.

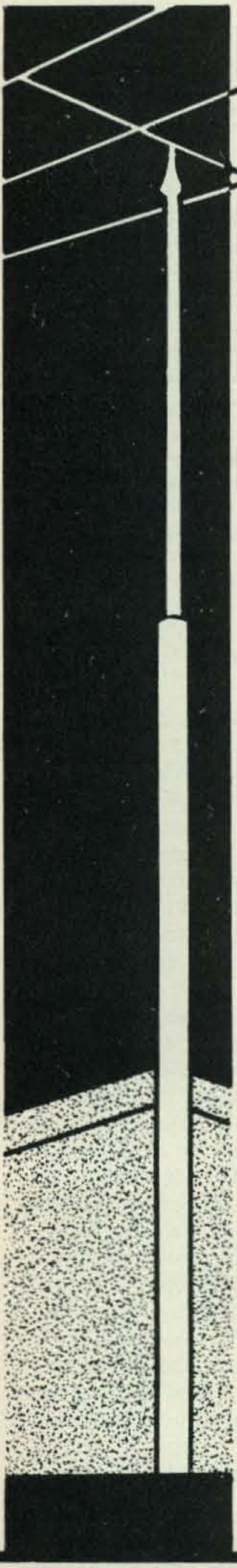
Here is an example which ties together the geometry of propagation, optimum radiation angle and height of the antenna above ground. Suppose that short wave communications is desired between two points 1000 miles apart. Assuming propagation is to be via the F layer, fig. 4 shows that for an F layer height of 150 miles, the optimum wave angle is 13 degrees; for a height of 250 miles it is 23 degrees. In practice, the antenna design radiation angle is generally taken as the average value of the two limiting heights, which in this example would be 18 degrees.

From fig. 5, a wave angle of 18 degrees can be achieved with a horizontal antenna approximately 0.8 wavelengths above ground. If the optimum band for this circuit is 20 meters, this means the antenna should be placed 16 meters above ground, or 53½ feet. (1 meter = 3.281 feet).

This article is intended to serve only as an introduction to the complex factors involved in the propagation of short wave radio signals via the ionosphere. A more detailed discussion is contained in *Ionospheric Radio Propagation,* the most comprehensive text presently available on this subject.[2] Additional data concerning the optimum design of antennas taking into account propagation factors can be found in the ARRL Antenna Book, published by the American Radio Relay League, Newington, Conn. 06111.

In summary, to optimize short wave communications over a particular path, use only those amateur bands that lie between the MUF and LUF, and make sure that your transmitting antenna is designed around the optimum radiation angle. ■

**Troubled with TX-I?
Read this month's
Q & A Column
on page 82**



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Illustrated: Tristao MM-35 "Mini-Mast"

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Don't Be Afraid of the Big Bad Blackout

BY JOHN J. SCHULTZ,* W2EEY

Ionospheric disturbances are most frequent during and immediately following maximum sunspot activity. The maximum of the current sunspot cycle, number 20 appears to have occurred in November 1968. As a result, a high level of ionospheric storminess is expected during the next two or three years. A basic understanding of the phenomena involved, the warnings that are available, and the corrective actions that often can be taken, may enable the h.f. operator to maintain communications during many such disturbances, whereas, under other circumstances he might have given up in frustration.

THE regular periodic changes in the ionosphere which affect propagation conditions are often difficult enough to live with for the h.f. operator or DX enthusiast who likes to maintain definite schedules. However, through the use of propagation aids and forecasts one can develop a good degree of confidence in which bands at which times will be usable for a desired path.

The occurance of *ionospheric disturbances* are usually another matter. These disturbances cannot really be predicted as such—only warning given when they are most likely to occur or when they seem to be building up—and they catch most operators unaware. When signals start to fade or completely disappear the tendency is to give up on a QSO until conditions improve or to randomly try different bands or modes of operation in order to maintain communication. A great deal of time, of course, can be lost in the process.

Actually, there are some ionospheric disturbances that are so intense that in fact nothing can be done about the situation other than waiting for propagation conditions to return to normal. But many disturbances are of lesser intensity and something can be done by an operator to maintain communication. To operate effectively during ionospheric disturbances requires an understanding of how these disturbances affect propagation and the alternatives available for communication over a given path. Anticipating the time of a disturbance from the warnings available often allow alternative plans to be put into effect before the peak of a disturbance is reached.

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The plan that one develops depends upon the equipment available, the paths involved, the siting of stations working each other, etc. Such plans must be developed on an individual basis but this article does provide a discussion of the characteristics of various ionospheric disturbances. A review of the effect of such disturbances and their characteristics is particularly appropriate now since the most severe disturbances are expected to take place during the next two or three years. (See fig. 1)

Effect of Disturbances

Generally, the effect of ionospheric disturbances on the h.f. bands is to weaken signal levels, either suddenly or gradually, sometimes

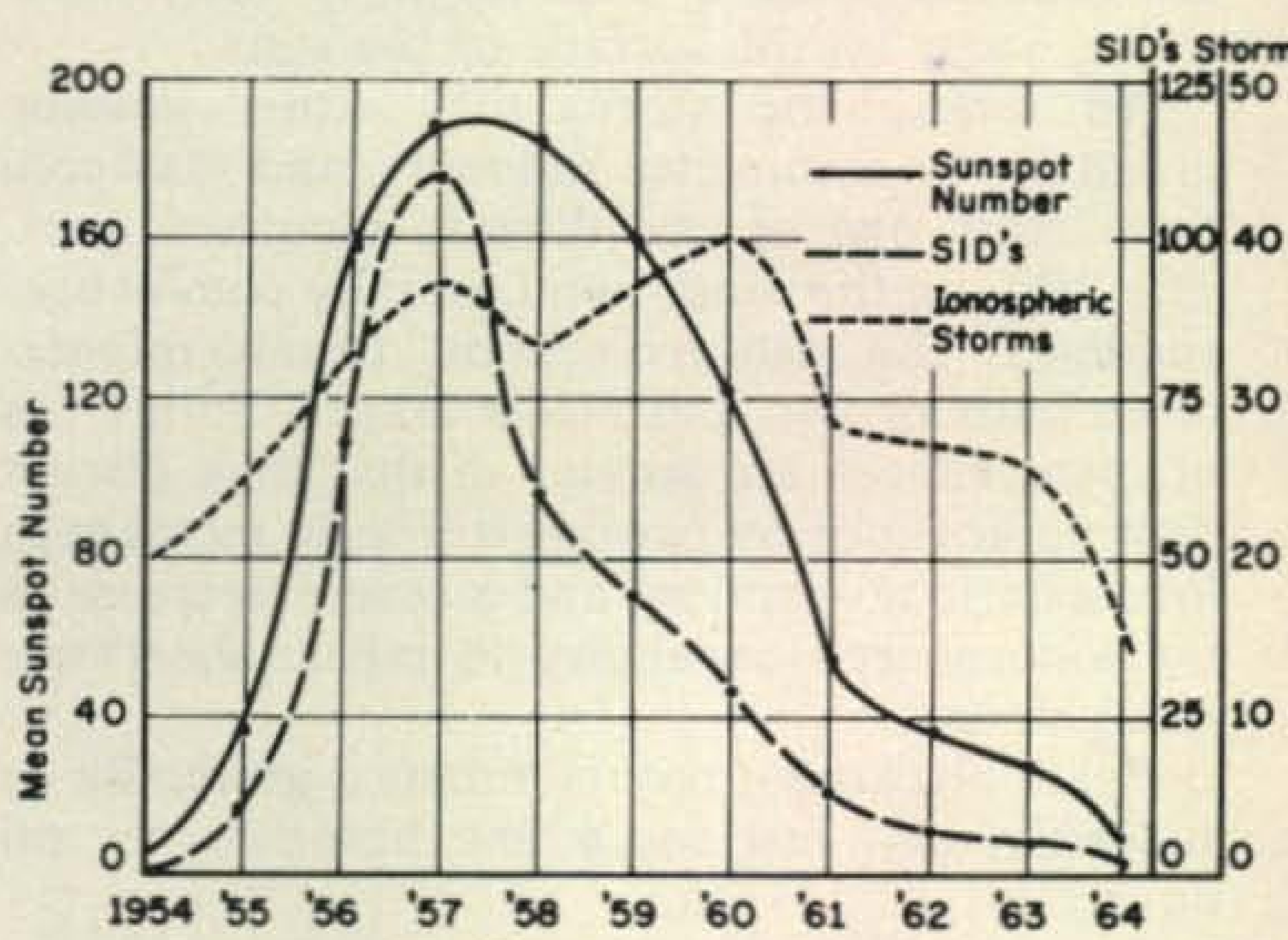

Fig. 1—Relationship among mean sunspot number during cycle 19 (1954-1964), the annual number of SID's, and the annual number of ionospheric storms observed over the North Atlantic path during cycle 19.

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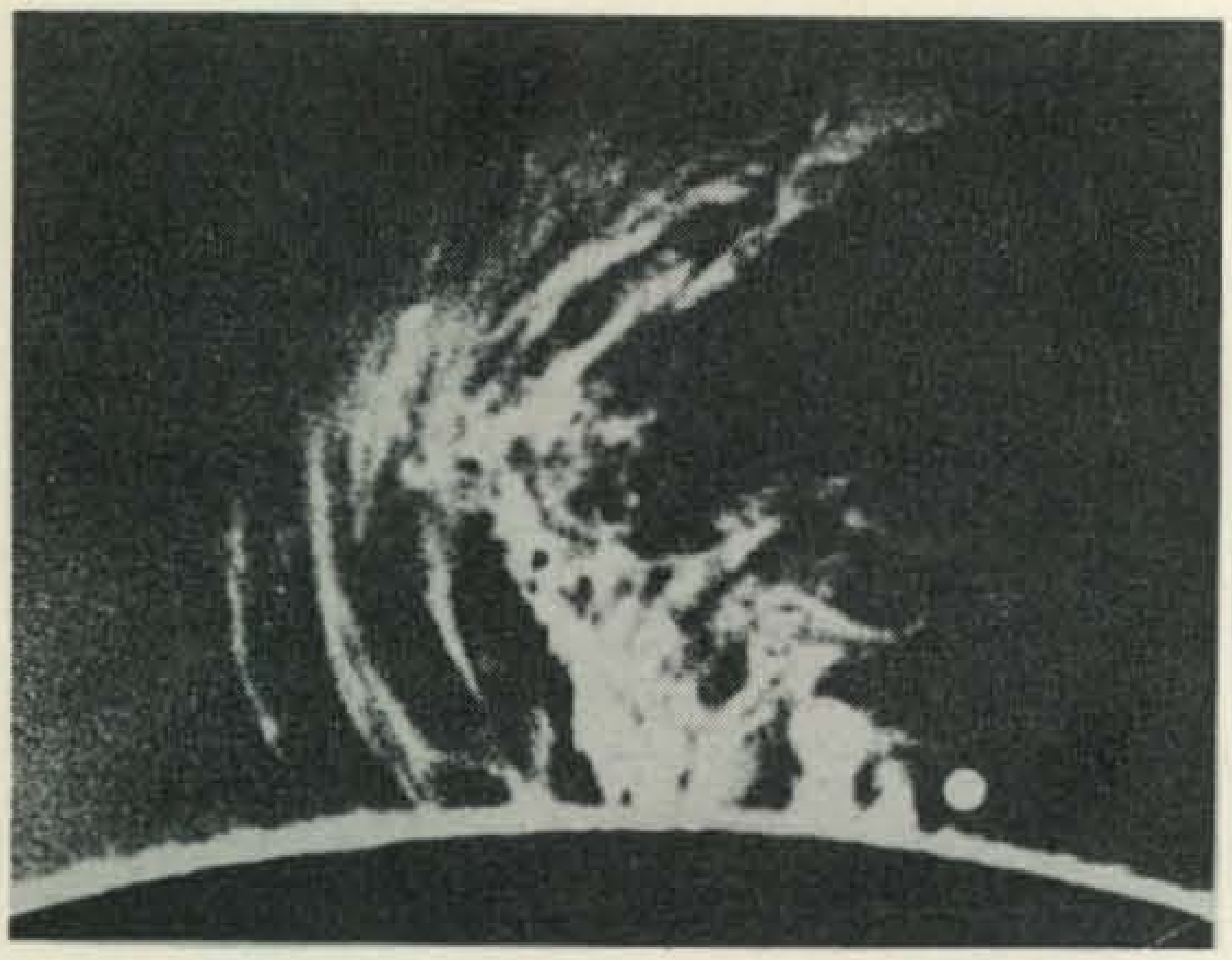

A flare on the surface of the sun ejecting gaseous material and solar radiation millions of miles into space. Photographed with a special telescopic camera at the Palomar Observatory, Mt. Wilson, California.

to the point where signals (and even atmospheric noise) completely disappear. The effect can be quite dramatic and when the noise level is greatly reduced one may even suspect that a receiver is defective. On the other hand, certain disturbances can cause rapid, erratic signal fading, echos and a great increase in the noise level in portions of the h.f. range.

The two main type of disturbances which occur with distinctly different characteristics are the *ionospheric storm* and the *sudden ionospheric disturbance,* usually abbreviated SID. The SID is also referred to as a shortwave fadeout or as the Dellenger effect (named after the late Dr. John H. Dellenger, an American pioneer in radio propagation research who was among the first to identify this type of disturbance). The *polar blackout,* another type of ionospheric disturbance which is somewhat of a cross between an ionospheric storm and a SID, will also be discussed.

Ionospheric storms, SID's and polar blackouts are believed to have their origin in solar flares which occur on the surface of the sun.

An ionospheric storm may either develop gradually or commence suddenly, and may continue from one or two days to almost a week. The SID, on the other hand, usually commences suddenly, and lasts from about twenty minutes to an hour or two, but rarely longer. Both types of disturbances are similar in that they disrupt communications by causing a drastic increase in ionospheric absorption, and a severe decrease in the ionosphere's capability to reflect shortwave radio signals.

Polar blackouts may commence gradually or suddenly, and last for a few hours to several days.

Solar Flares

Solar flares are believed to be sudden changes in the magnetic fields within and in the vicinity of large sunspots. They occur suddenly and are violent explosions during which an enormous amount of matter is ejected from the surface of the sun. Among this matter are vast quantities of ultraviolet energy, X-rays and cosmic radiation travelling at the speed of light, and charged particles, called corpuscles, which travel at much slower velocities.

Solar flares also produce a type of radio noise which often can be detected on frequencies below 300 mc.

The terrestrial effects of these flares are to produce ionospheric disturbances in the earth's atmosphere.

The ultraviolet, X-ray and cosmic radiation travelling with the speed of light, blankets the lower levels of the ionosphere within minutes after a flare occurs, causing heavy signal attenuation and a SID.

The corpuscles, travelling at a much slower speed, reach the ionosphere from 18 to 36 hours after the effects of the flare have been observed, causing heavy signal attenuation and an ionospheric storm.

Polar blackouts can result from either ultraviolet, X-ray, cosmic or corpuscular radiation from a solar flare.

Since solar flares are associated with large sunspots, they occur far more frequently during years of high solar activity and very rarely when the solar cycle is near minimum.

SIDs

Depending upon the intensity of the flare, and the angular relationship between the sun and

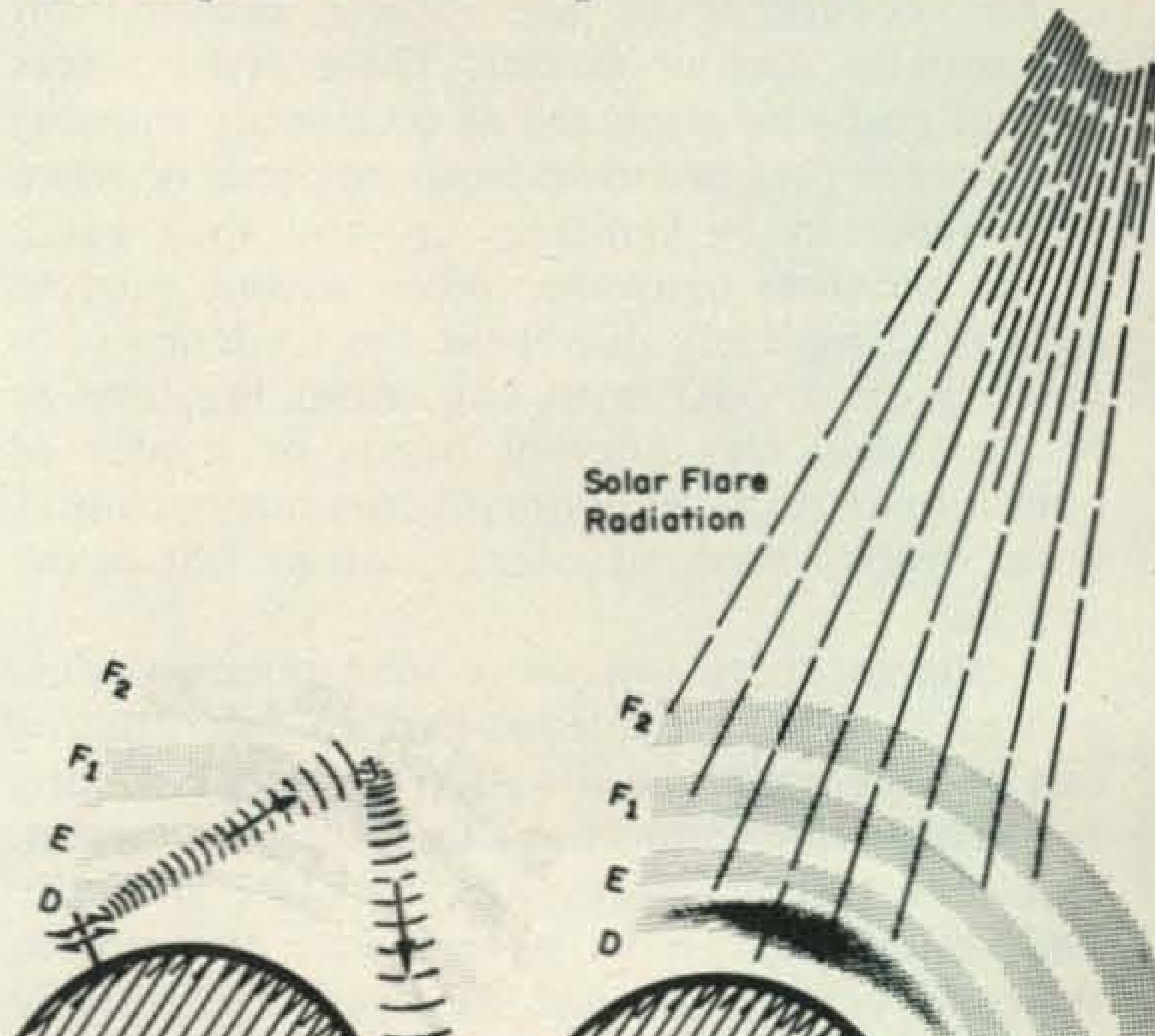

Fig. 2—Under normal conditions, the daylight ionospheric layers can be represented as shown at (A). The radiation from an intense solar flare *produces unusual* ionization of the lower layers, particularly the D layer (B), and the result is a sudden ionospheric disturbance.

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earth, the effect upon radio communications can range from nil to a complete blackout.

Since the radiation produced by the flare travels with the speed of light, the effect of the flare takes place within minutes after it has occurred. If the earth and the spot on the sun's surface where the flare occurred are in-line, the flare's radiation penetrates most of the normal ionospheric layers, as shown in fig. 2, causing sharply increased ionization of the D layer region. This results in increased absorption of signals—particularly in the lower h.f. bands, although all h.f. signals can be effected. Signals fade out suddenly (in a minute or less) and may not return for a period of several minutes to several hours, after which they gradually increase again.

There are a number of characteristics about this type of disturbance that should be noted. The D layer ionization frequencies in the *lower* portion of the h.f. range *first*. Higher frequency signals are the last effected and also the first to penetrate the "blanket" when the effect of the flare diminishes. So obviously a higher frequency band should be tried during such a disturbance. Also, since the SID is caused by solar radiation, the dark side of the earth will not be affected. The use of a dark side path, even though longer in distance, may avoid the effects of the disturbance. In equatorial regions where the flare radiation is more perpendicular to the ionospheric layers, SIDs are usually more intense. Equatorial signal paths, therefore, will be affected more than those in higher latitudes.

When a SID is so intense that no countermeasure seems to help—as were many of those that occured during 1958 and 1959 after the last peak in the sunspot cycle—there is nothing to do but wait out the end of the disturbance, trying the higher frequency bands first after an hour or so. Between 8 and 10 SIDs can be expected monthly, on the average for the next year or two.

Once in a while a solar flare will occur that is not in-line with the earth, and its radiation will spin off into outer space, missing the earth entirely and producing no noticeable affects in the ionosphere.

On the other hand, especially during periods of low solar activity, SIDs will occur when no flares are visible on the sun's surface. These are called M-type SIDs and are caused by "hot spots" on the sun that do not erupt into flares, but do emit large amounts of radiation.

Ionospheric Storms

The occurance of a solar flare is frequently followed some 18-36 hours later by an ionospheric storm. The time delay is due to the fact that the charged particles generated by the solar flare travel at approximately 1,000 miles a second as compared to travel at the speed of light for the radiation produced by the solar flare. The SID produced by the radiation has usually com-

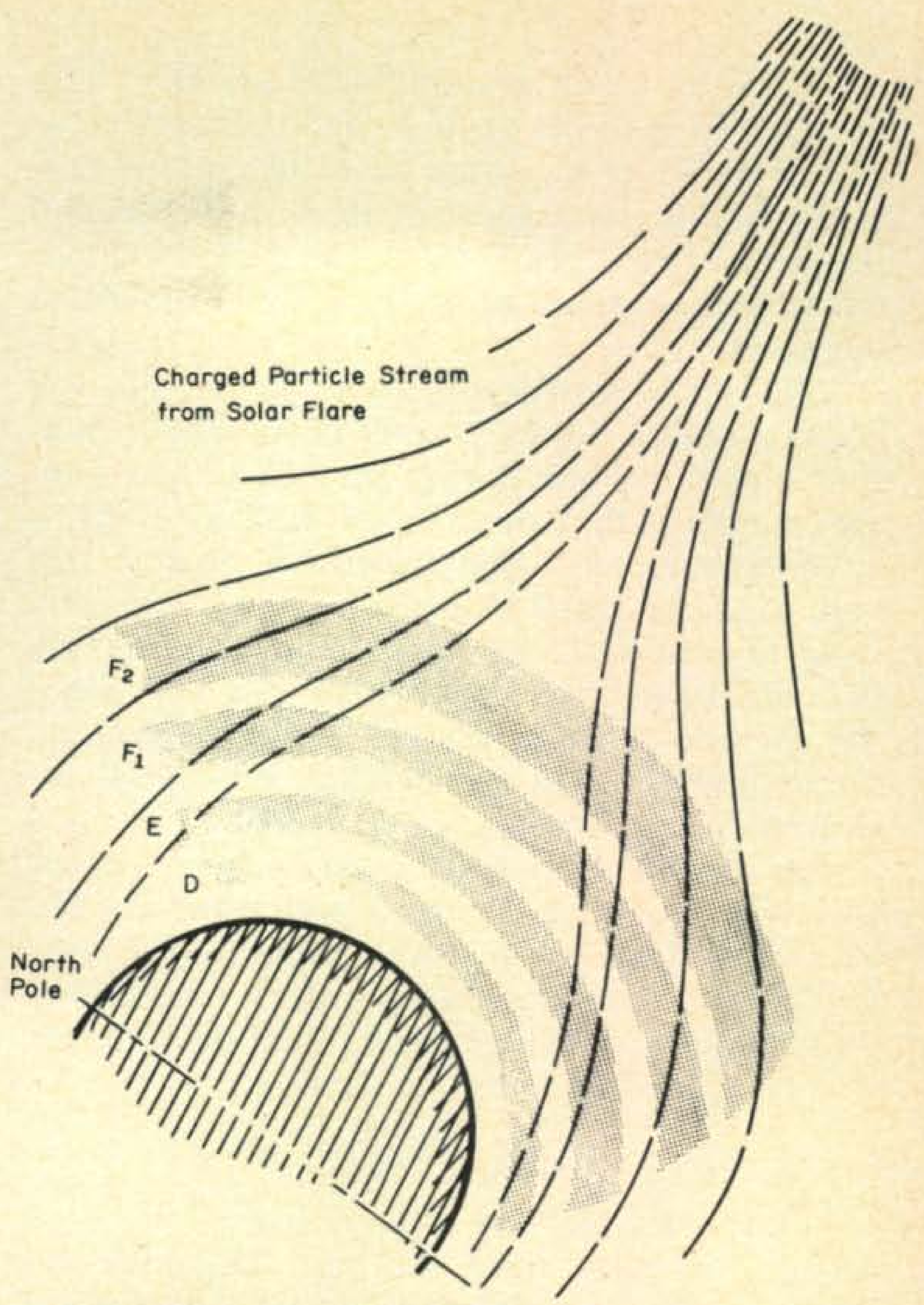

Fig. 3—The charged particle stream from a solar flare tends to divert to the pole regions due to the earths magnetic field. The velocity of these particles passing through the ionospheric layers, particuarly the higher layers, disturbs these layers and produces an ionospheric "storm".

pletely disappeared by the time the ionospheric storm starts. The storm also affects propagation in quite a different manner than the sudden ionospheric disturbance.

The charged particles as they approach the earth are deflected by the earth's magnetic field which causes them to move toward the magnetic poles as illustrated in fig. 3. The rapid drift of these particles disturbs the *upper* regions of the ionosphere more than the lower layers. A variety of effects may occur—the F layer may seem to disappear, to change its ionization rapidly or to seemingly split into many layers. The first effect, of course, means the loss of signals that are too high in frequency while the other effects will produce rapid fading and echos.

During ionospheric storms, the highest frequency which the F-layer will reflect may be reduced by as much as 50% below normal. Although the F layer is primarily affected, severe storms cause similar behavior in the E region as well. Under extreme conditions, the combination of a weaker ionosphere and increased absorption results in a radio blackout, during which time long distance shortwave communication may become impossible to many areas of the world, especially on circuits passing near the earth's magnetic poles.

The onset of an ionospheric storm is usually detected in both the daylight and darkness areas of the world at the same time. The storm generally begins simultaneously in the northern and southern extremities of the earth, expanding into the temperate zones as the severity of the storm increases.

Ionospheric storms may occur as much as 100 hours a month during periods of maximum sunspot activity, while during periods of low sunspot numbers they occur about half as often.

Obviously, one countermeasure against this type of disturbance is to try a lower frequency band to continue communications. The relaying of traffic by a different path may also help. Since the charged particles concentrate at the poles, a signal path passing through the equatorial region may be completely unaffected by such a storm while a trans-polar path may be useless. The use of a dark-side path will generally *not* help. The disturbance develops and disappears gradually as compared to a sudden ionospheric disturbance and will generally last much longer —from one to three or more days.

Polar Blackouts

Polar blackouts are caused mainly by high cosmic radiation from the sun. The rays are guided by the earth's geomagnetic field toward the polar regions, and because of their high energy level they penetrate deep into the lower ionosphere, causing heavy absorption of h.f. signals.

Some polar blackouts are associated with very large flares and SIDs, while others are associated with ionospheric storms. Those associated with flares usually produce absorption in the polar cap region which lasts from a few minutes to a few hours. Polar blackouts associated with ionospheric storms generally last up to several days at a time.

Polar cap absorption (PCA) is generally confined to the earth's polar regions, and affects only those h.f. signals that pass through these regions. Polar blackouts associated with ionospheric storms also produce absorption in the polar regions, but as the storm intensifies the absorption region moves southward towards the mid-latitudes.

Very strong auroral displays are usually associated with most polar blackouts, especially during severe ionospheric storms.

SIDs, ionospheric storms and polar blackouts are often interrelated. A SID will occur minutes after a flare takes place on the sun's surface, followed in 18 to 36 hours by an ionospheric storm. Polar cap absorption will usually take place with the SID, while vivid auroral displays will occur during the ionospheric storm, as the absorption belt moves southward.

The characteristics of various ionospheric disturbances and corrective action that may be taken are summarized in Table I.

Storm Warnings

Ionospheric disturbances cannot be predicted in the same manner nor with the accuracy of normal propagation conditions. However, sci-

Table I—Types of Ionospheric Disturbances

	SID	Ionospheric Storm	Polar Blackout (PCA)	Polar Blackout (auroral)
Commences	Suddenly	Gradually	Suddenly	Gradually
Duration	Several Minutes to Several Hours	Several Hour to Several Days	Several Minutes to Several Hours	Several Hours to Several Days
Region Most Affected	Daylight Areas	Polar Regions and Mid-Latitudes, Day and Night	Polar Regions, Day or Night	Polar Regions and Mid-Latitudes Day and Night
Region Least Affected	Darkness Areas	Low Latitude and Equatorial Regions	Mid-Latitude and Equatorial Regions	Low Latitude and Equatorial Regions
Bands Most Affected	20-160 Meters	10-40 Meters	15-160 Meters	10-160 Meters
Bands Least Affected	10-15 Meters	80-160 Meters	10 Meters	—
Seasonal Peak	Any Season	Early Fall Through Spring	Any Season	Early Fall Through Spring
Sunspot Cycle	Peaks During High Period	Peaks During High and Medium Periods	Peaks During High Period	Peaks During High and Medium Periods
Corrective Action	Work Dark Paths Go Higher in Freq. on Daylight Paths	Work Low Latitude and Equatorial Paths Go Lower in Freq. on High Latitude and Trans-Polar Paths	Work Low Latitude and Equatorial Paths. Go Higher in Freq. on High Latitude and Trans-Polar Paths	Work Low Latitude and Equatorial Paths

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EEE	(.)	No forecast or warning statement.
III	(..)	FLARES expected.
SSS	(...)	PROTON FLARE expected.
TTT	(-)	Magnetic storm expected.
UUU	(..-)	Magnetic storm and FLARES expected.
VVV	(...-)	PROTON FLARE and Magnetic storm expected.
HHH	(....)	Stratospheric warming observed.
DDD	(-..)	Stratospheric warming observed and FLARES expected.
BBB	(-...)	Stratospheric warming observed and PROTON FLARE expected.
MMM	(--)	Stratospheric warming observed and magnetic storm expected.

	Day before that of issue (hours GMT)				Day of issue	IN PROGRESS	NIL
	00-06	06-12	12-18	18-24	00-04		
Second 3-letter set: PROTON EVENT	MMM (--)	TTT (-)	HHH (....)	SSS (...)	III (..)	GGG (--.)	EEE (.)
Third 3-letter set: GEOMAGNETIC STORM	UUU (..-)	AAA (.-)	BBB (-...)	DDD (-..)	NNN (-.)	PPP (.--.)	EEE (.)

Fig. 4—Letter code for WWV and WWVH Geophysical alert bulletins. A typical message is described in text. The second and third sets of letters pertain to the occurrence of and approximate time *observed* solar or geophysical events. The coding for the beginning time and type of proton or geomagnetic event is shown.

entific observations of solar activity can give at least some indication of the possibility of a significant solar flare developing. Of course, once a flare has actually started, its development can be watched and some predictions made regarding its storm effects and magnitude.

Most amateurs are aware of the short term propagation forecasts broadcast by WWV for condition on a typical North Atlantic signal path. WWV broadcasts general propagation information on 2.5, 5, 10, 15, 20 and 25 mc twelve times every hour. The data is transmitted at 4½ minutes past the hour and every five minutes thereafter. Given in slow Morse Code, the transmissions consist of the letters N, W or U, followed by a number between 1 and 9. The letters designate propagation conditions at the time of broadcast, as follows:

N—Normal propagation
U—Conditions unstable or erratic, signals subject to fading noise
W—Radio storm in progress, condition below normal or disturbed

The numbers designate propagation conditions forecast for the following six-hour period, as follows:

1. Useless; 2. Very Poor; 3. Poor; 4. Poor-to-Fair; 5. Fair; 6. Fair-to-Good; 7. Good; 8. Very Good; 9. Excellent.

If, for example, propagation conditions are normal at the time of broadcast, but are expected to become poor during the late evening hours, WWV would transmit N3 in Morse Code.

Although these forecasts indicate whether or not conditions are disturbed, they give no details about the nature of the disturbance. For this purpose, separate bulletins, called geophysical alerts are also carried by both WWV and WWVH on each of their standard frequencies. The alerts are first broadcast, in slow Morse Code, for a given day at 0418 GMT by WWV and at 0448 GMT by WWVH and repeated at hourly intervals. The actual issue time of the alert is considered to be 0400 GMT, and the alert is repeated until a new one is issued. The broadcast consists of the prefix GEO followed by three groups of three letters. The meaning of each of the letter groups is shown in fig. 4.

For example, the following message (in International Morse Code)

GEO SSS EEE DDD

signifies:

GEO—Solar geophysical message
SSS—PROTON FLARE expected
EEE—No PROTON EVENT between 0000 GMT yesterday and 0400 GMT today
DDD—GEOMAGNETIC STORM occurred (began) between 1800-2400 GMT yesterday

27-Day Recurrence Cycle

It takes 27 days for the sun to make a complete rotation on its axis, with respect to the earth. This means that an active sunspot associated with a flare which occurred today, will be in line with the earth again 27 days from now. Ionospheric disturbances, therefore, have a tendency to recur every 27 days, often for several rotations of the sun, before the active spot dies out.

The 27-day recurrence cycle, although far from perfect, is a fairly good way of self-predicting ionospheric disturbances, especially ionospheric storms and M-type SIDs.

Summary

An h.f. operator can be warned of an ionospheric disturbance by the 27-day recurrence cycle, and by the WWV broadcasts.

The sequential effects of disturbances can also be a warning. When a SID is in progress,

[*Continued on page 98*]

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VHF Ionospheric Propagation

BY GEORGE JACOBS, W3ASK and STANLEY LEINWOLL*

LONG-distance propagation via ionospheric reflection normally takes place over the frequency range 3 to 30 mc. Higher frequencies are generally propagated through the troposphere and are often limited to distances not much greater than line-of-sight. From time-to-time, however, ionospheric propagation *is possible* in the lower v.h.f. range and openings on the 50 mc amateur band may take place over distances of up to several thousand miles, while openings on 144 mc may be possible up to approximately 1300 miles.

This article reviews the conditions under which ionospheric propagation may be possible on the 50 and 144 mc bands, and the characteristics of such openings that may result from regular F_2-layer reflection sporadic-E, auroral and meteor ionization, and trans-equatorial and ionospheric scatter.

Regular F_2-Layer Ionization

Regular F_2-layer ionospheric openings may be possible on 50 mc during years of high solar activity. Openings on this band took place for many hours at a time for distances of 2000 miles or more, and between the United States and all other continents during the maximum periods of the past two sunspot cycles, 1947-1950 and 1956 to 1960. Many trans-continental openings and openings between north and south America have been reported during the present period of peak solar intensity.

F_2-layer openings on the 50 mc band peak during the winter months to Europe and the Far East, and during the spring and fall months to Africa, South America, Australasia and other areas in a more-or-less southerly direction. Signal levels are often exceptionally strong during these openings, and communication over very great distances may be possible with relatively low power levels.

Regular F_2-layer openings on 50 mc are a daytime propagation phenomena, with the band opening to Europe during the hours before noon, to Africa during the noontime period, to South America during the afternoon and sometimes extending into the early evening, and to the Far East and Australasia during the late afternoon and early evening hours, local standard time in the United States.

Propagation conditions in the 28 mc band may often provide clues to 50 mc openings during the fall, winter and spring months. When F_2-layer openings are observed on 28 mc over distances of 1200 miles *or less,* the m.u.f. is rising rapidly and 50 mc may also be open in the same general direction, but over a considerably greater distance.

For the next year or two, solar activity may still be high enough to permit some F_2-layer 50 mc openings from the fall through the spring months in the United States. Openings of this type will, however, decrease as the solar cycle declines, with little likelihood of any taking place during years of low solar activity.

The regular F_2 layer of the ionosphere is never sufficiently electrified to propagate signals on the 144 mc band. Not even during the unprecedented peak years of 1957-58 were frequencies in this range propagated via the F_2-layer.

Sporadic-E Ionization

There frequently forms in the vicinity of the normal E-layer of the ionosphere, clouds or patches of abnormally intense ionization, which are capable of reflecting radio waves of frequencies much higher than those reflected by the

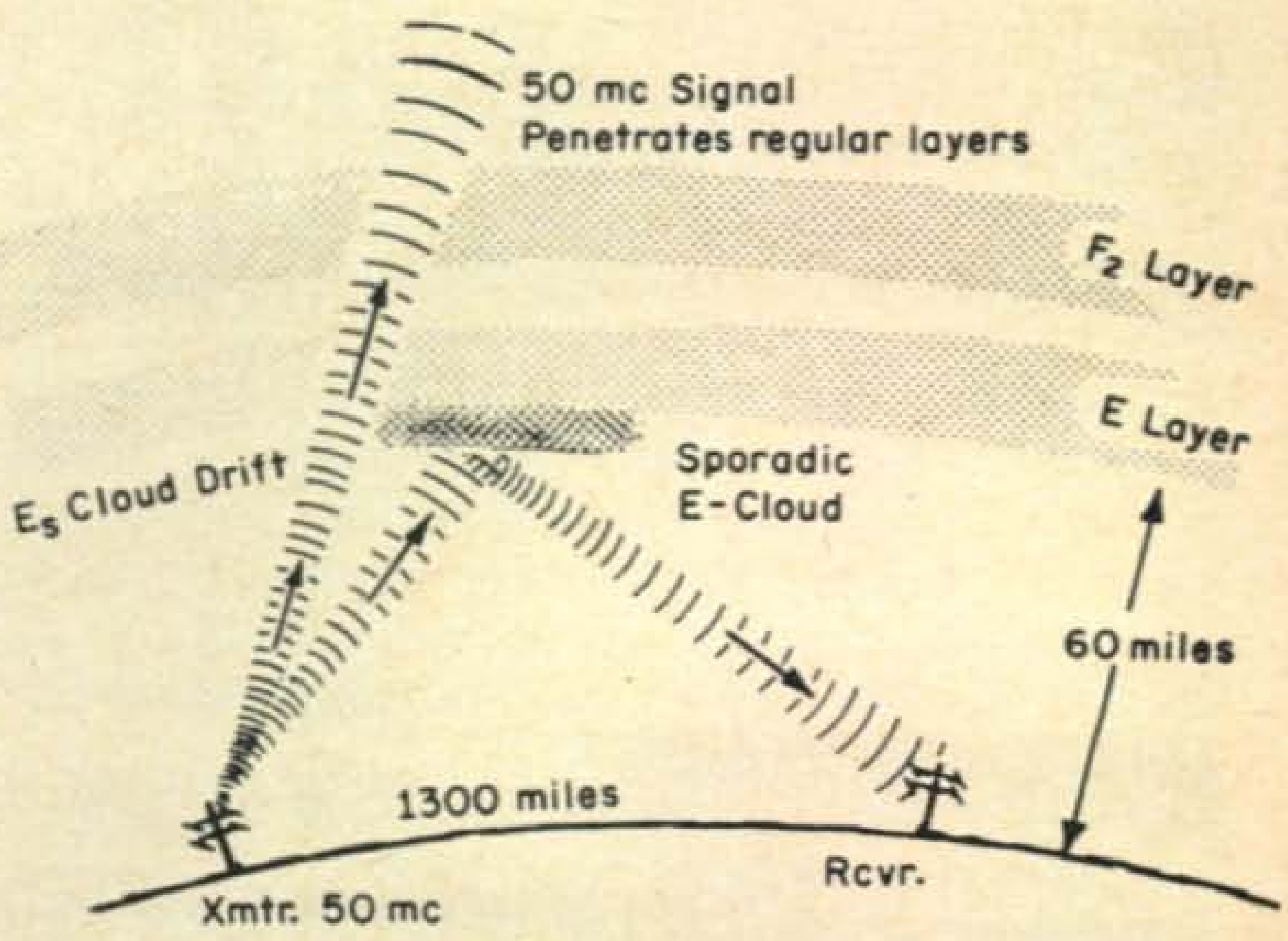

Fig. 1—50 mc short-skip propagation by means of sporadic-E reflection.

*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11050.

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regular E or F layers. These clouds usually cover a rather small geographical region, approximately 50 to 100 miles in diameter. They occur more or less at random and are relatively short lived, usually dissipating within a few hours. This *sporadic* ionization generally occurs about 60 miles above the earth's surface, at about the same height as the regular E layer. For this reason it is called *sporadic-E* ionization, or Es.

As a result of an intensely ionized sporadic-E cloud, it is at times possible to communicate over relatively long distances on the 50 mc band, and on some occasions on 144 mc as well (See fig. 1).

The height at which sporadic-E ionization occurs limits one-hop propagation to a maximum distance of approximately 1300 miles. During periods of widespread Es ionization, two-hop propagation may sometimes be possible up to distances of approximately 2400 miles. Band openings due to Es are often referred to as *short-skip* openings for this reason.

Reflection from sporadic-E clouds takes place with very little signal loss, resulting in exceptionally strong signal levels during most openings, even when very low power levels are used. Quite often it is possible to maintain communications considerably off the great circle path between two stations by means of back and side scatter from sporadic-E clouds. For example, a station in eastern New York State may work another station in the central part of the State by both stations pointing their antennas toward a common Es cloud, say for example, located over Georgia.

Sporadic-E ionization varies diurnally, seasonally and geographically. It occurs most frequently, and with greatest intensity, in polar and equatorial regions. In mid-latitudes, for example in the United States and Europe, it occurs most often during the late spring and summer months and during December, and has a tendency to peak during the late morning hours and again about sunset, although it can occur at any time.

In equatorial regions, Es is essentially a daytime phenomenon, with little seasonal variation. In polar regions, sporadic-E occurs most frequently during the nighttime hours, and again there is little seasonal variation, except for somewhat of an increase during the spring and fall.

Sporadic-E ionization is subject to erratic and often rapid variation. The ionized clouds are known to drift, generally in a westerly or northwesterly direction, at approximately 150 to 250 miles per hour. The drift appears to be due to winds that are believed to exist in the ionosphere. Because of this drift, reception areas can change within a relatively short period of time, and it is not uncommon for a sporadic-E opening to fade out completely from an S-9 plus level in a matter of a few minutes.

While the relationship between Es and the sunspot cycle is not yet fully understood, it appears that Es occurs somewhat more frequently in mid-latitudes as the solar cycle *declines*. If this is true, sporadic-E propagation on 50 mc is likely to be more prevalent during the next several years.

What causes sporadic-E ionization is not yet fully known. Since it occurs more often during the hours of daylight, it seems that ultra-violet radiation might play some role in its formation. Since it also occurs at night, especially in polar regions, auroras and meteor trails are other suggested possible sources of ionization. More recent theories indicate that the ionization might be caused by shearing forces associated with rapid wind movements in the ionosphere.

Since little is known about the ionizing sources for Es, its behavior cannot be predicted by positive means at the present time. Statistical studies show, however, that a sharp increase takes place at mid-latitudes during the late spring and summer when short-skip openings up to distances of about 1300 miles should be possible on the 50 mc band between 5 and 10% of the time, during the daylight hours. Occasional openings up to approximately 2400 miles may also be possible on 50 mc, and up to 1300 miles on 144 mc. The optimum time for v.h.f. short-skip openings is between 8 and 11 A.M. and 6 and 8 P.M., local standard time.

Here's a useful tip for predicting 50 mc *short-skip* openings. The geometry of propagation is such that as the skip distance *decreases* on the 28 mc band, the highest frequency that will be

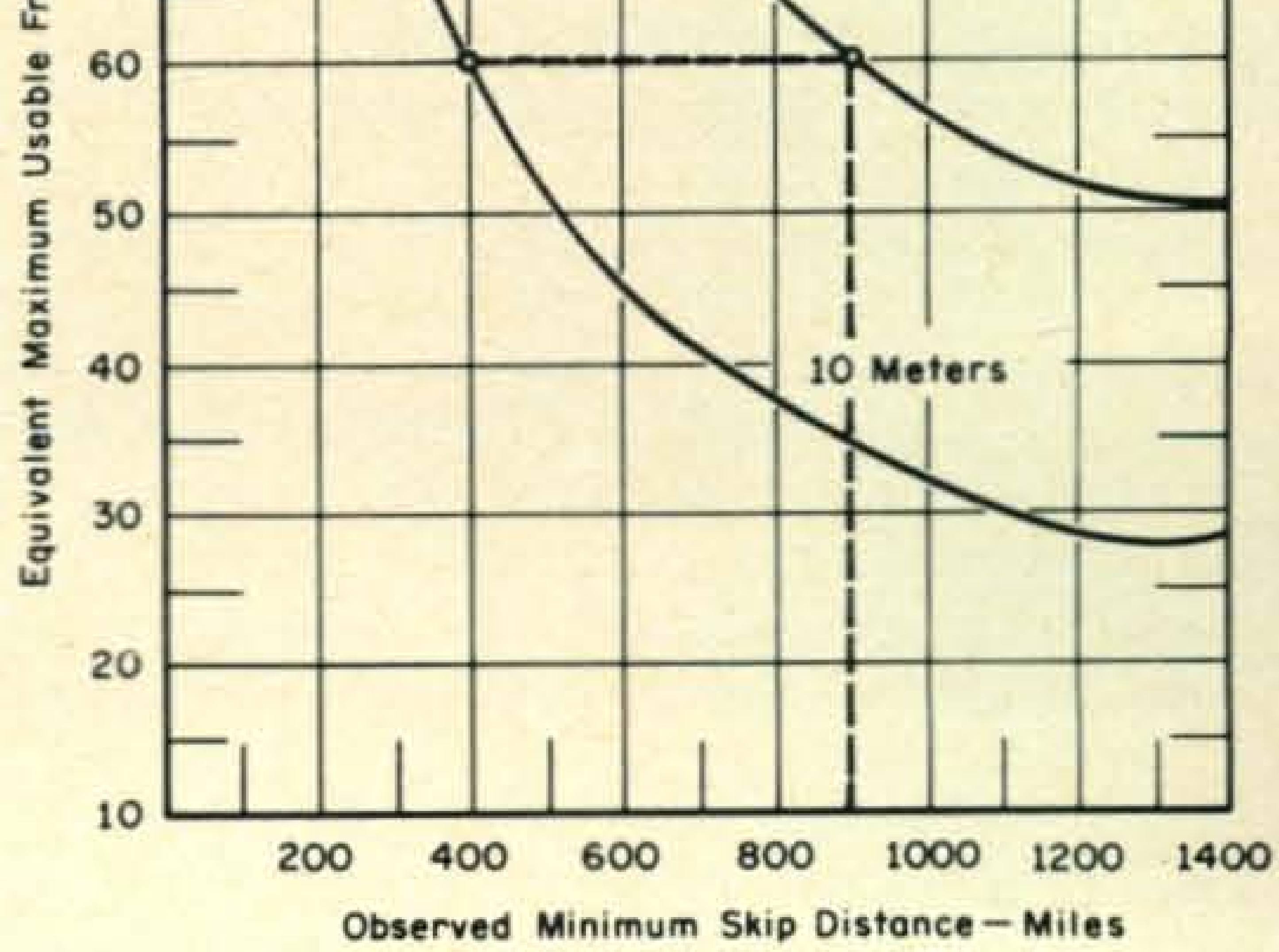

Fig. 2—Chart describing correlation between sporadic-E openings on the 10 meter amateur band and possible 6-meter openings at the same time. The example shows a minimum skip distance of 400 miles observed on 10 meters; from the chart 6 meters should be open with skip greater than 900 miles.

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reflected by a sporadic-E cloud is *increasing*. By observing the *minimum* skip distance heard on 28 mc during an Es opening, and using the chart shown in fig. 2, it should be possible to tell whether or not 50 mc is open, and what the skip distance might be.

For example, if the minimum skip heard on 28 mc in a south westerly direction is observed to be 400 miles (it's the distance to the *nearest* skip station heard that counts, not others), from fig. 2 the intersection between 400 miles and he 28 mc curve corresponds to an muf of 60 mc. This means that 50 mc short-skip openings in a south-westerly direction is very likely. The minimum skip distance that can be expected on 50 mc can be found from fig. 2 by locating the intersection between 60 mc and the 50 mc curve. The resulting distance is found to be 900 miles. A useful rule of thumb to remember is that when skip stations are heard less than *500 miles* away on 28 mc, the chances are very good that 50 mc will open in the same general direction.

Auroral Ionization

Corpuscular radiation, consisting of charged particles emitted time-to-time from the sun's surface (usually from solar flares), bombard the atoms and molecules of the gases present in the rarified atmosphere at the extremities of the earth, causing them to ignite, forming an auroral display.

Of all natural phenomena, auroras are probably the most breathtaking and spectacular. They arc across the night sky as weird, yellowish-green, dancing ribbons and violently throbbing rays, or as great draperies folding and unfolding. Some of the rarer displays may also contain shades of red and purple. They occur at E layer height in the ionosphere, about 60 miles above the earth's surface, and can be seen obliquely from the ground for distances up to about 600 miles from the zenith point (See fig. 3).

Observations made over the past 100 years, and intensified during the past decade with investigation by high flying airplanes and satellites, have defined areas of the world where auroras occur most frequently. The zones of maximum occurrence, where they are seen on approximately 250 nights a year, are belts about 23 degrees wide centered on the northern and southern magnetic poles. In the northern hemisphere, the zone arcs across northern Alaska, central Canada, the southern tip of Greenland and Iceland, the northern tip of Norway, and the northern coast of European Russia and Siberia.

Auroras are seen less frequently as one proceeds south of this zone. In the northern areas of the U.S. mainland, they are seen between 10 and 40 nights a year, while in southern states several years may pass before one is seen.

Auroras play havoc with shortwave communications. The excessive ionization which causes auroras also causes severe signal absorption. As a result, an aurora acts like a screen, shielding shortwave transmissions from passing through. For this reason, trans-polar communication from the United States is extremely difficult and often unreliable. The presence of auroral effects on propagation can frequently be detected by a unique fading component, consisting of a low frequency "flutter" of from 100 to 1000 c.p.s. which the aurora superimposes on a signal. During intense auroral activity, this fading component is often strong enough to render a voice signal unintelligible.

There is a very close relationship between ionospheric storms and the occurance of auroras. During storms, the zones in which auroral effects are most pronounced expand and move southward. The more severe the storm, the further south the affected area. During great storms auroras have been seen as far south as Cuba, virtually blacking out shortwave communications throughout the entire northern hemisphere.

While auroral displays can seriously disrupt communications on the amateur h.f. bands, propagation on 50 and 144 mc often *improves* during these periods. Ionization associated with an aurora is often intense enough to reflect or scatter 50 and 144 mc signals over distances up to about 1300 miles, when propagation over these paths by other modes may not be possible.

Auroral ionization varies rapidly in intensity and height. This often causes severe multipath distortion on v.h.f. signals reflected from an aurora. Voice modulation is often unintelligible on 50 mc signals, and nearly always on 144 mc. While voice communication may sometimes be possible using s.s.b., experience has shown that keyed c.w. is the most effective way to communicate under these conditions

While auroras may occur at any time of the year, they take place most frequently during the fall and spring months, usually peaking during March and September. A secondary peak takes place during the winter months, with the fewest number occurring during the summer.

Geographically, the more northerly the latitude, the greater the number of v.h.f. auroral

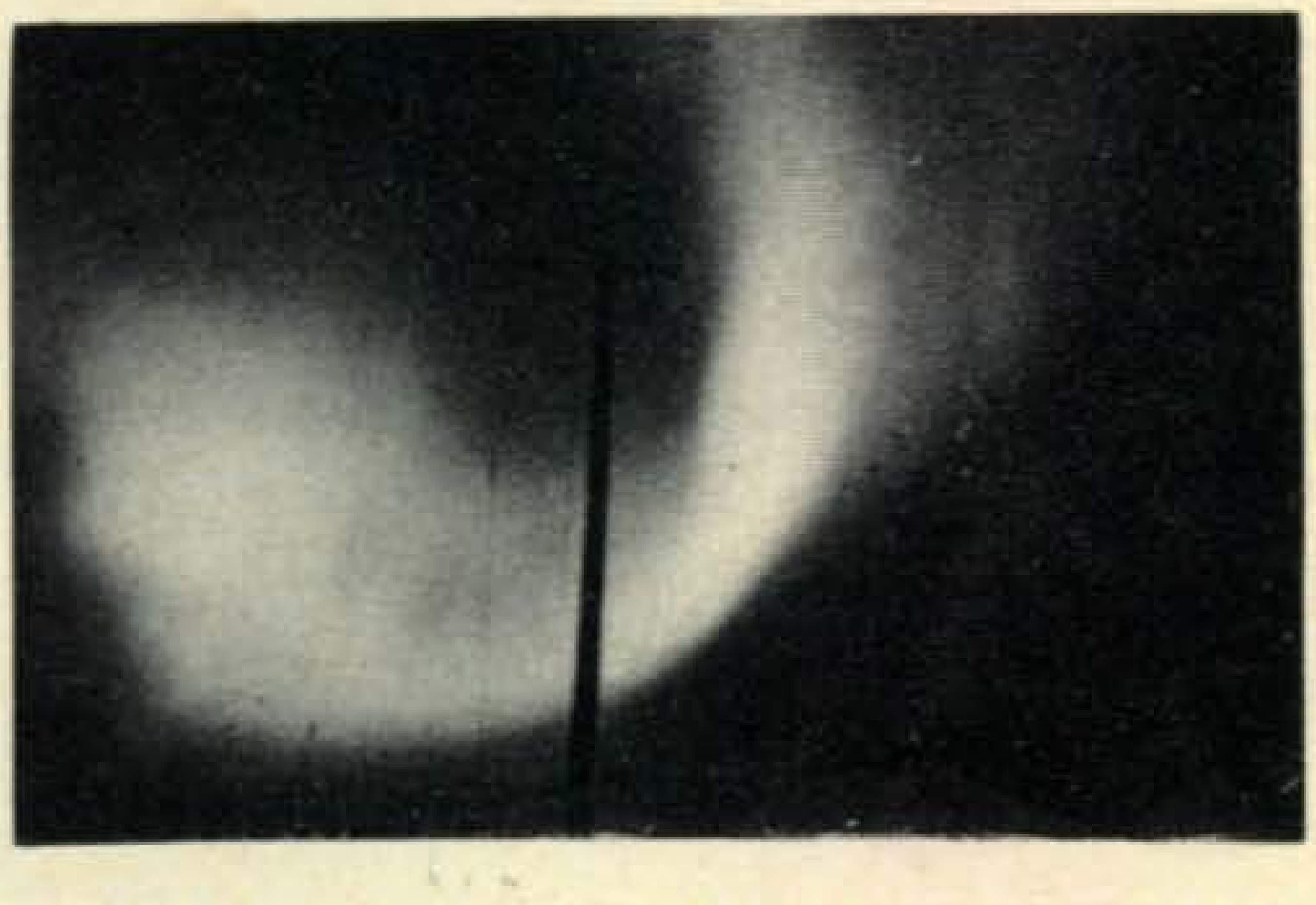

Fig. 3—A brilliant aurora of the type associated with ionization intense enough to reflect 50 and 144 mc signals between 300 and 1300 miles.

openings. In the U.S., the northern tier states are favored with fairly good openings between 50 and 75 days a year. In the central states openings may occur between 10 and 35 days a year, while considerably fewer occur in the southern tier states.

While auroral displays can be seen visibly only during the hours of darkness, their radio affects are felt during the daylight hours as well. Most v.h.f. openings begin during the late afternoon and early evening hours, lasting from several minutes to several hours. During prolonged ionospheric storms, auroral openings may occur and re-occur several times throughout a day, for several days in a row. Communication by means of auroral reflection can take place over distances between approximately a few hundred to a thousand miles, with some approaching the geometrical maximum of 1300 miles.

Since auroras occur in northern areas, *north* is the optimum antenna bearing to establish communications by this propagation mode. Once communication is established, antennas should be rotated slowly to maximize signal reflection or scatter from the auroral ionized regions.

Since most auroras are produced by solar flares, they occur most frequently two or three years after a peak in solar activity has been reached, when flares are most numerous, and they taper off gradually thereafter, occurring infrequently during periods of minimum solar activity. With the peak of the present sunspot cycle occurring a year ago, a maximum number of v.h.f. auroral openings are expected during the next year or two.

Since v.h.f. auroral openings often coincide with ionospheric storminess, the best times to check for these openings are during periods when the ionosphere is predicted or expected to be disturbed. Warnings of v.h.f. openings may be had by carefully monitoring reception on the h.f. bands. When an ionospheric storm is noted, usually by erratic or flutter fading on signals, or a lack of signals, auroral openings may be possible on the 50 and 144 mc bands.

Meteor Ionization

Meteors, or shooting-stars as they are often called, are particles of mineral and metallic matter which are continually entering the earth's atmosphere from outer space. It has been computed that hundreds of millions of meteors, most of them microscopic in size, enter the earth's atmosphere every 24 hours. This figure increases many fold during certain times of the year, when meteor showers occur.

As large meteors enter the earth's atmosphere at velocities of up to 50 miles per second, the intense heat generated by friction with the upper air causes them to leave an ionized trial behind as they burn some 30 to 100 miles above the earth. This ionization is often intense enough to reflect or scatter v.h.f. signals over distances of several hundred miles. Signals reflected by meteor ionization can be identified by the very short, sudden bursts in signal strength that take place when the ionized trail passes through the path of the signal. The signal increase, on the order of 20 to 40 decibels, is sharp and sudden, lasting for a few seconds then gradually decreasing. A burst may last from a few seconds to a half minute or so before fading into the background signal or noise level. A Doppler shift may also often be noticed on signals reflected from meteor trails. This is caused by the rapid motion of the reflecting point. In some cases the shift can amount to as much as 2 kc and last for several seconds.

Meteor reflected signal bursts are of little communication value unless they occur frequently enough, or are of sufficient duration to permit the transmission of some information. A 50 mc signal may appear as a few readable words, while on 144 mc the burst is usually shorter, often being nothing more than a ping. At this rate, even during major meteor showers, it requires a great deal of time and patience to transmit information between two stations. For this reason, high keying speeds are preferable to voice transmissions, although the exchange of voice information may at times be possible on 50 mc, especially when using voice-controlled s.s.b.

During a typical 24-hour period between 300 and 500 meteor reflected bursts lasting five seconds or longer can be counted on 50 mc. Approximately 25% of these will last from between 10 and 30 seconds, and occasionally one may last considerably longer. A great number of bursts will be heard on 28 mc and the lower frequency bands and considerably fewer on 144 mc and higher frequencies.

While meteors may occur at any time, most of them enter the earth's atmosphere between

Shower Name	Date of Peak Intensity	Shower Duration (Days)	Number of Meteors per Hour
Quadranids	January 3	1	35-40
Lyrids	April 21	2	12-15
Eta Aquarids	May 5	9	12-20
Delta Aquarids	July 29	10	20-30
Perseids	August 12	5	50
Orionids	October 21	4	20-25
Taurids	November 5 & 12	20	12-15
Leonids	November 17	4	20-25
Geminids	December 13	5	40-50
Ursids*	December 22	2	15

*Peaks during the early afternoon hours, all others peak during the hours of darkness.

Fig. 4—List of major meteor showers. The dates given are approximate, and the intensity of various showers may vary from year-to-year. About 20 other showers of less intensity also occur during the year; 7 between January and June, 13 between July and December.

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midnight and dawn, peaking between 5 and 7 A.M., local time. Since ionized meteor trails occur at an average height of 60 miles, the optimum communication range is approximately 800 miles, with maximum range about 1300 miles. Seasonally, considerably more meteors occur during June and July than at any other time, with a minimum number occurring during January and February.

From time-to-time, on a regular basis, the earth moves through areas in space in which there are very large swarms of meteors. During such periods, called *meteor showers,* meteors enter the earth's atmosphere with more than average frequency. During many showers meteors will appear at the rate of one to two each minute and during certain very large showers, many thousand may be observed during a single night. The possibility for 50 and 144 mc communication by means of ionized meteor trails increases considerably during meteor showers.

Figure 4 lists the major showers, the dates they occur and the average number of meteors that will probably enter the earth's atmosphere each hour during these periods. While meteor burst communication can be quite difficult, requiring a great deal of time and patience to move a small amount of information, it does provide a means for intermittent ionispheric communication on the v.h.f. bands over distances of between approximately 800 and 1300 miles.

Trans-Equatorial Scatter

Strong 50 mc band openings can occur, particularly during periods of moderate and high solar activity, over long north-south paths spanning the magnetic equator at times when the expected maximum usable frequency is considerably lower for the paths involved. These are called trans-equatorial or TE openings.

TE propagation was first observed by radio amateurs during the intense solar period of 1947. They also have pioneered into this propagation mode during subsequent periods of moderate and high solar activity.

In the western hemisphere the magnetic equator lies approximately 20 degrees south of the geographical equator and roughly follows an arc extending from Lima, Peru to Recife, Brazil and passing through La Paz, Bolivia. The optimum distances for TE openings range between 1500 to 2500 miles above and below the magnetic equator. Typical TE paths of high reliability are Puerto Rico to Argentina, Japan to Australasia, Southern Europe to Zambia, etc.

TE propagation is believed to be due to a highly ionized bell-shaped distortion known to exist in the ionosphere over the magnetic equator. Radio signals entering this area at a favorable angle are reflected considerable distances between the sides of the bulge in much the same manner that a ball rebounds off the sides of a billiard table. This may result in a long single hop opening, without intermediate ground reflection, of up to 5000 miles.

TE openings occur most often during periods of moderate and high solar activity, and hardly at all during the remainder of the cycle. Although they may occur during any season, TE openings peak during the spring and fall months. TE is a nighttime propagation phenomenon, with most openings occurring between 8 and 11 P.M., local time at the path mid-point.

Signals must cross the magnetic equator in a north-south direction, or TE openings will not take place. A right angle crossing is optimum, but TE contacts have been reported between stations as much as 20 degrees off from a right angle crossing.

The TE maximum usable frequency is approximately 1.5 times greater than the daylight m.u.f. observed on the same path Thus 50 mc TE openings may be expected during the evening hours when an m.u.f. of 34 mc is observed during the daytime. TE openings may often occur on 50 mc when propagation is not possible on lower frequency bands on the same path, at the same time

In the western hemisphere 50 mc TE openings occur almost every night during the spring and fall months over an area extending from Mexico City in the north to southern Chile and Argentina in the south. Within this area there is little variation in signals from night-to-night and reliability is high. Less frequent openings extend into the southern and central areas of the United States, with openings falling off rapidly at greater distances to the north.

Serious flutter fading is often noted on shorter path TE openings, but voice readability is seldom seriously impaired on longer path openings.

The 144 mc band is too high in frequency for TE propagation.

Ionospheric Scatter

When a frequency is at or below the muf, ionospheric propagation takes place by reflection from the ionized layers existing in the earth's atmosphere. Signals strike the ionosphere obliquely and are normally reflected in a *forward* direction. When the signal is above the muf, it will penetrate the ionosphere, with a very small amount of energy scattered back towards the earth in more or less *random* directions. The mechanism involved in ionospheric scattering is not yet fully understood, but it is believed to be due to roughness in the ionosphere *and may involve* the earth's magnetic field in a complex manner. Scattering may take place from any of the ionospheric layers.

Until the post-war introduction of super sensitive receivers, advances in modulation techniques and in antenna design, scattered signals were of little communication value. With high gain antennas, high transmitter power and a good receiver, scatter openings are often ob-

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Propagation Mode	V.h.f. Bands Prop. Possible	Latitude Zone Peak	Time of Day Peak	Seasonal Peak	Optimum Sunspot Period	Communication Distance-Miles	Band Opening Period	Signal Characteristics
Regular F-layer reflection	50 mc	Temperate	Daytime	winter	High	E-W paths 1800-3600 N-S paths 1800-6000	Several minutes to an hour or more	Exceptionally strong
	50 mc	Low, Equatorial	Afternoon to late evening	spring & fall	High	E-W paths 1800-3600 N-S paths 1800-6000	Several minutes to an hour or more	Exceptionally strong
Sporadic-E	50 & 144 mc	High, Polar	Night	spring & fall	High & Moderate	300-1300	Several minutes to an hour or more	Weak to strong with some flutter fading
	50 & 144 mc	Temperate	Before noon & early evening	late spring & summer	All	800-2400 on 50 mc 1100-1300 on 144 mc	Several minutes to an hour or more	Exceptionally strong
	50 & 144 mc	Equatorial	All day	All seasons	All	800-2400 on 50 mc 1100-1300 on 144 mc	Several hours to a complete day	Strong with flutter fading
Auroral Ionization	50 & 144 mc	High & Temperate	Late afternoon & early evening	spring & fall	High & Moderate	300-1300 miles	Several minutes to an hour or more	Weak to moderately strong, with strong flutter fading. Voice badly distorted, c.w. recommended
Meteor Ionization	50 & 144 mc	All	Night & early morning	June & July & during specific shower periods	All	800-1300	Several seconds to a half minute or so per burst	Strong bursts High speed c.w. recommended
Trans-Equatorial	50 mc	Low & Temperate	Evening through midnight	Spring & Fall	High & Moderate	2400-5400	From one to several hours	Weak to moderately strong, with some flutter fading at times
Ionospheric Scatter	50 mc	Low & High	Evening through midnight	Spring & Fall	High & Moderate	600-2400	A few minutes to several hours	Weak, fluttery signals

◀ Fig. 5—Characteristics of v.h.f. ionospheric propagation modes.

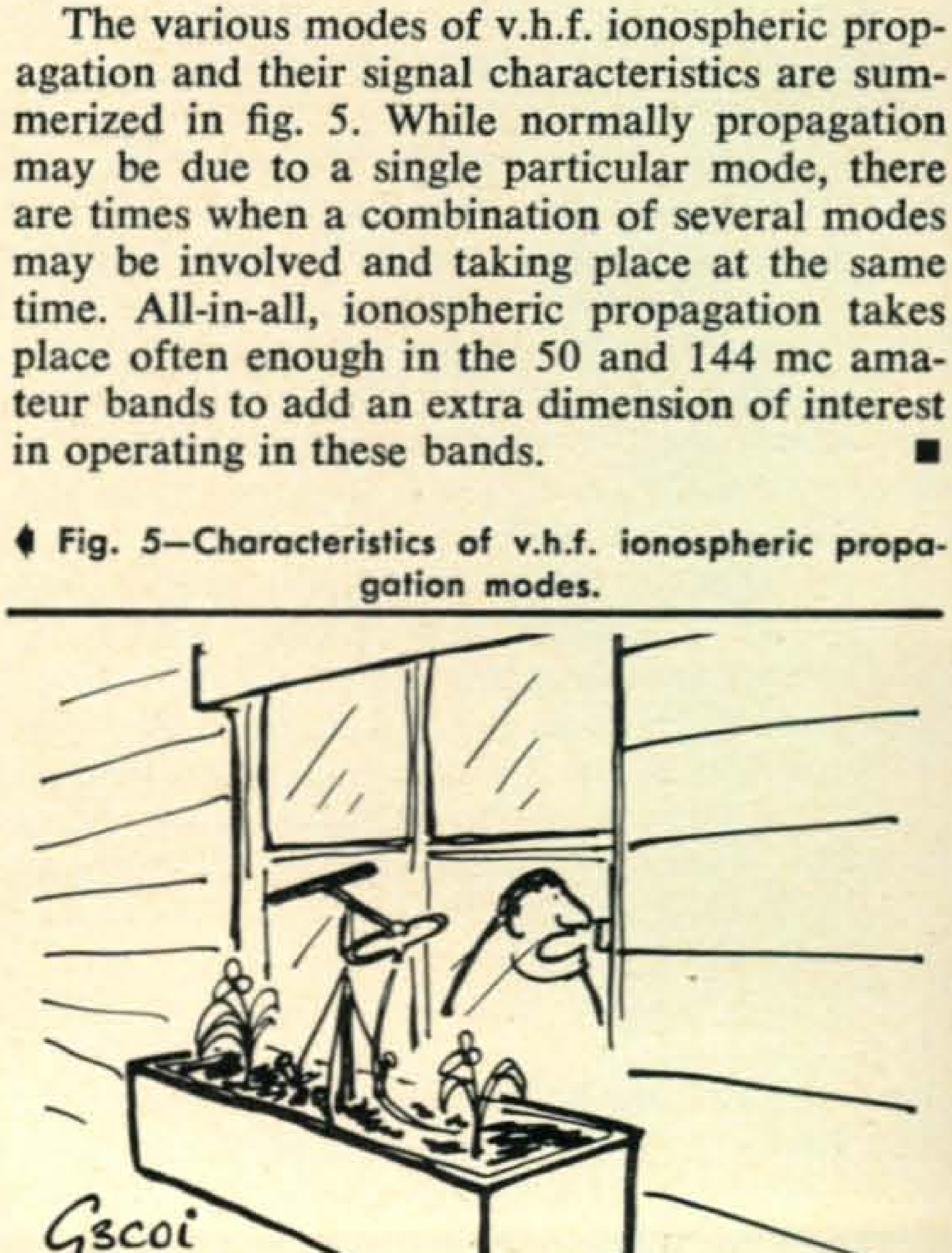
served on 50 mc, when this frequency is considered above the regular muf. Because only a very small part of a signal's energy is returned to earth by scatter, such signals are extremely weak and fluttery and marginal communications is possible at best.

Scattering appears to occur most often from ionospheric regions in the vicinity of the magnetic equator. In northern and temperate regions ionospheric scattering increases considerably with increases in magnetic activity and during ionospheric storms. While 50 mc scatter openings can occur at any time, they seem to peak during the evening hours of the spring and fall months, during periods of high and moderate solar activity.

To communicate by means of forward scattered signals, it is usual for both stations to direct their antennas at each other along the great circle path. To communicate by means of back scattered signals it is often best to orient both antennas at the apparent point of scatter, which may be considerably off the great circle path. This point can best be determined by slowly rotating until signal strength is maximized.

Signals scattered in a forward direction from the D and E layers may permit 50 mc openings over distances between approximately 600 and 1200 miles, while openings over considerably greater distances may be possible with signals scattered by the F layers. Backscattered signals may often permit 50 mc ionospheric communication between stations separated by relatively small distances.

The various modes of v.h.f. ionospheric propagation and their signal characteristics are summerized in fig. 5. While normally propagation may be due to a single particular mode, there are times when a combination of several modes may be involved and taking place at the same time. All-in-all, ionospheric propagation takes place often enough in the 50 and 144 mc amateur bands to add an extra dimension of interest in operating in these bands. ■



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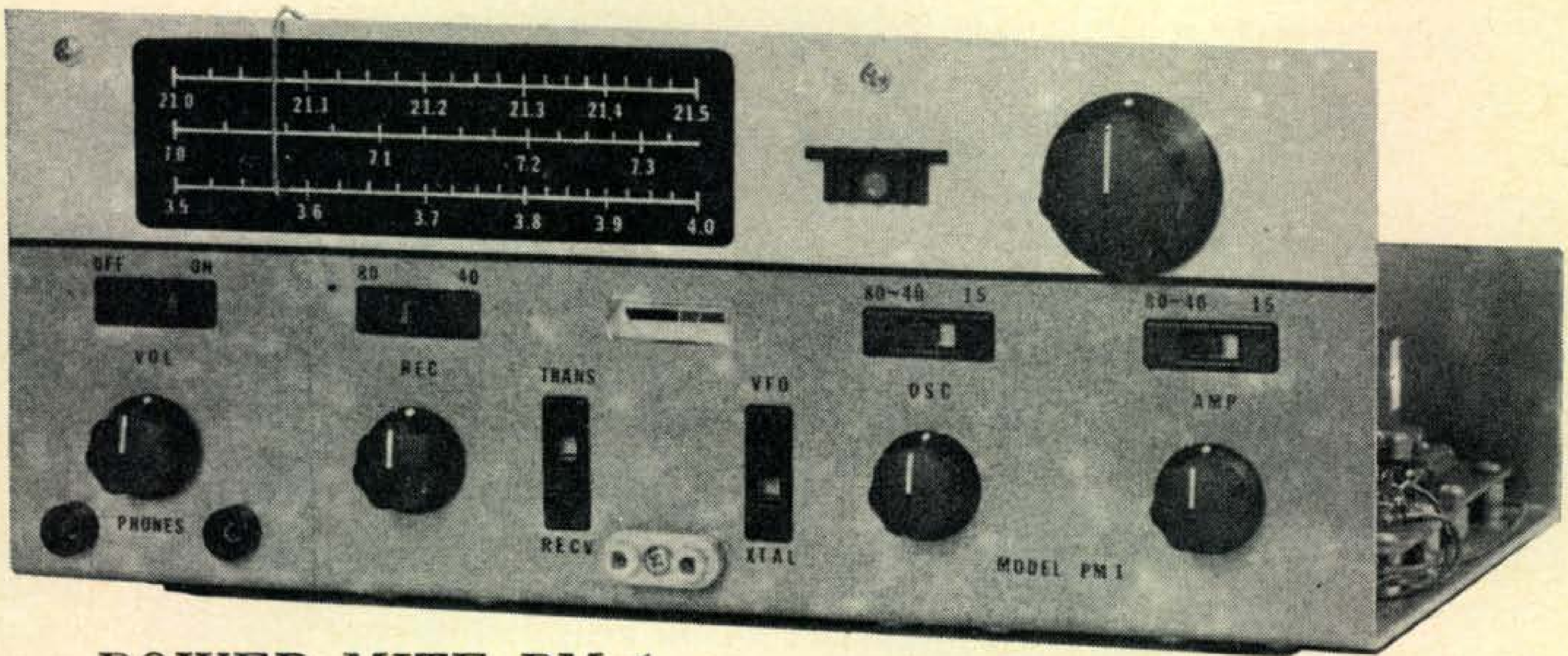

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A Sunspot Story– Cycle 20: The Declining Years

BY GEORGE JACOBS, W3ASK and STANLEY LEINWOLL*

The present sunspot cycle, the 20th observed since records have been kept, reached its peak a year ago and is now declining. In this article the authors explain and discuss sunspots, the sunspot cycle, its influence on shortwave propagation, and how to predict cycle behavior. They give their prediction of solar activity for the remainder of the present cycle, which they expect will reach a minimum during 1975.

ALTHOUGH no completely satisfactory theory as to what sunspots are, or what causes them, has as yet been advanced by scientists, numerous scientific studies undertaken during the past fifty years have shown that these large craters on the sun's surface have a direct influence on shortwave radio conditions.

Figure 1 is a photograph of the sun taken at the U.S. Naval Observatory in Washington, D.C. The sunspots appear as black spots on the solar surface. Figure 2 is an unprecedented close-up of a sunspot embedded in the solar surface.

Sunspots almost always appear in groups. The groups may range in size from small clusters of tiny specks a few hundred miles in diameter, to enormous groups stretching nearly a quarter of a million miles across the sun's surface, and containing individual spots as large as 80,000 miles in diameter . . . an area into which several planets the size of the earth could easily disappear!

Sunspots, although embedded in the sun's surface, appear to move in an east to west direction as the sun rotates. If a spot is born on the side of the sun out of view from the earth, it will first become visible as it crosses the sun's eastern edge. It will then drift westward across the visible face of the sun, and disappear out of sight behind the western edge in slightly more than 13 days, which corresponds to half the period of rotation of the sun. The spot then enters the hidden side of the sun, where it may remain for

*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11050.

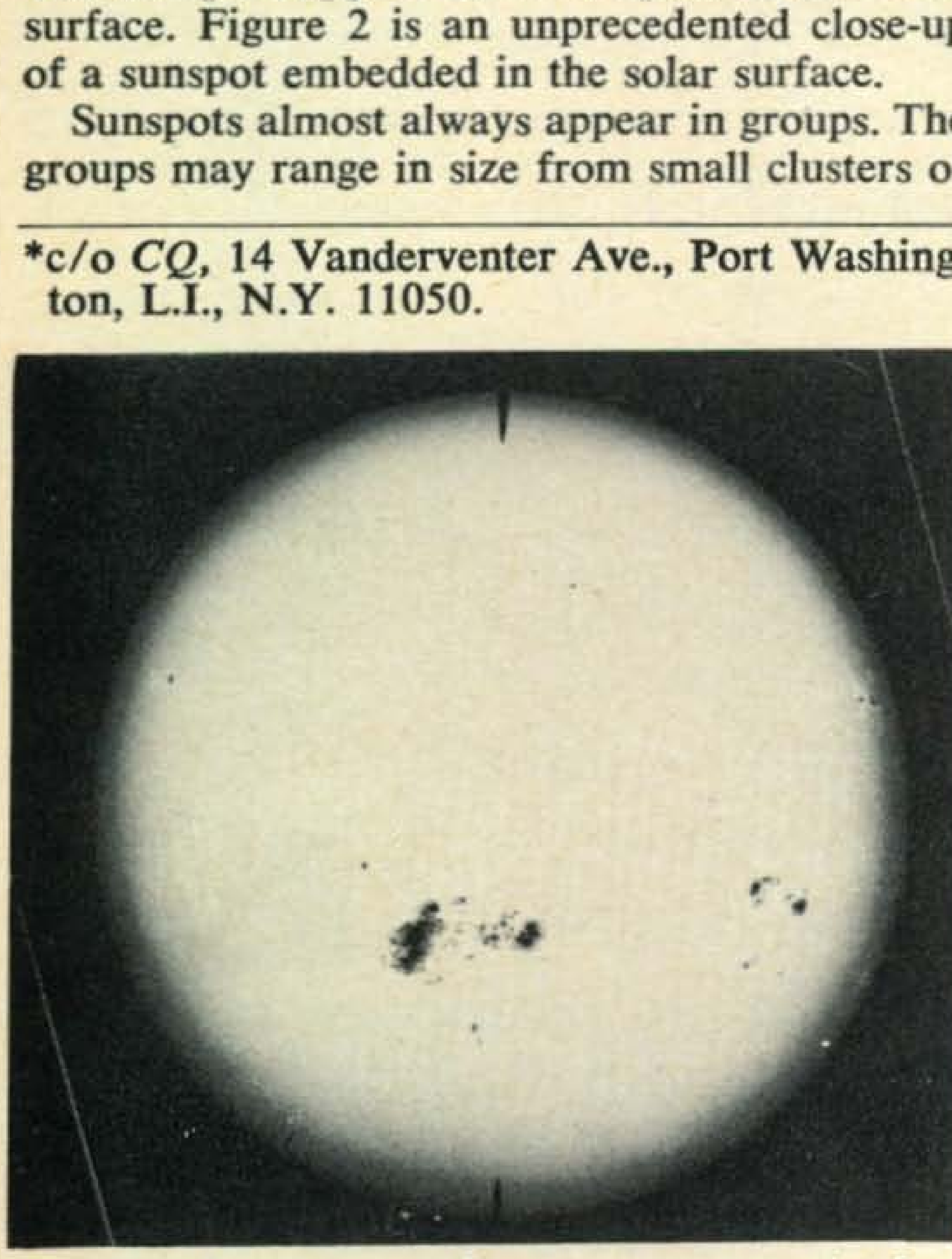

Fig. 1—A large group of sunspots seen on the face of the sun. The sunspots move from the east limb of the sun towards the west, as the sun rotates. *(Official U.S. Navy Photo).*

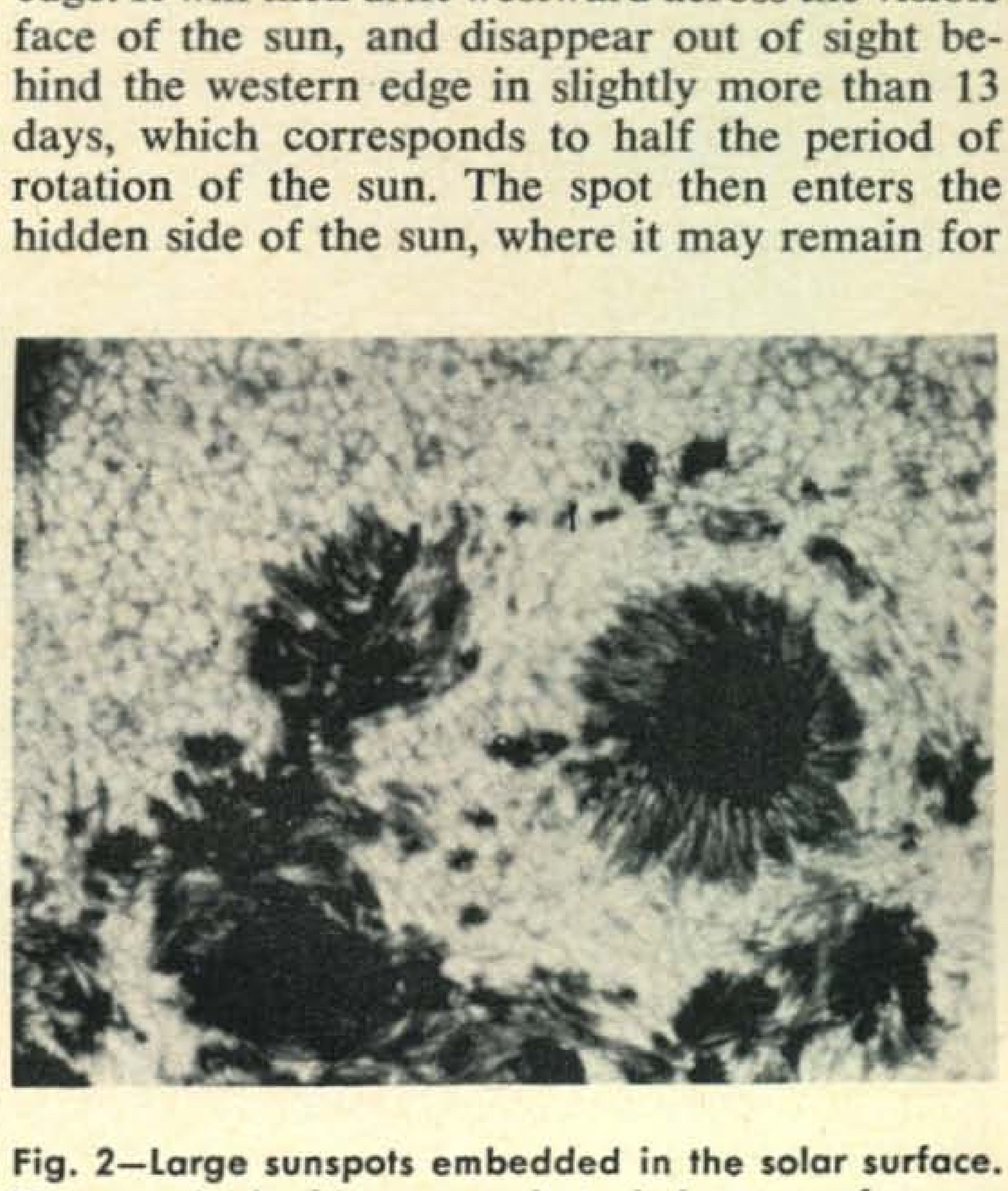

Fig. 2—Large sunspots embedded in the solar surface. Photographed with unprecedented sharpness from an unmanned research ballon *at an altitude of 80,000* feet. The granular composition of the sun's surface can be seen clearly. *(Official National Science Foundation Photo).*

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the duration of the 27-day solar period.

The lifetime of a sunspot, or sunspot group, varies from a few days to several months. Larger sunspots often are visible during several solar rotations, reappearing at the eastern edge of the sun approximately every 27 days. For this reason, many terrestrial phenomena which are believed to be influenced by sunspots tend to recur at intervals of about 27 days.

High Flying Animal or Electro-Magnetic Eruption?

History vagely records that sightings of sunspots before the invention of the telescope, if they drew any explanation at all, were usually thought to be either slow high flying animals, or far away clouds. When the Jesuit friar Joseph Scheiner, one of the first specialists in solar research saw his first sunspot with an early telescope in 1611, his fellow astronomers called it a stain on the lens of the telescope!

It was in fact Galileo, inventor of the telescope in 1610, who offered the first serious explanation of sunspots. In 1613, he wrote:[1]

"Having made repeated observations, I am at last convinced that the spots are objects close to the surface of the solar globe, where they are continually being produced and then dissolved, some quickly and some slowly; also that they are carried around the Sun by its rotation, which is completed in a period of about one lunar month. This is an occurrence of the first importance in itself, and still greater in its implications."

In this explanation, elementary as it was, Galileo was far nearer the truth than many of his successors, during the next 300 years.

During the 18th and 19th centuries, various explanations were given for sunspots by noted astronomers. Some considered sunspots to be cold mountain peaks towering above the luminous surface of the sun; others, believing that a fiery, luminous cloud surrounded the sun, thought sunspots to be holes in this solar cloud, caused by hurricanes, through which could be seen the cool of the sun!

One of the most significant discoveries concerning sunspots took place in 1908. Using his newly invented spectro-heliograph, Dr. George E. Hale of the Mount Wilson Observatory in California, photographed certain characteristics of the sun for the first time. From these, he was able to demonstrate that large sunspots are frequently engulfed in whirling masses of gas, or vortices.

Six years later, in 1914, Dr. Hale made another remarkable discovery, proving that magnetic fields, often more powerful than the magnetic field surrounding the earth, ocurred at the center of sunspots.

Working with these two important facts, that sunspots are engulfed in whirling masses of gas and are surrounded by magnetic fields, scientists during the past forty years have developed at least a partial explanation for sunspots. Many scientists presently think that sunspots are caused by a strong magnetic field deep within the sun's interior. Tremendous waves of energy generated from this magnetic field eventually break through the sun's surface in a mighty eruption of whirling masses of gas and other electrified material.

The whirlwind of electrified gas produces a strong magnetic field in its center. This imparts a certain amount of rigidity to the cloud of gas, causing the temperature in the vicinity of the magnetic field to drop below that of the sun's surface, resulting in a darkened area, or sunspot.

The Sunspot Cycle

Sunspots are known to have been observed by the Chinese many years before the birth of Christ. But it was not until 1611, one year after the invention of the telescope by Galileo, that permanent records of sunspot activity began. In that year, Galileo and his contemporaries began to draw pictures of the sun's surface by projecting telescopic views upon a white wall or screen. A number of Galileo's drawings of the solar disk made in 1612 still exist, and these show many large sunspots.

It was not until the middle of the 18th century, however, that many European astronomers independently began keeping sunspot records on a regular basis. To one of these, Hendrick S. Schwabe, a pharmacist from Dessau, Germany who engaged in astronomy as a hobby, goes the credit for the discovery of the sunspot cycle.

With the intellectual curiosity characteristic of a true scientist, Schwabe began his work on the sun in the early part of the 19th century, painstakingly counting the spots he saw with his small telescope, day after day and year after year. After several years he observed that the number of sunspots he saw varied over wide limits in a fairly regular manner. During some years he found the face of the sun almost completely free of sunspots month after month. During other years he saw hundreds of spots day after day. After observing the sun on almost every day that the weather permitted for nearly twenty years, Schwabe concluded that sunspots came and went in a periodic fashion, varying from a minimum, from a maximum to a minimum again in about a decade's time. He published his findings in 1843.

Sunspot Numbers

Shortly after Schwabe's discovery, the director of the Zurich Solar Observatory, Rudolf Wolf devised a means for all astronomers to describe relative sunspot activity in terms of a common standard. The Zurich Observatory had been recording sunspot data on a regular basis since 1749, and Wolf realized the great importance of having other observatories and astronomers, who used various types and sizes of telescopes, report their observations according to a common standard.

[1]Galileo, "Three Letters on Sunspots", Academia dei Lincei, Rome, 1613.

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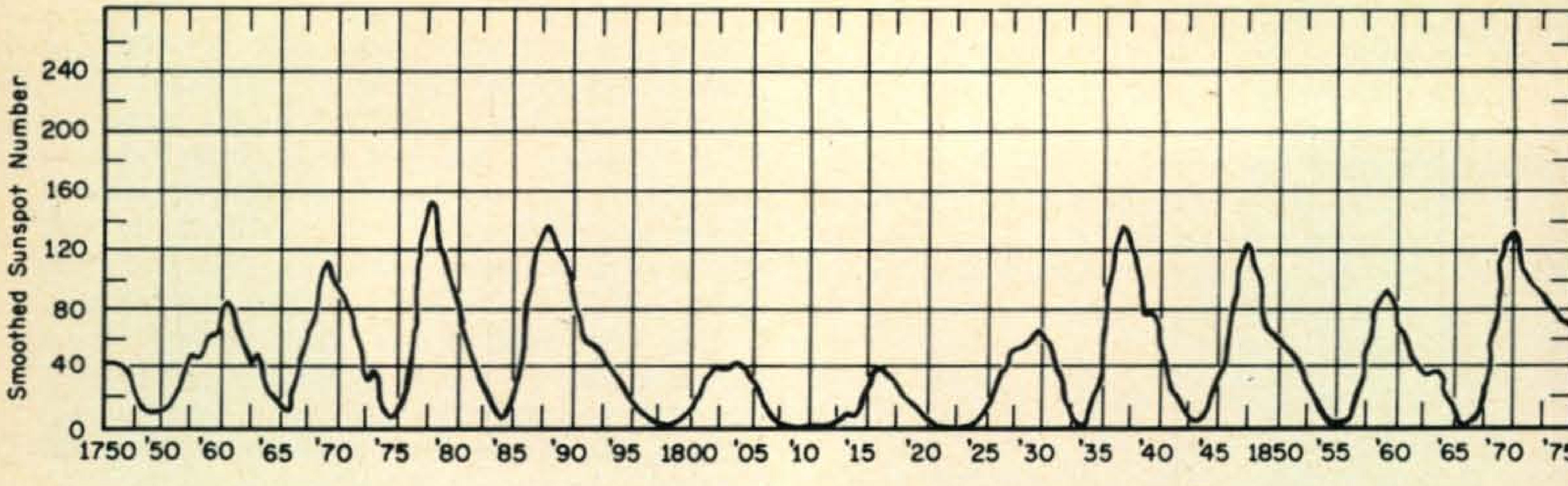

Fig. 3—A plot of all solar cycles recorded since 1750. To date 19

Wolf called his standard a "sunspot number." The sunspot number is obtained from daily solar observations of individual sunspots and sunspot groups, according to the following equation:

$$R = k\ (10\ g + f) \quad (1)$$

where: R is Wolf's relative sunspot number,
g is the observed number of sunspot groups,
f is the total number of sunspots observed, either individually or in groups, and
k is a factor for bringing the observations of many different observers into general agreement, and takes into account the type and power of the telescope used, the viewing conditions, and the individual observer.

The factor 10, which multiplies g, was selected by Wolf in order to give greater weight to the large active sunspot groups, which he intuitively judged to be a more important criterion of general solar activity, than to small spots of short duration.

The Zurich Observatory has been publishing daily sunspot numbers, recorded near mid-day, according to equation (1) since 1849. These have now come to be known as the "Zurich Sunspot Numbers," and represents the official sunspot count upon which sunspot information is based.

The daily sunspot number is subject to considerable day-to-day variation, and little correlation exists between the daily sunspot number and general shortwave propagation conditions. Even the monthly mean numbers are subject to month-to-month fluctuation and do not correlate too well with shortwave propagation conditions.

Experience has shown that a twelve-month running average, or smoothed sunspot number, serves as the best index of general ionospheric and shortwave conditions. The smoothed sunspot number takes into account the monthly Zurich numbers for a twelve month period, tending thereby to give a truer picture of long-term solar activity. It is the smoothed sunspot number, plotted over a long period of time, which exhibits the well known solar cycle variation.

Wolf began publishing daily sunspot numbers in 1849. This effort, since carried out by his successors at the Zurich Observatory, has resulted in a long, unbroken, and very valuable series of solar data over a century's duration. In addition, Wolf, using the sunspot records of earlier observers, reduced to sunspot numbers, data going back to 1749.

Daily and monthly Zurich sunspot numbers are published by the Zurich Solar Observatory. A complete listing of the daily numbers and the monthly average can be received monthly directly from the observatory at the following address: The Zurich Observatory, Eidg. Sternwarte, Zurich, Switzerland.

Monthly average sunspot numbers and the corresponding smoothed values also appear each month in *CQ's* PROPAGATION column.

While sunspots are now under daily scrutiny by the giant telescopes of dozens of solar observatories throughout the world, large ones can often be seen with the naked eye, *provided that a piece of smoked glass, negative film, or some other suitable ray filter is used to protect the eye from serious damage by the sun's rays.*

Occasionally, at sundown, or when haze or light fog obscures the sun's rays, large sunspots may be seen, often accidentially, without the use of a telescope or sun filter. Such was the case in London not long ago, where the Daily Telegraph and Morning Post reported that thousands of persons were able to see two enormous spots on the face of the sun during a foggy sunset. It was, no doubt, due to accidental occurrences of this sort, that history records the sightings of sunspots by the Chinese, Greeks, and Egyptians more than 1000 years before the invention of the telescope.

Sunspot Cycle Behavior

Figure 3, based on smoothed sunspot numbers observed since 1749, shows the cyclic nature of this solar index. In accordance with the Zurich Observatory's cycle numbering system, the cycle which began in 1755 is shown as cycle 1. Since

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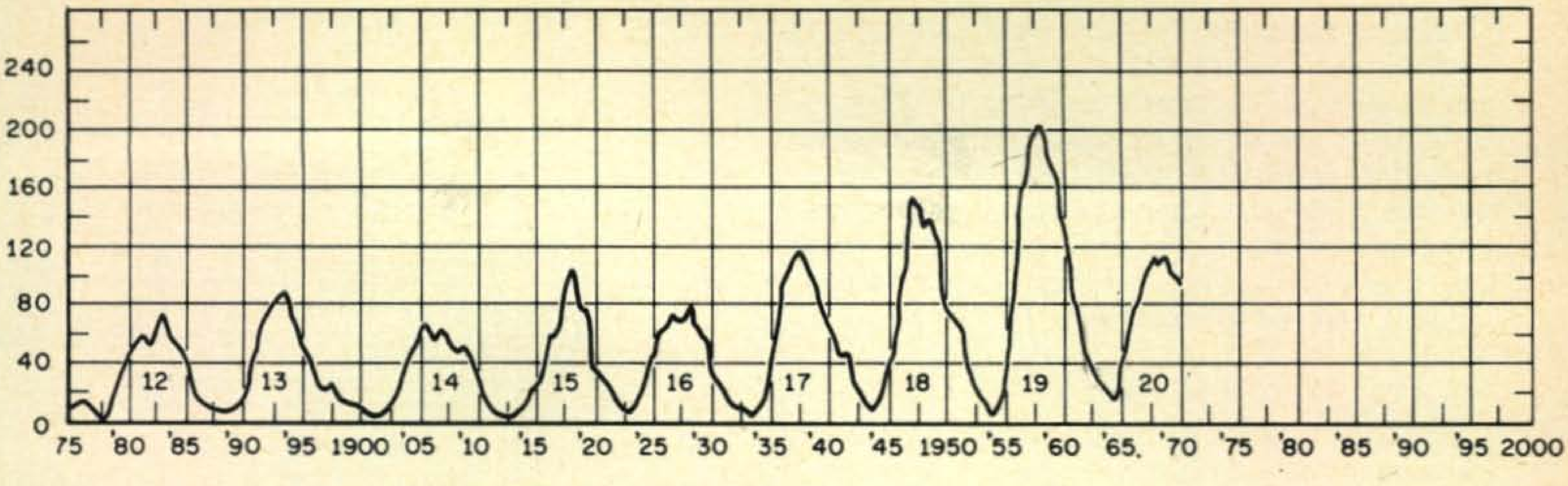

complete cycles have taken place; the 20th is now in progress.

that time nineteen complete cycles have occurred, and the twentieth is now in progress.

Inspection of fig. 3 shows that sunspot activity varies in a periodic manner, resulting in alernate minima and maxima at intervals of several years. The number of years for a complete cycle of activity, from minimum, through maximum, and back to minimum again, varies somewhat with each cycle, but has an average period close to 11 years. For this reason, the variation in sunspot activity is called the 11-year sunspot cycle. It should be noted, however, that no two cycles are exactly alike, and that some cycles have been as short as nine, and others as long as 14 years in duration. The last previous complete cycle, cycle 19, began in April 1954 and ended in September 1964. Cycle 20, the present cycle, began in October 1964 and is still in progress.

The following is a summary of other vital statistics concerning the nineteen complete sunspot cycles observed to date:

1. The cycle begins with a sunspot number between 0 and 11, with 5 as an average value.
2. The ascending period to a maximum value varies between 2.6 and 6.9 years, with 4.1 as the average.
3. The maximum values recorded range between '49 and 201, with 109 as an average.
4. The descending period from a maximum to minimum varies between 4 and 10.2 years, with 6.7 as the average.
5. From minimum to maximum to minimum takes an average of 10.8 years, with the ascent somewhat faster than the descent.
6. The interval between the maxima of two adjacent cycles varies between 7.3 and 17.1 years, with an average of 10.9 years.

Figure 4 shows the average sunspot cycle described by the characteristics summerized above. It must be emphasized, however, that there have been some rather large deviations from these average values in the characteristics of many individual cycles.

Sunspots and Ultraviolet Radiation

From the radio communication viewpoint, perhaps the greatest discovery concerning sunspots was made during the early 1930's when Dr. Edison Pettit and his associates at the Mount Wilson Observatory found a direct relationship between the smoothed sunspot number and the intensity of ultraviolet energy radiated by the sun.

Beginning in 1924, Dr. Pettit undertook daily systematic measurements of the intensity of ultraviolet radiation emanating from the sun. During the years 1924-1928, he found a steady increase in the ultraviolet level as the smoothed sunspot numbers increased. After 1928, when the cycle began to decline, Dr. Pettit observed a corresponding decrease in ultraviolet intensity.

Dr. Pettit's work in this field, and similar measurements made elsewhere in the world, have led to the conclusion that the intensity of ultraviolet radiation reaching the earth from the sun can be measured by the smoothed sunspot number.

Since ultraviolet radiation from the sun is mainly responsible for forming the ionosphere, which makes possible shortwave radio communications over long distances, Dr. Pettit's discovery was of paramount importance because in relating the sunspot number to the intensity of

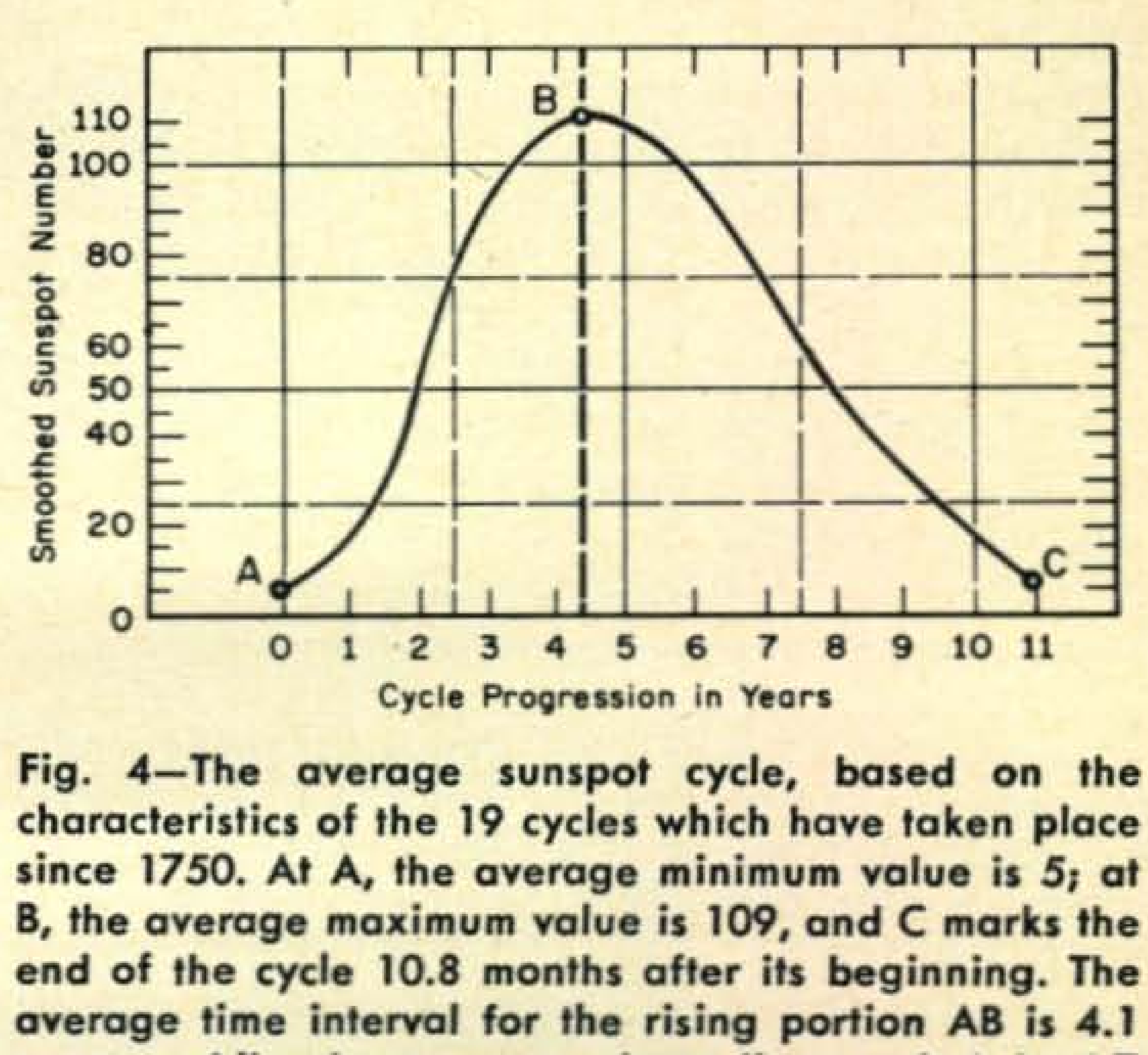

Fig. 4—The average sunspot cycle, based on the characteristics of the 19 cycles which have taken place since 1750. At A, the average minimum value is 5; at B, the average maximum value is 109, and C marks the end of the cycle 10.8 months after its beginning. The average time interval for the rising portion AB is 4.1 years,, while the average decending period is 6.7 years.

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ultraviolet radiation, he was also relating it to the intensity of ionization. The smoothed sunspot number is, therefore, an index of the general level of ionization in the upper atmosphere. Ionization is greatest when the smoothed numbers are high and when the numbers are low, ionization is relatively weaker. To Dr. Pettit goes credit for giving practical importance to sunspots and the sunspot cycle.

Sunspot Cycle Prediction

Since the discovery of the sunspot cycle by Schwabe in the middle of the nineteenth century, considerable interest has been shown in forecasting the trends of future cycles. Becoming somewhat of a sport for mathematicians, statisticians, and those who have a flare for studying cycles, the methods of prediction have covered a wide range. Until recently these predictions were largely of academic interest, but with Dr. Pettit's discovery of the relationship between sunspot numbers and ultraviolet intensity, the prediction of sunspot activity has assumed considerable practical importance since long range forecasts of shortwave propagation conditions are based upon predicted smoothed sunspot numbers

Since there is at present no satisfactory theory fully explaining the cause of sunspots or the sunspot cycle, an exact prediction of their future behavior is not possible. However, because of the cyclic nature of sunspots, empirical methods for determining future cyclic behavior can be derived from observed patterns of previous cycles.

Based upon a statistical analysis of the basic cycle characteristics discussed previously, the authors of this article have developed an empirical method for determining future solar activity.[2]

Using this method over the past fifteen years for predicting the smoothed sunspot values appearing monthly in *CQ's* Propagation column, an overall accuracy of better than 90% has been achieved.

It was this same method that resulted in the prediction, made in March 1956,[3] that the 19th cycle then in its infancy would reach its maximum by mid-1958, and that it would be the highest ever recorded. A record breaking peak of 201 occurred in March 1958!

The same empirical method will be used to predict the behavior of the present sunspot cycle during its declining years.

Although present sunspot predictions are based upon empirical methods developed from the behavior of previous cycles, there is an observable pattern on the sun itself that makes it possible to predict the final stage of a cycle with a high degree of accuracy. This is the drift pattern of spots from high solar latitudes towards the solar equator, as the cycle progresses.

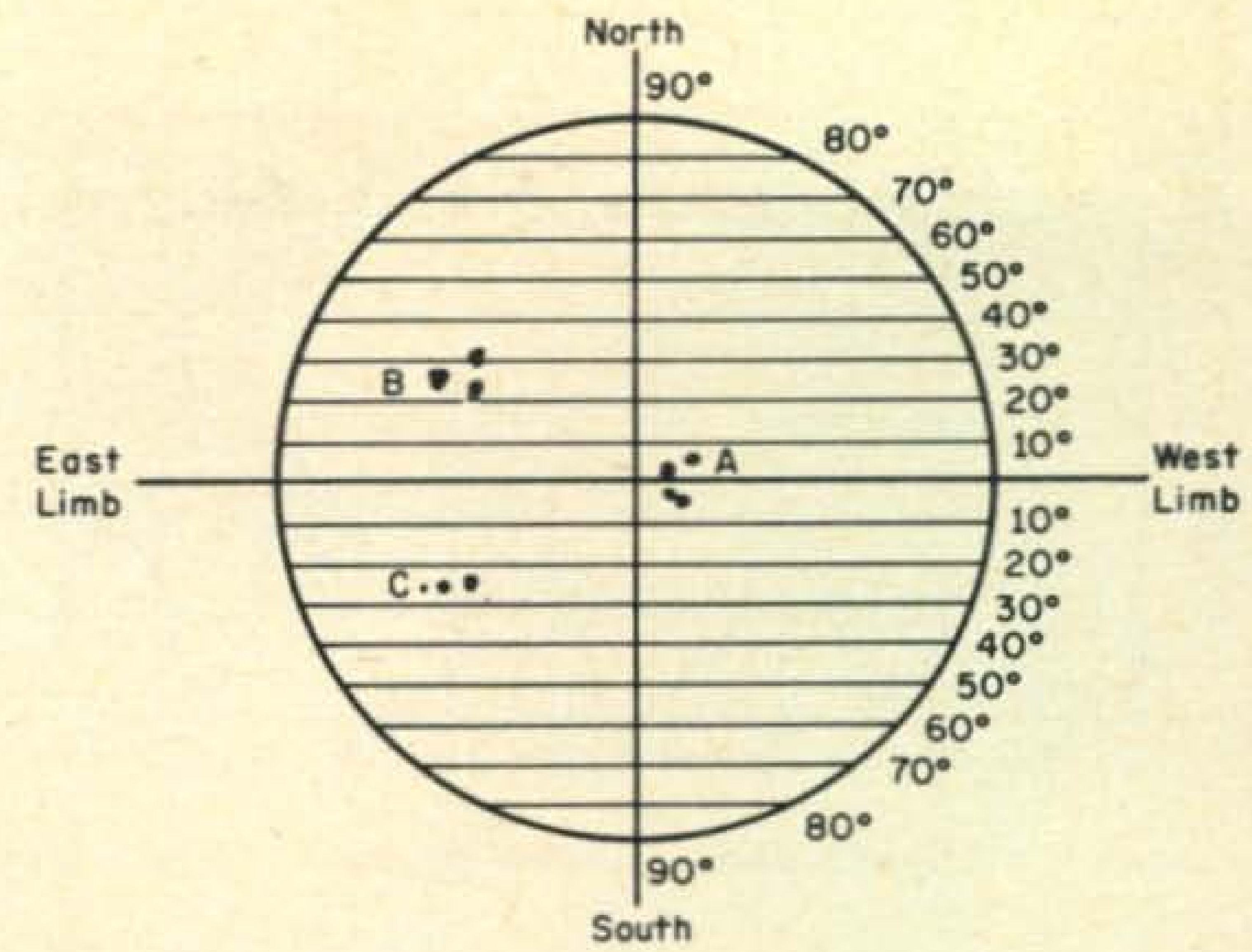

Fig. 5—At the start of a new solar cycle, sunspots first appear in two zones, 25 and 30 degrees north and south of the sun's equator (shown at B and C). As the cycle progresses the spots occur closer and closer to the equator. At A, sunspots are shown breaking out almost on the equator, as the cycle nears its end.

At the start of a new solar cycle, sunspots first appear in two zones, 25 to 30 degrees north and south of the sun's equator (see fig. 5). As the cycle progresses, the zones in which sunspots occur slowly drift towards the equator by about two degrees a year. By sunspot maximum, most spots break out at about 15 degrees, and by the end of the cycle, the sunspots nearly touch the solar equator. For almost a year, both the new and the old cycles overlap, with spots of the new cycle seen in high latitudes, while the few remaining spots of the old cycle appear near the equator. The date usually assigned to the end of the old cycle and the beginning of the new one is when the spots of both cycles are equally numerous.

The lattude drift of sunspots during a cycle is a reliable physical indication of sunspot minimum, and it can also be used as a rough indicator of others phases of the solar cycle. Perhaps, as more data is accumulated from future sunspot cycles, physical laws based on the rate of sunspot drift may replace present empirical methods as a more accurate means for predicting sunspot behavior.

Cycle 20, Its Past

A few words about the last complete sunspot cycle, Cycle 19.

Rising rapidly from a very low beginning (smoothed sunspot number 3.3) in April, 1954, it reached an unprecedented peak of 201.3 during March, 1958. The previous record of 158.6 was recorded during May, 1778 (cycle 3) The great intensity of the cycle can be seen from the fact

[2]The method is based upon that suggested by M. Waldmeier, Director of the Zurich Observatory, in "A Prediction of The Next Maximum of Solar Activity, Terrestrail Magnetism & Atmospheric Electricity", Vol. 51, 1946, p. 270.

[3]Jacobs, G., "The Sunspot Story; Cycle 19—Once In a Lifetime Conditions", *CQ*, March, 1956, p. 28; June, 1956, p. 24.

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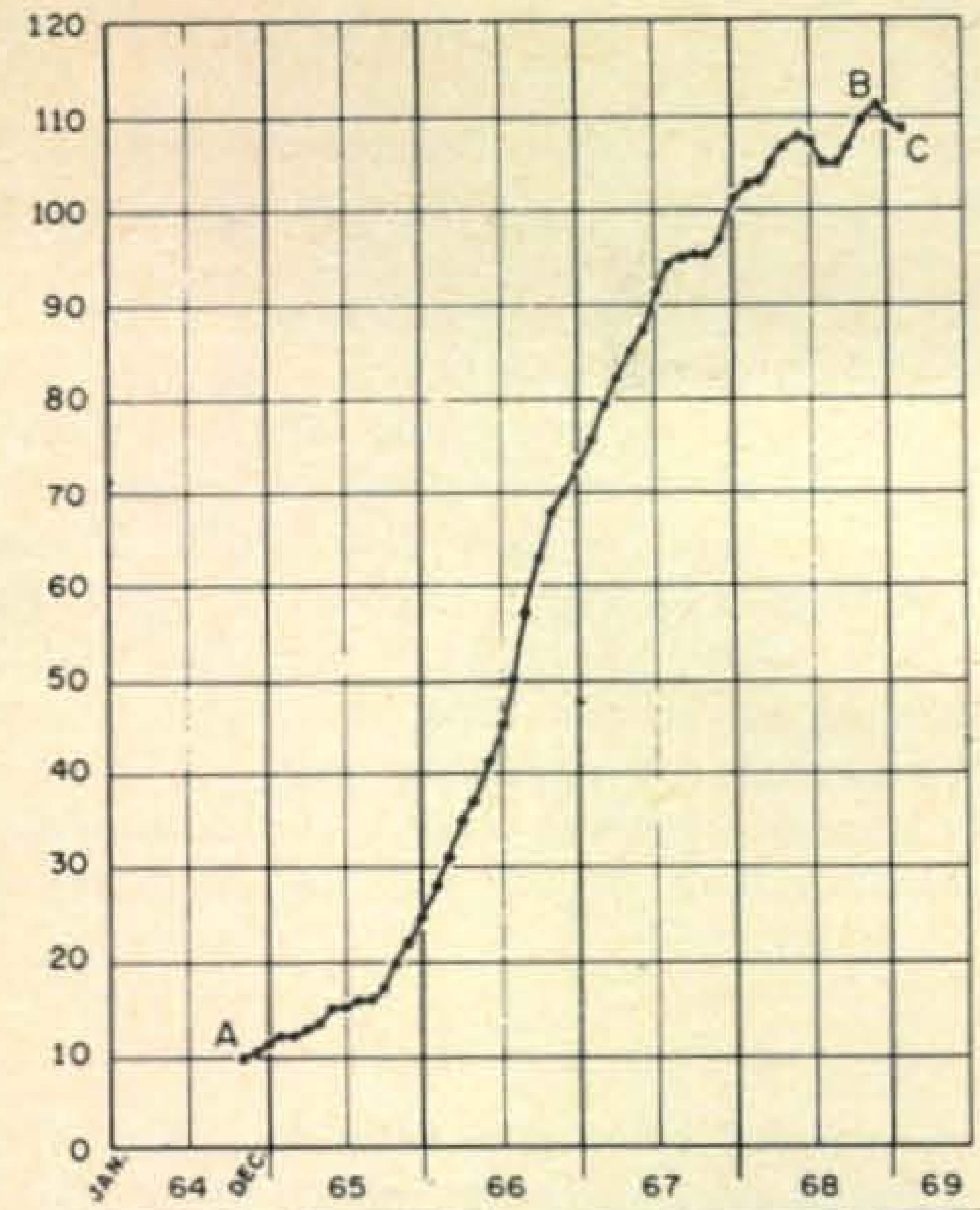

Fig. 6—Progress of Sunspot Cycle 20, October 1964 through January 1969. At A, the start of Cycle 20, the smoothed sunspot number was 9.6. The peak of Cycle 20 occurred November, 1968 with a smoothed sunspot number of 111. The latest value shown at C is 109 for January 1969.

that it rose past the previous level of record high sunspot activity during November, 1956, and remained above this level for nearly three years.

As a result of this unusually high level of solar activity, high frequency radio communication conditions were better during the years 1957-1959 than they had ever been in the entire history of radio.

Cycle 19 reached its minimum level only ten years after it began, by October, 1964 with a smoothed number of 9.6. Its ending marked the beginning of the present sunspot epic, Cycle 20.

Cycle 20, the present sunspot cycle, began during October, 1964 with a smoothed sunspot number of 9.6. Figure 6 shows that it began at a slightly higher than average level of solar intensity, but since then has followed the average cycle almost exactly. In fact, the course of the present cycle parallels that of the average cycle more closely than any previous cycle.

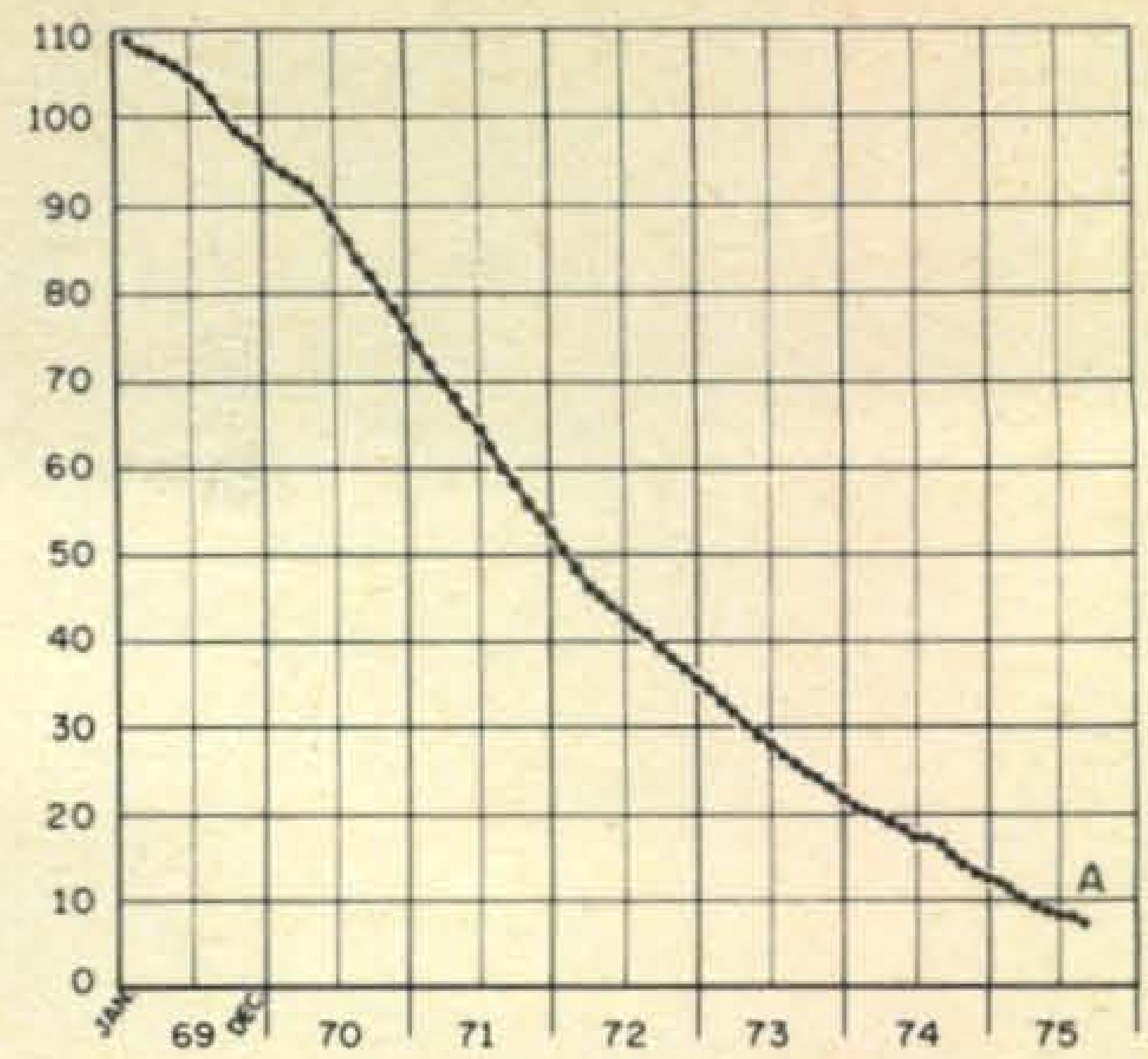

Fig. 7—Predictions for the remainder of Sunspot Cycle 20. The cycle minimum is expected to occur sometime during 1975, with the most likely month being August (A).

The present cycle appears to have reached its peak during November, 1968 with a smoothed sunspot number of 111.

The peak of the present cycle is considerably lower than the peak values of the previous two cycles. Cycle 19 soared to a record breaking maximum of 201 during March, 1958, and cycle 18 peaked during June, 1947 with a smoothed sunspot number of 152.

Cycle 20, Its Future

Cycle 20 has passed its peak level of intensity and is now declining.

According to the empirical prediction method developed by the authors, the present cycle should continue to decline steadily until a minimum value is reached sometime during 1975, with the most probable date for the end of the present cycle being August, 1975, with a minimum smoothed sunspot value of approximately 7.

Table I lists the smoothed sunspot numbers already recorded for cycle 20, and those predicted for the remainder of the cycle. The pre-

Table I

Values of smoothed sunspot numbers observed during Cycle 20. Italic figures indicate values predicted for the remainder of the cycle.

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Jan.		12	28	75	103	109	95	74	50	34	21	12
Feb.		12	31	79	103	108	94	72	48	33	20	11
Mar.		13	35	82	105	108	93	70	46	32	20	10
Apr.		14	37	85	107	107	92	68	45	30	19	9
May.		15	41	87	108	106	90	66	44	29	18	9
Jun.		15	45	91	107	105	88	64	43	28	17	8
Jul.		16	50	94	105	104	86	62	42	27	17	8
Aug.		16	57	95	105	102	84	60	41	26	16	7
Sep.		17	63	95	107	100	82	58	40	25	15	
Oct.	9.6	20	68	95	110	99	80	56	38	24	14	
Nov.	10	22	70	97	111	98	78	54	37	23	13	
Dec.	11	25	73	101	110	97	76	52	36	22	13	

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dicted values are shown also in graphical form in fig. 7.

The accuracy of short range sunspot predictions generally varies with the phase of the solar cycle, and the number of years in advance for which the predictions are made. During the ascending period of solar activity, accurate forecasts can not usually be made for more than six months in advance. During the descending period, forecasts for several years in advance are often reliable within reasonable limits (less than 20% difference between predicted and observed values). Predictions are more accurate during periods of declining solar activity because sunspot numbers change at a considerably slower rate than during periods of increasing solar activity.

Impact on Shortwave Communications

The sunspot cycle is a reliable index of the ionosphere's capability for reflecting shortwave, or high frequency radio waves over long distances. As the cycle declines, the ionosphere's capability of reflecting radio waves decreases, and the upper limit of the frequency range reflected decreases accordingly.

If the sunspot cycle is arbitrarily divided into the following three phases,

High intensity when smoothed sunspot numbers exceed 90

Moderate intensity when smoothed sunspot numbers are between 50 and 90

Low intensity when smoothed sunspot numbers are less than 50

The following levels of intensity can be expected during the remainder of the present cycle:

High intensity until mid 1970

Moderate intensity from mid 1970 through 1971

Low intensity from 1972 through at least the end of 1975, and possibly for a year or so during the early stage of Cycle 21.

The present solar cycle is declining steadily towards a minimum which is predicted to occur sometime during 1975, with the most likely month being August.

The impact of declining solar activity upon propagation conditions in the shortwave amateur bands during the next six or seven years is discussed further in another article appearing in this months special issue of *CQ*.[4] ■

[4] "Seven Year Propagation Forecast", Jacobs, G. and Leinwall, S., *CQ*, Nov. 1969, p. 52.

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A Seven Year Propagation Forecast For The Amateur DX Bands

BY GEORGE JACOBS, W3ASK AND STANLEY LEINWOLL

Solar activity is now declining and is expected to reach a minimum by 1975. As a result, propagation conditions will change considerably in the h.f. bands during the next several years. In summary, DX conditions on the 6, 10, 15 and 20 meter bands are expected to deteriorate steadily, while conditions on 40, 80 and 160 meters should improve correspondingly. In this article, the authors examine more than 50 DX paths, describe the changes that are expected to take place, and include a band-by-band forecast for the next seven years.

A DIRECT relationship exists between solar activity, expressed as a smoothed sunspot number, and the range of frequencies that can be used for h.f. communications between two points.[1] Figure 1, for example, shows the relationship observed between the maximum usable frequency (MUF) at noontime and smoothed sunspot numbers on a typical trans-continental USA path. Similar data is available for the past two complete sunspot cycles for almost all areas throughout the world, for any time of day or night.

The propagation study in this article is based on the analysis of such data, around-the-clock, for more than 50 DX circuits. Observations made during previous solar cycles can, therefore, be correlated with the values of predicted solar activity for the remainder of the present cycle, to produce a long-range propagation forecast.

In addition, the necessity for taking into account seasonal propagation variations brings the total number of circuit analysis curves used in this report to nearly 250.

Space limitations do not permit the publication of each circuit analysis curve used in preparing this article. Pertinent data from these curves has, however, been summerized in tabular form, and propagation conditions expected to occur during the coming years of low solar activity will be discussed in relation to each amateur band in which ionospheric propagation takes place.

Long Range Propagation Study

A long range propagation study must take into account differing conditions during the four seasons of the year for high, medium, and low periods of sunspot activity.

According to "A Sunspot Story-Cycle 20: The Declining Years," appearing elsewhere in this issue of *CQ*, maximum sunspot activity (smoothed sunspot numbers greater than 90), will continue from the present time to approximately mid-1970. Medium sunspot activity (smoothed sunspot numbers between 90 and 50), will run from mid-1970 to early 1972. Low sunspot activity (smoothed sunspot numbers less than 50), will extend from early 1972 through 1976.

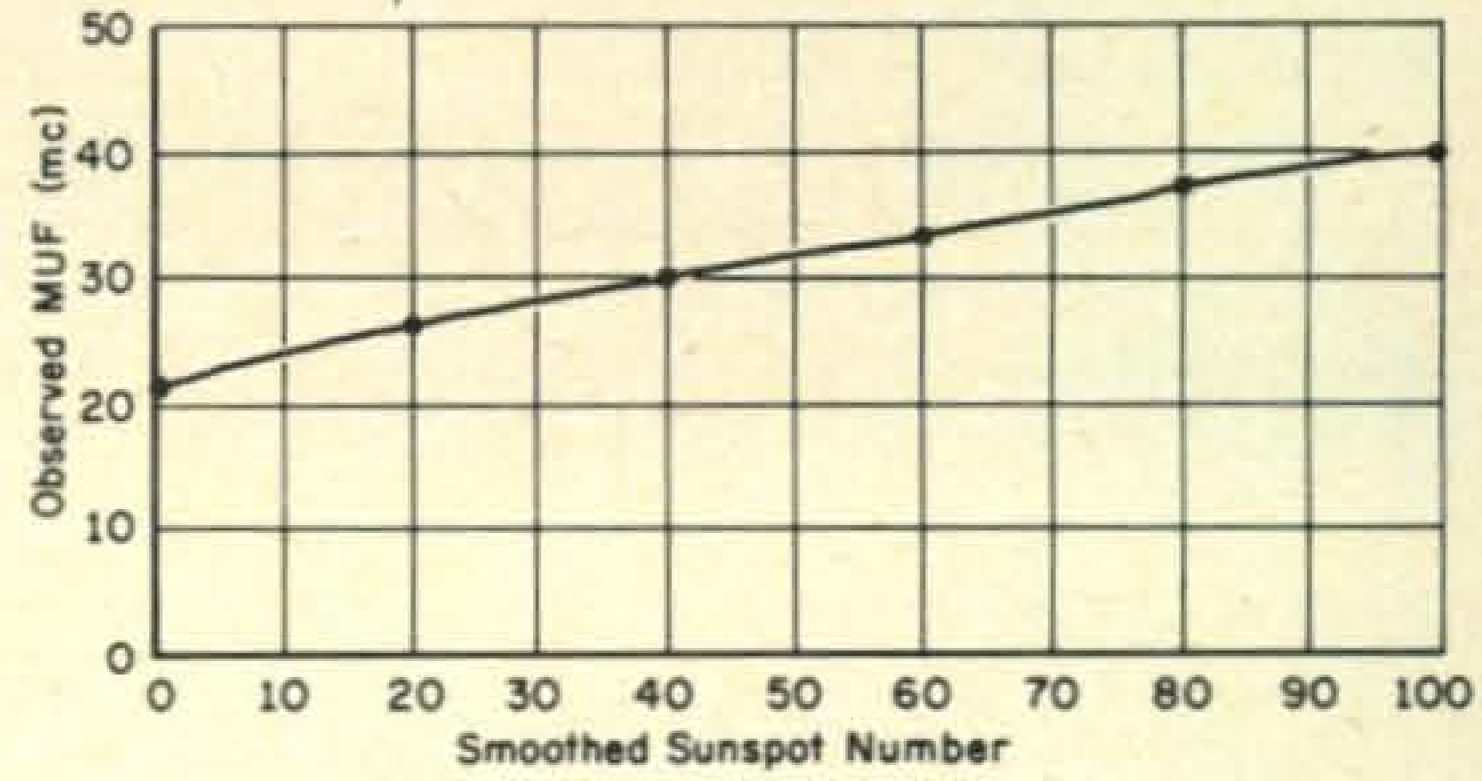

Fig. 1 — Relationship between noontime MUF's and smoothed sunspot numbers on a trans-continental USA circuit. Values are based upon median wintertime readings observed during previous sunspot cycles.

*c/o *CQ*, 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11768.

[1]See Jacobs, G. & Leinwoll, S., "Optimizing Short Wave Communications", on page 25 of this special issue of *CQ*.

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Figures 2, 3 and 4, depict circuit analysis data for the three phases of the solar cycle, high, medium and low, for the path between eastern USA and western Europe, for the winter season.

Based on these, and similar data for 49 other DX paths, drawn for other seasons of the year, the following table has been devised showing the *average number of hours* each amateur band is used daily. The tabulation clearly shows the seasonal variations in the average number of hours that each band is usable, as well as the significant changes that take place in each band between periods of high and low sunspot activity.

Table I shows that the number of hours that blackout conditions occur on the eastern U.S.A. to western Europe path increases significantly as the solar cycle declines, and that the total number of hours all bands are open over this path shrinks considerably from maximum to minimum sunspot conditions.

To give greater validity to the results found for the eastern USA–western Europe path, this propagation study also includes a similar analysis of the following paths between the USA and nine other areas of the world:

1. Eastern USA–Australasia
2. Eastern USA–South & Central Africa
3. Eastern USA–Central Asia
4. Central USA–Central Asia
5. Central USA–South America
6. Central USA–Australasia
7. Western USA–Western Europe
8. Western USA–Far East
9. Western USA–South & Central Asia

Table I shows that as the sunspot numbers decline, the number of openings on the higher frequency bands (10, 15 and 20 meters) decreases sharply. For example, at the minimum of the sunspot cycle the 10 meter band is not expected to open at all on the eastern USA–western Europe path, and the 15 meter band will open less than one-eigth the number of hours it did during the recent sunspot peak. The number of hours that 40 meters opens on this circuit remains about the same throughout the solar cycle, but signals will be strongest during the minimum of the cycle. The number of hours that both the 80 and 160 meter bands open increases as the cycle declines.[1]

Table I

The number of hours each amateur band is usable daily (falls between the MUF and the LUF) during the four seasons of the year: a comparison between high and low sunspot activity for the eastern USA —western Europe path.

High Solar Activity (SSN = 100)								
	Band (Meters)							
Season	*160*	*80*	*40*	*20*	*15*	*10*	*6*	*Blackout*
Winter	1	3	8	9	7	4	0	6
Spring	0	2	6	12	7	4	0	5
Summer	0	0	2	10	5	1	0	10
Fall	0	2	6	12	7	4	0	5
Total	1	7	22	43	26	13	0	26

Low Solar Activity (SSN = 10)								
	Band (Meters)							
Season	*160*	*80*	*40*	*20*	*15*	*10*	*6*	*Blackout*
Winter	2	6	5	6	3	0	0	9
Spring	1	3	7	11	0	0	0	7
Summer	0	1	3	6	0	0	0	14
Fall	1	3	7	11	0	0	0	7
Total	4	13	22	34	3	0	0	37

[1] The average daily number of hours an amateur band is expected to open on a particular circuit serves as an index for a particular season. For example, in Table I, the 40 meter band is expected to open for 5 hours a day during the winter season of low solar activity. This index, taken for each of the four seasons and totalled, becomes the "Total" column in Table I. The "Total" is significant only as a convenient index for making comparisons. In Table II the "Total Hours Usable" for each band is totalled to give an overall "Total Usable" index.

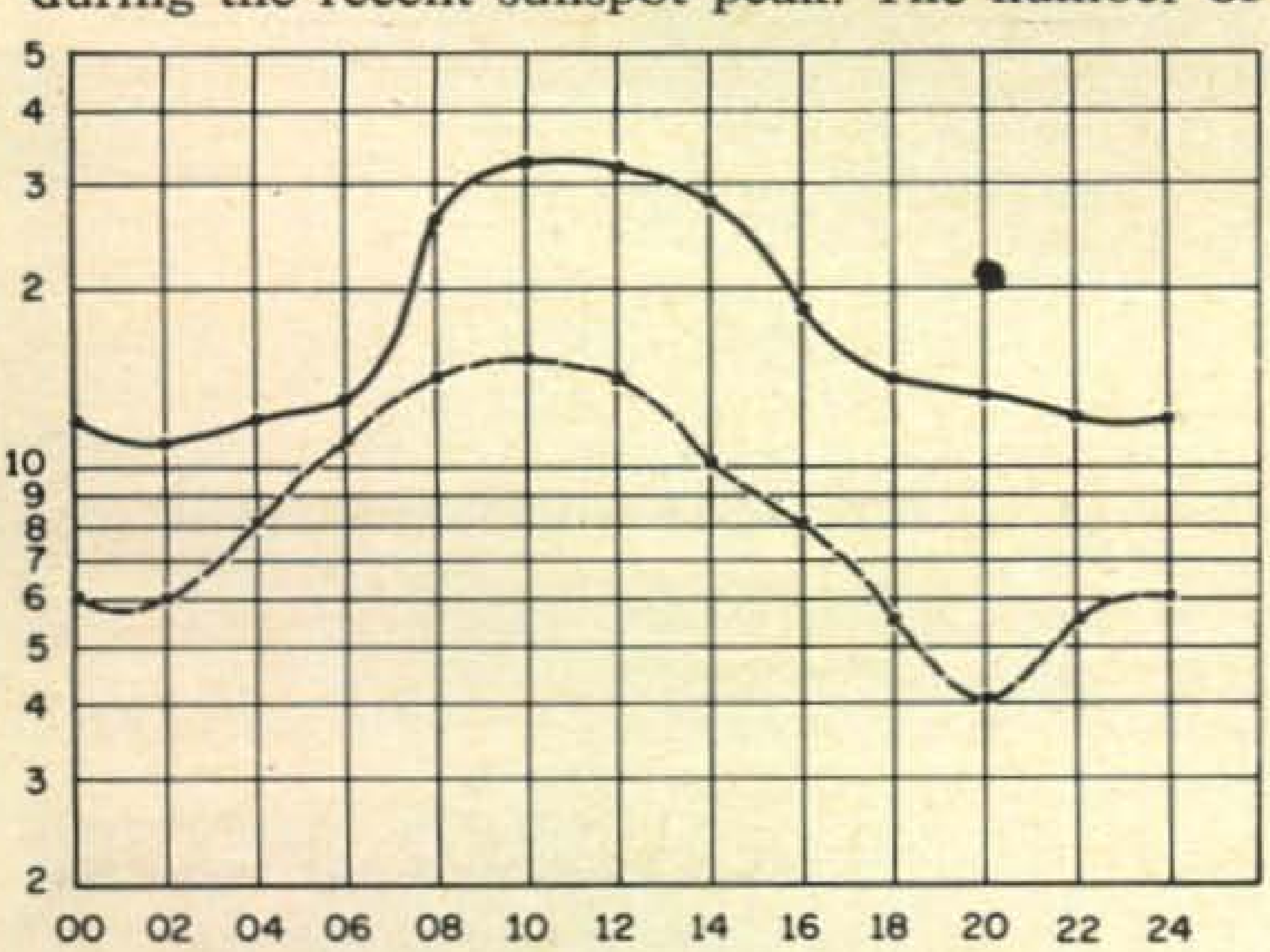

Fig. 2—Circuit analysis curve eastern USA to western Europe, high sunspot activity (SSN 100); winter season. Solid line is MUF, dashed line is LUF. LUF based on 250 watts of c.w. effective radiated power.

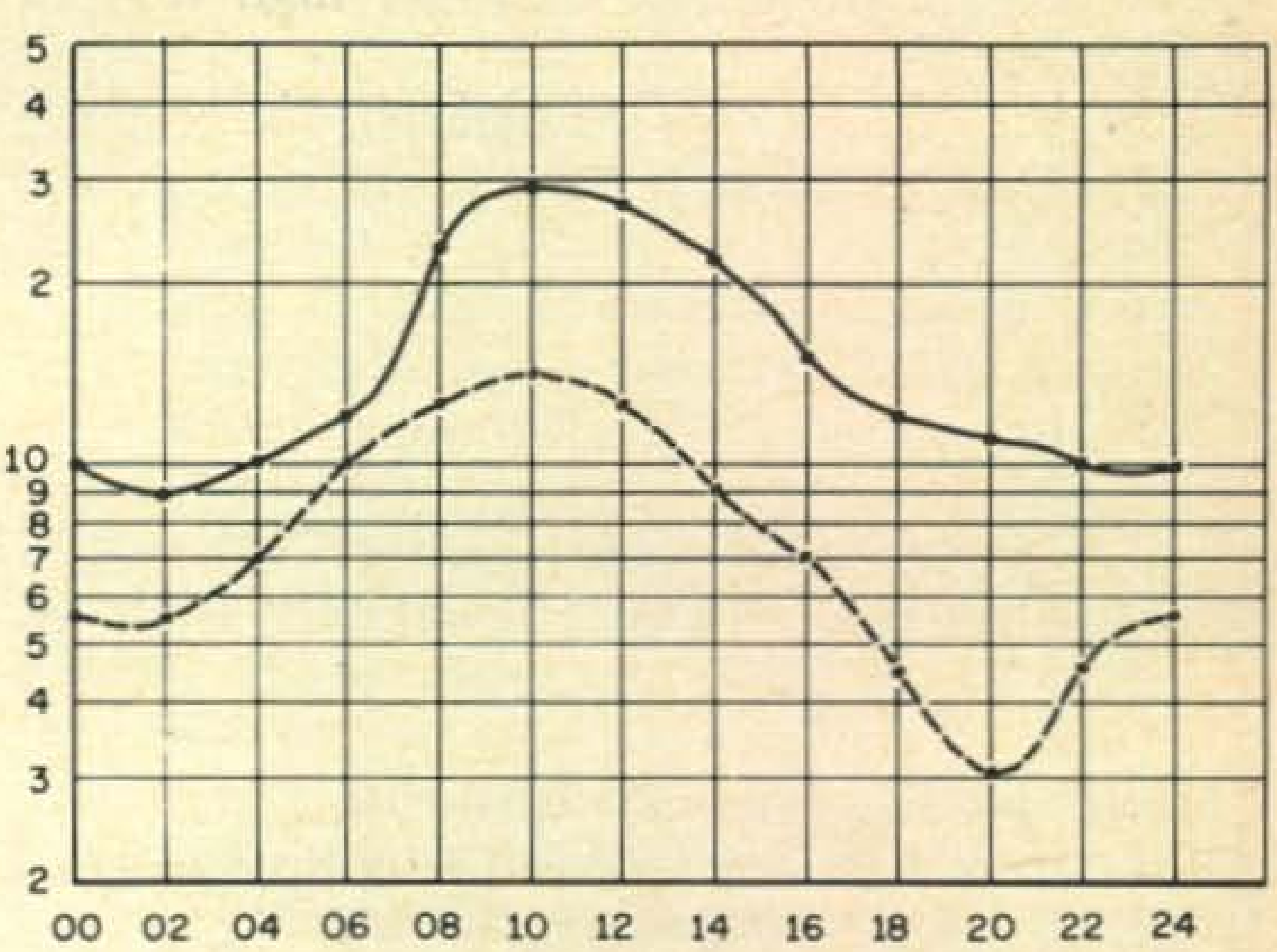

Fig. 3—Circuit analysis curve east coast USA to western Europe, medium solar activity, (SSN 70), winter season. Solid line is MUF, dashed line is LUF. LUF is based upon 250 watts of c.w., effective radiated power.

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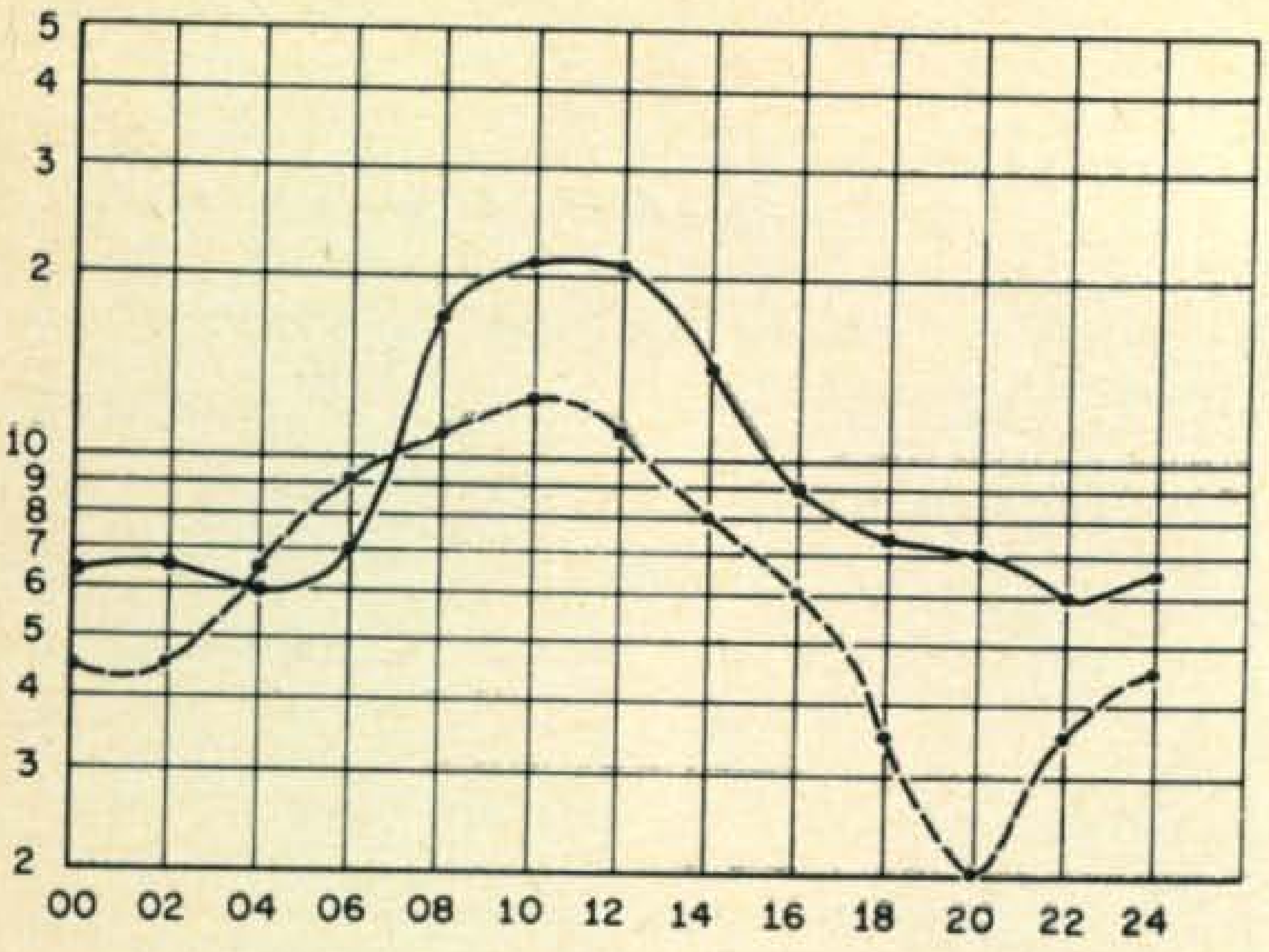

Fig. 4—Circuit analysis curve east coast USA to western Europe, low sunspot activity (SSN 10); winter season. Solid line is MUF, dashed line is LUF. LUF is based on 250 watts effective radiated power, c.w.

Although the statistics vary somewhat for each circuit, openings on the 6, 10, 15 and 20 meter bands decrease considerably, while openings on 40, 80 and 160 meters increase somewhat, as the sunspot cycle declines towards a minimum.

From the data appearing in Tables I and II, the following general conclusions can be drawn concerning propagation conditions on the amateur bands between 6 and 160 meters during the next five years or so, as the present sunspot cycle declines.

a. The total number of hours that all bands on a particular circuit remain open ("Total Usable" column in Table II) drops sharply as the cycle declines. The reduction varies considerably for the representative circuits considered in this article, the overall average reduction being 39%. This means that on the amount of spectrum between 6 and 160 meters that will be open for ionospheric propagation during the coming period of low sunspot activity (from about mid-1972 to 1976) will be *less than two-thirds* of the amount usable during the present period of relatively high sunspot numbers.

b. For the circuits considered, the average time that no amateur band opens on a particular circuit is 25% greater at sunspot minimum than it is during periods of maximum solar activity. On some circuits the number of blackout hours is 50% greater at sunspot minimum than at maximum.

c. As the solar cycle declines towards a minimum, there is a shift in emphasis from the higher to the lower frequency bands. During periods of high solar activity the 10, 15 and 20 meter bands open most frequently; while during periods of low sunspot activity the bands opening most frequently are 20, 40 and 80 meters. The 6 meter band, which opened to many areas of the world during the unprecedented sunspot activity of 1957 and 1958, will not be open at all for regular ionospheric propagation during periods of low solar activity. Except for circuits in a north-to-south direction, 10 meters is not expected to open very often as the sunspot numbers dwindle. On the other hand, 160 meters, which rarely opens for DX when the sunspot count is high, is expected to open to many areas of the world during low periods of solar activity.

The Amateur Bands Around the Cycle

The following is a band-by-band summary of conditions as they are expected to exist during the summer, winter, and equinox periods of sunspot high, medium, and low. Such a summary is a very ambitious undertaking and can only serve as a guide. A complete presentation would have to describe conditions on a great many circuits for many different periods. It would take more space than has been allocated here.

We attempt to present an *overall average* picture for an amateur located somewhere in the northern hemisphere.

This summary of band conditions is intended to indicate qualitative changes in each amateur band from season to season during various phases of solar activity. A smoothed sunspot number range between 90 and 100 has been selected for high solar activity; a range between 50 and 90 for medium, and below 50 for low activity.

Maximum Solar Activity: Present to mid-1970

6 meters. *Summer:* Except for a rare trans-equatorial opening during the evening hours, no DX expected. Sporadic-E short-skip openings should peak, with frequent openings between 1000 and 1400 miles.

Equinox: Some F_2-layer DX openings should be possible on north-south paths during the late afternoon and early evening hours. Trans-equatorial openings also peak during this season, during the evening hours. Some auroral and meteor scatter openings also possible.

Winter: Not much expected except for an occasional meteor, auroral, or sporadic-E opening.

10 meters. *Summer:* With daytime MUF's at low seasonal values, there should be fewer DX openings than during other seasons. During high solar activity some north-south openings should be possible, particularly during the late afternoon and early evening hours, local time. Peak Sporadic-E short-skip propagation is expected, with frequent openings between approximately 400 and 1400 miles.

Winter: During winter high, this will be the best band to many areas of the world, with excellent DX possibilities almost daily from slightly after sunrise to sunset.

Equinox: Fairly good conditions in this band, particularly in early spring, and late fall. The closer we get to summer, the fewer the openings. Conditions should be optimum during the daylight hours and in particular from a few hours after sunrise to sunset.

15 meters. *Summer:* This is generally the best

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all-around band for DX during the summer months. In addition to very good overall conditions in the band during the daylight hours, the band is often open to some areas of the world well into the hours of darkness. Because of increased seasonal sporadic-E activity, very frequent short-skip openings, up to 1300 miles, can be expected.

Winter: Propagation conditions should be excellent during the daylight hours, with peak conditions existing from before noon until sunset. Short-skip openings from 600 miles outward should occur frequently.

Equinox: While DX openings should be possible anytime during the daylight hours, peak conditions are expected from a few hours before, to a few hours after, local sunset. Generally, DX should be excellent from early morning well into the evening, with the possibility of the band remaining open well into the night on some of the longer north-south paths.

20 meters. *Summer:* Although daytime conditions on 20 meters are expected to be fair, this will definitely be the best nighttime band for DX to most areas of the world, with good activity expected throughout the hours of darkness. Because absorption increases as the daytime frequency is lowered, there may be some days of the month when daytime openings beyond 1500 or 2000 miles will not be possible.

Winter: Since F_2-layer critical frequencies reach maximum levels in the early afternoon during the winter, when sunspot activity is at a maximum, short-skip openings during the early afternoon and early evening hours are expected to occur quite frequently. Although the band may be open for DX all day long, it will be at its best at a little after sunrise, and again around sunset.

Equinox: During the evening hours, 20 meters is generally best, with around-the-clock DX possible toward the end of spring, and at the beginning of fall. Early spring and late fall short-skip should also be quite good.

40 meters. *Summer:* Because of high absorption, daytime DX possibilities are not considered very good. Short-skip daylight openings are expected during the daylight hours at distances ranging from 100 to 1000 miles. In the evening and night hours, DX becomes likely, but noise levels are still rather high, and the band is only fair for DX.

Winter: During the hours of darkness this is generally a satisfactory band for DX, with daytime activity limited to short-skip openings varying from a few miles to several hundred miles, increasing in the evening and nighttime hours. At night, absorption and noise levels in this band are exceptionally low, and some really booming signal levels can be expected.

Equinox: The 40-meter band is usually the best around-the-clock short-skip band for the spring and fall months. Through the evening and nighttime hours the band should be fairly good for DX, although late spring and early fall noise levels might still be rather high.

80 meters. *Summer:* Conditions in this band are generally unsatisfactory in the summertime. Daytime absorption is so high that contacts beyond 200 miles or thereabouts are unlikely, with even the short-skip contacts subject to high noise and heavy absorption. There is a possibility that some nighttime DX openings can be established, but signals will be generally weak and noisy.

Winter: Heavy daytime absorption in the 80-meter band limits openings to 300 miles and below. During the evening hours, this distance increases and DX openings over all-dark paths should be possible on several nights in the winter period.

Equinox: Daytime openings are again limited to relatively short distances, with DX a virtual impossibility. Skip distance gradually increases as darkness approaches. DX contacts over all-dark paths should be possible to some areas of the world.

160 meters. *Summer:* There is very little hope for openings of any significance in this band throughout the daylight hours, with noise and absorption much too high for success. At night, if one is patient, openings beyond several hundred miles are possible, but DX oppenings occur very infrequently.

Winter: The winter offers the best opportunities for 160-meter devotees. During the daylight hours, critical frequencies are much too high, and absorption, even of vertically incident waves, is usually complete. Therefore, there is no skip at all. At night, however, it is a different story. After sunset, critical frequencies begin to fall

Table II

The total amount of time (average daily totals for the four seasons that each amateur band is usable: a comparison between high and low sunspot activity for paths between the U.S.A. and nine areas of the world.

Circuits (Sunspot)	*Band (Meters)* 160	80	40	20	15	10	6	Total Usable	Black-out
1. Eastern USA—Australasia									
High	1	4	10	21	18	19	0	73	52
Low	3	5	15	9	7	0	0	39	72
2. Eastern USA—South and Central Africa									
High	1	3	11	21	19	27	0	82	40
Low	3	9	14	12	13	2	0	53	59
3. Eastern USA—Central Asia									
High	0	0	1	9	9	1	0	20	77
Low	0	0	2	6	0	0	0	8	88
4. Central USA—Central Asia									
High	0	0	1	11	9	1	0	22	84
Low	0	0	2	8	9	0	0	10	87
5. Central USA—South America									
High	2	16	24	37	54	35	3	171	14
Low	6	20	26	22	30	9	0	113	21
6. Western USA—Australasia									
High	1	6	9	19	21	21	1	78	39
Low	4	9	16	9	15	3	0	56	55
7. Western USA—Western Europe									
High	0	0	2	10	14	2	0	28	70
Low	0	1	3	8	1	0	0	13	84
8. Western USA—Far East									
High	0	6	14	24	33	15	1	93	35
Low	1	7	19	17	13	0	0	57	51
9. Western USA—South and Central Asia									
High	0	1	5	14	26	20	1	67	43
Low	0	3	9	10	13	1	0	36	63

rapidly with a resultant increase in 160-meter skip. Although the skip often is limited up to distances of 1000 to 2000 miles, multihop DX contacts at distances up to several thousand miles are possible.

Equinox: In the evening and nighttime hours, skip distances can extend from 100 to 1500 miles, with some DX openings to considerably beyond this range possible. Propagation via the ionosphere during the daylight hours is again unlikely.

Medium Solar Activity: Mid-1970 to early 1972

6 meters. *Summer:* No F_2-layer DX activity expected. As during sunspot high, seasonal sporadic-*E* levels should make a few openings possible at distances from 1000 to 1400 miles out. An occasional trans-equatorial opening may be possible during the evening hours on north-south paths.

Winter: No DX possibilities, but some short-skip openings due to sporadic-*E*, auroral and meteor scatter may take place.

Equinox: Auroral displays are at a maximum during equinoxial months, and 6-meter propagation off the aurora is about the best hope there is for activity in this band during the period.

10 meters. *Summer:* Conditions on north-south circuits, particularly into the southern hemisphere, should be fairly good, with a fair chance for DX openings during the daylight hours. The summer peak in sporadic-*E* activity should make short-skip openings from 500 to 1500 miles out possible approximately 25% of the days.

Winter: DX openings in the 10-meter band will be fair to good for this period. Restricted to the daylight hours, conditions should be optimum during the pre-noon hours on openings from an easterly direction; during the afternoon and early evening hours on openings from the south, and during the evening hours from the west and northwest. There will also be frequent short-skip openings at distances ranging from 1000 to 2000 miles.

Equinox: During the spring and fall, fairly good DX openings should be possible on east-west paths, but not as frequent as during the winter months. North-south openings, on the other hand, are more frequent than during winter. This balance makes the overall DX picture fairly good during the daylight hours.

15 meters. *Summer:* Increased sporadic-*E* activity should make short-skip openings from 500 to 1500 miles out a fairly regular daytime occurrence. DX conditions should also be fairly good on 15 meters, and particularly good on circuits into the southern hemisphere. Regular F_2-layer propagation should be at its best from around noon to sunset, local time.

Winter: This is expected to be the best daytime band for DX, with contacts to most areas of the world possible on practically every day. Higher daytime critical frequencies should result in regular short-skip openings beyond 700 miles or so.

Equinox: Daytime DX is excellent, with conditions in this band similar to what they are in the winter, except that the band remains open somewhat longer.

20 meters. *Summer:* Just as 15 meters was the best daytime winter band, so 20 meters is the best daytime summer band. It should remain open from sunrise to after sunset to most areas of the world, on practically every day of the period. Short-skip propagation from distances of 200 to 2000 miles should be possible practically every day.

Winter: Band conditions are generally similar to summer, except that they will not open as long. This is due principally to the fact that the length of the day is considerably less than for other seasons.

Equinox: Although daytime conditions in the 20-meter band are not as good as during the summer months, overall conditions are still fair, with increased DX contacts over north-south circuits during the daylight hours and with the possibility that the band will be open around the clock on some of these circuits on several days. Short-skip propagation similar to summer, but from the *F* region rather than via sporadic-*E*.

40 meters. *Summer:* In general, DX openings will be possible during the evening and nighttime hours. Daytime skip should range up to 700 miles or so, with noise levels during these hours rather high.

Winter: This is expected to be the best all-round nighttime band, both for DX as well as regular short-skip propagation. Daytime activity is expected to be limited to short-skip openings up to approximately 1000 miles distant.

Equinox: During the evening and nighttime hours, generally satisfactory conditions are expected for DX. During the daylight hours, short-skip propagation varies from contacts to distances up to approximately 100 miles.

80 meters. *Summer:* Because of relatively high F_2 critical frequencies, as well as high absorption levels, daytime openings beyond 250 miles will be rare. During the evening and nighttime hours, conditions will improve, with fair DX expected on some nights to some areas of the world.

Winter. Throughout the daylight hours, because of generally high critical frequencies, DX openings in this band are not expected; short-skip openings will be possible on a 24-hour basis, while during the hours of darkness, because of seasonally lower nighttime critical frequencies, generally satisfactory DX to many areas of the world is expected.

Equinox: Daylight conditions in the 80-meter band are expected to be similar to winter conditions; at night, conditions will improve, with some DX possible, particularly on circuits into the southern hemisphere. Short-skip is expected to vary from approximately 350 miles during the day, to over 2000 miles at night.

160 meters. *Summer:* As during sunspot high, daytime absorption is still too high to enable contacts much beyond 100 or so miles. As darkness approaches, the skip is extended until, in the hours of darkness, openings out to about 2000 miles are possible. Some DX into the southern hemisphere, where winter conditions prevail, can be expected.

Winter: For the daylight hours, the 160-meter band is far below the workable range, even on

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short-skip. During the late afternoon, critical frequencies begin to fall rapidly; with this fall, an improvement in openings is expected, until chances for DX become fair during the late night hours. Short-skip becomes possible from around sunset to sunrise.

Equinox: As before, the 160-meter band is at its best during the period from sunset to sunrise, when absorption is at minimum. During these periods, skip may vary from 1000 miles to distances considerably beyond, with DX possible on nights when noise levels are below the seasonally normal levels. Very little, if any, daytime skip is expected.

Low Solar Activity: Early 1972 to Mid-1976

6 meters. The low part of the sunspot cycle is indeed a bleak one for 6-meter enthusiasts. Because of relatively low ultraviolet radiation from the sun, normal critical frequencies are also quite low. Consequently, even when abnormally high radiation occurs for this time of the cycle, it is not enough to boost frequencies to levels where the 6-meter band will open. During the spring and fall, when some auroral activity is possible, the band may open for short-skip. In the summer, when sporadic-*E* is at a maximum, there may also be an occasional opening, but it is not likely. In addition, during periods of heavy meteor activity, such as the Perseids of early August, openings are possible. However, in all of the above cases, openings are the exception, and, as we said above, these are bleak years for 6 meters.

10 meters. DX possibilities in this band, too, are rather poor, although overall activity is considerably better than in 6 meters. The best opportunity for DX in the 10-meter band occurs in the late fall, winter, and early spring, and then only on circuits into the southern hemisphere. During the summer months, when sporadic-*E* activity is at a maximum, fairly regular short-skip openings up to 1000 to 1500 miles distant can be hoped for. As with 6 meters, openings for brief periods can be expected for periods of meteor showers, and aurora.

When 10 meters is open at distances of 500 miles or below, there is an excellent chance that 6 meters will be open in the same direction, at about two or three times the distance.

15 meters. *Summer:* DX openings in this band are expected to be fairly good, and fairly regular, particularly on circuits into the southern hemisphere. Because of relatively high sporadic-*E* activity, short-skip activity should be good to excellent at distances from 300 to 1500 miles out.

Winter: Through the daylight hours, DX openings should be generally fair to good, particularly during the period from noon to around sunset. Short-skip should be fairly consistent from around sunrise to sunset, but not much expected at night, when critical frequencies are way down.

Equinox: About the only consistent DX in this band in the spring and fall occurs on circuits to Africa and Latin America from the northern hemisphere. Short-skip openings may be fairly good from distances of 1000 miles and over.

20 meters. *Summer:* During the summer in the low part of the sunspot cycle, the 20-meter band is the best band for consistent daytime DX to all parts of the world. It should remain open from approximately sunrise to sunset. In addition, the seasonal increase in sporadic-*E* activity should make short-skip openings a rather frequent occurrence.

Winter: Although the hours of daylight are considerably fewer than during the summer, what daylight hours there are will be good for DX activity in the 20-meter band. Between 15 and 20 meters, there should be no lack of wintertime daylight DX activity to anywhere in the world.

Equinox: Again this is the best daytime band for DX activity to all areas of the world. From sunrise to sunset, openings should occur very frequently. Excellent short-skip openings from distances of 500 to 1000 miles and greater should be possible.

40 meters: *Summer:* In the summertime, because of greater thunderstorm activity, there is naturally more noise on most shortwave bands; as the frequency is lowered, this noise becomes more pronounced. In spite of increased noise levels in the 40-meter band, however, nighttime DX openings should be numerous and consistent, from sunset to sunrise, to all parts of the world. Daytime short-skip should be good to 1000 or 1500 miles out.

Winter: This band will open for DX before sunset, and will be good for DX to all parts of the world for a few hours, after which the MUF's fall below 7 mc to many areas of the world. On other circuits, however, particularly into or toward the southern hemisphere, the band may remain open all night, until after sunrise.

Equinox: The band should be good throughout the evening and night hours and up to sunrise for DX openings to many parts of the world. Short-skip variations are numerous, ranging from 100 miles to over 1000 miles out during the daylight hours.

80 meters. *Summer:* Generally fair DX is possible on this band at night to many areas of the world, although noise levels will be high. During the daylight hours, openings up to 500 miles and beyond will be likely, with short-distance openings likely on a 24-hour basis.

Winter: This will be the best late-night long-distance band during the winter low period. DX openings to many areas, particularly in an east-west direction, should be possible late at night up to an hour or so before sunrise. Short-skip openings, from several hundred to over 1000 miles should be possible to some areas of the world.

Equinox: DX openings to many areas of the world are expected to be fair to good during the evening and nighttime hours, up to sunrise. Daytime short-skip will vary considerably, from local openings to distances of 1000 miles or so.

160 meters. *Summer:* Nighttime DX is expected to be only poor to fair, although long-distance openings, particularly in a north-south direction may be possible. During the daylight hours, noise and absorption will be at seasonal peak values, and no skip is expected.

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INTERSTELLAR DX

BY LOUIS BERMAN,* K6BW

Now that the Condon Report on UFOs has scientifically laid to rest the flying saucer bugaboo, let us examine, in detail, a more reasonable avenue of approach in establishing contact with another civilization in space through the medium of electromagnetic radiation, or what is commonly referred to as "interstellar communication." Interstellar flight, on the other hand, whether from the Earth or to the Earth from God knows where, while attractive theoretically from the point of view of relativity theory, seems almost hopeless of achievement from the technological standpoint. Some of the insuperable difficulties inherent in interstellar flight will first be enumerated before the second alternative, interstellar communication, is discussed.

From the known space distribution of solar type stars within our Galaxy and from the fraction of their planets likely to be inhabited by technologically competent societies, astronomers have estimated the average separation between such civilized communities to lie somewhere between 300 and 1000 light years. We now address ourselves to this problem: How much fuel would an ideal rocket ship need for a payload weight of 100 tons[1] to make a round-trip flight toward a distant civilization 300 light years away at a speed of 99.5 percent of the speed of light? In optimizing the interstellar flight program, we will not be niggardly about choosing the best requirements available, even though they may be never attainable in practice.

The most efficient rocket engine conceivable (only theoretically) is a photon rocket powered by the controlled annihilation of equal amounts of matter and anti-matter. The spaceship will leave the Earth at rest velocity, (1) accelerate rapidly to within 0.5 percent of the velocity of light, coast most of the way, then (2) decelerate quickly toward the target civilization, turn around, (3) accelerate to nearly the velocity of light, coast again during most of the return trip, and finally, (4) decelerate quickly back to zero velocity on Earth. When solved according to relativity mechanics, these four actions, each one of which involves a mass ratio of 20:1, will require a total initial spaceship weight of 16 million tons! All except the 100-ton payload consists of propellant weight which is completely expended by the time the ship returns home. The round-trip journey will last 60 years measured in the astronauts' time (relativity at work here) and 600 years measured in Earth time. At its maximum speed of 99.5 percent of the speed of light, the spaceship will be blasted by 3000 billion, billion atoms per second on every square meter of its exposed surface (relativity at work here, also) even though the actual interstellar space density of matter, mostly hydrogen, is only one atom per cubic centimeter. This bombardment is several hundred times the output of a high-intensity proton accelerator; it would require concrete shielding ten feet thick to protect the astronauts inside, adding to the payload weight and immeasurably increasing the total weight of the spaceship. The conclusion to be drawn from these findings is that close contact with outside intelligent beings may not be realized for centuries, if ever. Therefore, the only other rcourse open to us in the foreseeable future is to attempt to establish electromagnetic exchanges with other communicative societies.

*1020 Laguna Ave., Burlingame, Calif. 94010.

[1]The Apollo moonship, exclusive of its booster, weighs 45 tons.

Interstellar DX

Let us look into the possibilities of interstellar DX. It is of interest, in order to appraise our chances of success, to make an intelligent inquiry of the total number of communicative civilizations within our Galaxy. A communicative society is one which is technologically competent and sufficiently motivated to carry on interstellar communication. Following the lead of other investigators, with some slight modifications, we shall define N as the number of galactic societies with a developed technology willing to communicate with each other. Thus,

$$N = S \times P \times B \times I \times M \times L \qquad (1)$$

Each of the factors on the right hand side of equation (1) will be treated in turn. S represents the number of stars that have developed likely planetary systems out of a total estimated population of 200 billion stars in our Galaxy. Ruled out are (1) the binary and multiple stars which constitute approximately 50 percent of the stellar population for the reason that the orbital motions of planets around two or more suns would be too unstable to permit uninterrupted biological development of life and (2) the hotter, more rapidly rotating stars than the sun with life spans too short to develop planetary systems; these constitute some 25 percent of the stellar population. It is postulated that the vast majority of the cooler, longer-lived solar-type stars with masses between 0.1 and 1.25 solar masses are rotating slowly because angular momentum (the quantity of rotation or revolution) has been transferred from these stars to the planets during the process of giving birth to planetary systems. In summary, the number of single solar-like stars that have formed planetary systems during the 10 billion years of the Galaxy's existence is estimated to be one-fourth of the total number. For these stars, the creation of a planetary system is a common, natural event; hence, the value of S is probably 50 billion stars.

The next factor, P, equals the number of planets in each planetary system suitable as the abode of life. Such planets must lie within a so-called "habitable zone" surrounding the parent sun, where the appropriate physical conditions, temperature, atmosphere, water, *etc.*, are conducive to the support and maintenance of life. In our solar system, Two planets, Earth and Mars (Venus' surface is too hot) are inside the life zone. As a conservative figure, we estimate one planet per system as the average number with a suitable environment for the development of life.

The factor, B, represents the fraction of congenial planets on which life actually emerges. If biological evolution follows the pattern on Earth, beginning with an atmospheric mix of methane, ammonia, and water vapor enveloping a warm, watery planet leading to the production of the amino acids and the subsequent highly complex organic molecular compounds that constitute all life processes, then the factor, B, may be set equal to unity on the assumption that life will eventually, under the proper conditions, gain a foothold, flourish, and evolve into a myraid of forms sooner or later.

The following factor, I, is the fraction of biological species that eventually emerges into a technically competent culture ultimately capable of engaging in interstellar communication. Given a couple of billion years of effort, the probability that Nature will produce at least one type of sentient creature, similar or even superior to homo sapiens, is 100 percent; hence, the factor, I, is equal to 1.

The factor, M, equals the fraction of extraterrestrial societies that are stimulated to attempt interstellar communication. There could exist many civilizations not interested in communicating with their fellow neighbors. Our own interstellar communicative curiosity extends back less than a decade during our 5000 years of civilization. In the absence of any information to the contrary, we will assume that one out of every two competent galactic societies is presently a communicative society; hence, $M = 0.5$.

The final factor, L, is the most uncertain one of all to evaluate. It represents the ratio of the life expectancy of the communicative species to the biological age of the planet. Considering the possibilities of self-destruction by nuclear holocaust, biological disasters occasioned by faulty genetic engineering, aberrations in the planet's ecology resulting from human stupidities and blunders, terrestrial and extra-terrestrial catastrophies, and other unforeseen calamitous events befalling mankind, one is tempted to predict that the moments of civilized glory may be brief, indeed, in the life span of an intelligent species. If 99 percent of the world's inhabitants were to perish, there would still remain

[*Continued on page 98*]

See page 110 for New Reader Service

How to Prepare Ads for Amateur Radio Magazines

THINKING about starting a small business on the side? Each year several hundred hams around the country do, and many eventually run ads in the various ham magazines offering their new products or services of interest to amateurs. Many of these ham ventures become regular and successful businesses. But the ads you see in a magazine don't just happen; they take a bit of time and planning, and that's only justified, since your ad program can make or break your business venture. The purpose of this article is to show you how to go about preparing your ads to get the maximum return for your money with the least effort.

First, let's talk about choosing the magazine or magazines you'll be advertising in. The first logical step is to write each of the publications for copies of their advertising rate cards to determine your costs. And here's where you should also ask for something else—the magazines' distribution figures. The reason for this is that when you buy an ad, whether it be just a one incher or a two page spread, your costs should be measured by determining how many readers you'll be reaching for each ad dollar spent. To simplify this let's use round numbers. One amateur publication offers about 100,000 readers monthly and charges about $400.00 for a full page ad to regular advertisers. This means that the cost for that magazine is actually about $4.00 per thousand readers. Cost per thousand (CPM as the trade normally refers to it) is the standard accepted method to determine actual advertising cost. Another ham publication charges about $125 for the same full page ad, but that magazine only reaches some 15,000 readers each month, so the cost per thousand is actually more than $11.00 per thousand. Thus, in reality, the magazine which appears to be less costly actually costs far more. And don't be fooled into buying the largest ad you can at the cheapest rate per page that you can find, because in the long run you'll be getting a far smaller return on your investment. In other words, don't buy on cost per page or cost per inch but do buy on cost per reader reached.

Now that you've determined where to spend your money, it's time to decide how large or small your ad should be. This should be determined by several factors. One of course, is your budget. You can't run full pages if you can only afford to buy small fractions. But keep this in mind: small ads can be very effective if the product or service is one that your potential customers need. Many advertisers have been regulars in the ham mags for more than thirty years and still they only run one or two inch ads each month, because that's all the space that's needed to sell their product.

Of great importance is the price you're going to be charging for your product. It brings tears to the eyes of an advertising salesman to see an ad come into the office which is going to cost the advertiser four or five hundred dollars when the item being offered sells for say two or three dollars. The ad man knows that it will take far too many sales than the market will justify, just to pay for the ad, and that after one or two ads his customer will disappear into limbo. He'd far rather see a one or two inch ad that will bring the customer a profit and make him a regular advertiser, than a full page ad that will send the customer looking for other ways to make a buck.

Estimate very conservatively how many items you think can be sold from your first ad and multiply that number by the profit margin on each item. The figure you arrive at should be the very most you should spend on your ad. Shoot for a break-even point on the first ad, and count on the snowball effect from future sales to make your advertising a profitable affair.

And speaking of snow-ball effect, this is a very important term to consider. Don't throw all your ad dollars into the first ad hoping to make enough to pay for the next ad. It doesn't work that way. Most hams are careful buyers and many wait around to see the second or third ad to determine whether the advertiser is here to stay. Only then will they risk their money on a direct-mail order. So budget your initial ad money to buy at least three months of advertising, even if you have to run smaller ads at the outset. In the long run you'll get a far more profitable return, and not be gambling on a single month's sales potential.

Now let's look at what's going to go into your ad. Pictures are very helpful and should be included if at all possible, but are not an absolute necessity. The same thing holds true for coupons, especially in the ham market. Most hams don't like to cut their ham magazines, so a coupon is often a waste of valuable space and money. The heading is very important, and so is a complete mailing address. Avoid post office box addresses if possible. Hams prefer to deal with businesses that they can reach by phone to settle a problem, and most hams shy away from anonymous P.O. boxes where they lose the security of a personal contact to protect their investment.

In preparing your ad copy, keep in mind that most of the amateur magazines have the facilities to help you with your layout. The larger publications have artists who can make your ad pretty presentable, far more so than you might accomplish on your own. Don't be bashful; if you need help, ask for it. You'll be surprised at the cooperation you'll get from the magazines. After all, the publishers want your advertising to be profitable so that you'll become a steady customer, and they'll do everything possible to make it so. If you're planning a series of large ads (half or full pages) it's probably wise to select a local ad agency. This costs a few dollars more, but the agency can be very useful in directing your marketing approach. And also remember, if you're looking to sell through jobbers or dealers as well as via direct mail, make this known in your ad. Most ham ads are thoroughly perused by dealers and jobbers looking to take on new lines.

If your ad is to be type set by the publication, keep in mind that the more information you supply him, the better job he can do. If you want your phone number in the ad tell him. He's not a mind reader. If you want your logo to be in reverse type (white letters on a black background) tell him this too. He can only work with what you give him, so give him as much as possible and let him do any cutting that needs to be done. And most important of all, if you're going to give him copy to be set, try to give him a rough penciled layout of the way you want your ad to

[*Continued on page 98*]

NEW DX 2000-L THE MOST ADVANCED LINEAR AMPLIFIER ON THE MARKET TODAY

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- 1000 Watts AM, CW & RTTY
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See page 110 for New Reader Service

CQ Reviews: The Swan Cygnet Model 260

BY WILFRED M. SCHERER,* W2AEF

A RECENT piece of equipment that has aroused considerable interest is the Swan Cygnet, Model 260, which is a compact s.s.b. /c.w. transceiver with a self-contained loudspeaker and a built-in power supply for operation from both 117 v.a.c. and 12-14 v.d.c. sources. The only extras required for getting on the air are a microphone (or key) and an antenna. This model thus meets the need for a complete one-package unit for fixed-station, portable or mobile operation.

In addition, in order to hold down the cost of an entire operating setup, the Cygnet 260 has been designed as a simple-as-possible-job providing only the bare essentials needed for receiving and transmitting s.s.b. and c.w. Being thus "built to a price," a number of luxuries or frills available with higher-priced or more elaborate gear are not incorporated in this unit.

Facilities

The Cygnet 260 provides complete coverage of the 3.5-28 mc amateur bands with a transmitting-input power of 260 watts p.e.p. on s.s.b. and 180 watts (d.c.) on c.w. A Pi-network with an adjustable loading control permits matching to 50-70 ohm loads.

Operation with s.s.b. is providd on only the sideband normally used on each band; that is: l.s.b. on 3.5 and 7 mc; u.s.b. on 14, 21 and 28 mc. This limitation is not of a serious nature, inasmuch as the expense of avoiding it usually is not justified, since most s.s.b. operators seldom take advantage of switching sidebands, such as may be helpful for dodging QRM.

Sideband selection is obtained with a 2.7 kc bandwidth filter that has a 6-to-50 db shape factor of 2.2. The sideband suppression is rated as 45 db at 1 kc and the carrier suppression as 60 db.

Grid-block keying is used with c.w. Also included for c.w. is an 800 c.p.s. frequency offset on transmit. Manual operation is required, thus precluding break-in c.w. operation.

On receive, preselector-type tuning peaks up the r.f. circuits which are the same as those used for the transmitter driver. These circuits are thus simultaneously peaked for both receive and transmit operation. The receiver-output level is adjusted by an r.f. gain control. There is no a.f. gain control, nor is a.g.c. provided.

A different v.f.o.-tuning range and separate dial scales are used for each band. The 3.5.-4.0 mc, 7.0-7.3 mc and 14.0-14.35 mc ranges are calibrated in 5 kc steps, the 21.0-21.45 mc range in 10 kc steps and the 28.0-29.7 mc range in 20 kc steps. Calibration marks are spaced about 1/8" apart except on 28 mc where they are near 1/16". A high-ratio drive setup provides slow (vernier) tuning which requires 22-24 revolutions of the knob for the entire coverage of any band.

There is no meter on the set, but instead a tuning-eye type of indicator is incorporated for observing the relative r.f.-output level from the transmitter and is used for tuneup. Unlike a meter, it indicates the instantaneous peak levels and thus serves as an excellent and accurate modulating-level monitor. This is especially useful inasmuch as the mic gain is an internal control screw-driver adjusted through a hole in the bottom of the cabinet. Once set for average mic and voice conditions, readjusting the control for slightly different conditions may be avoided by using a voice level or speaking distance from the mic

*Technical Director, *CQ*.

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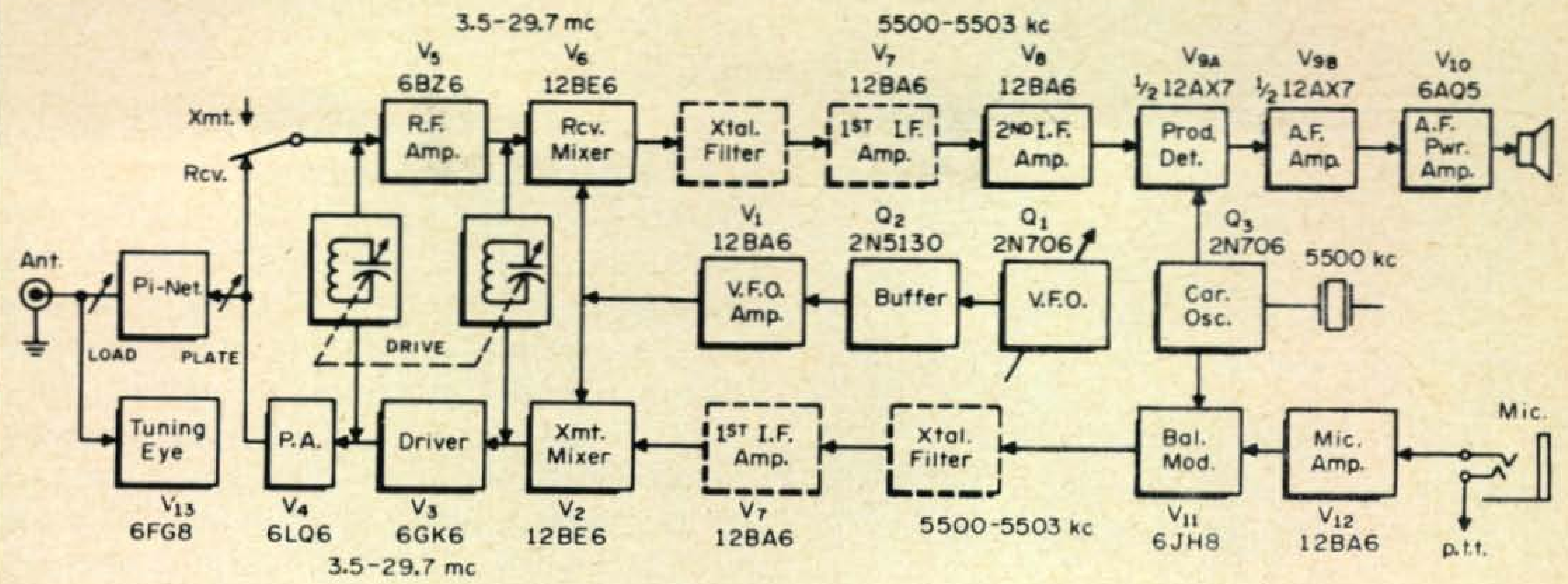


Fig. 1—Block diagram for the Swan Cygnet 260. Functions with dashed lines are common to both the receiving and transmitting setup. Technical details are given in text.

that results in proper modulation as indicated by the eye.

In this respect, it also is a visual aid for maintaining peak levels below the flattopping point, as there is no a.l.c. for automatically preventing over-drive.

Actually, the only real need for a meter is in connection with setting the bias, in which case a rear-apron jack is provided for plugging in an external meter as described later. Although some operators might like to have a meter for indicating the relative strength of received signals, this is an un-necessary frill, since the objective is to hear or copy a signal, not look at it!

Early models of the Cygnet 260 were supplied with an attached p.t.t. mobile-type of microphone, but some problems were encountered by Swan in obtaining microphones with uniformily good response. Also many owners have indicated they prefer a mic jack on the set to enable them to choose a mic best suited for their voices or for either fixed or mobile operation. Therefore, later models of the 260 incorporate a mic jack and are supplied without microphone.[1]

Provisions are available only for push-to-talk operation with s.s.b. There is no v.o.x., another luxury often not employed by operators anyway or if used at all is employed as a lazy man's p.t.t., rather than as a full break-in system.

The current drain with a 12-14 v.d.c. power source is 8 a. on receive and 20 a. peak on transmit. With a 117 v.a.c., 50/60 c.p.s., source the power consumption is 150-400 watts. An export model of the set also is available for which the 50/60 c.p.s. a.c. input is 208/220/240 v instead of for 117 v.

The size of the model 260 is 5½″ × 13″ × 11″ (H.W.D.) and it weighs 24 pounds. A carrying handle on one side of the case is provided for portability.

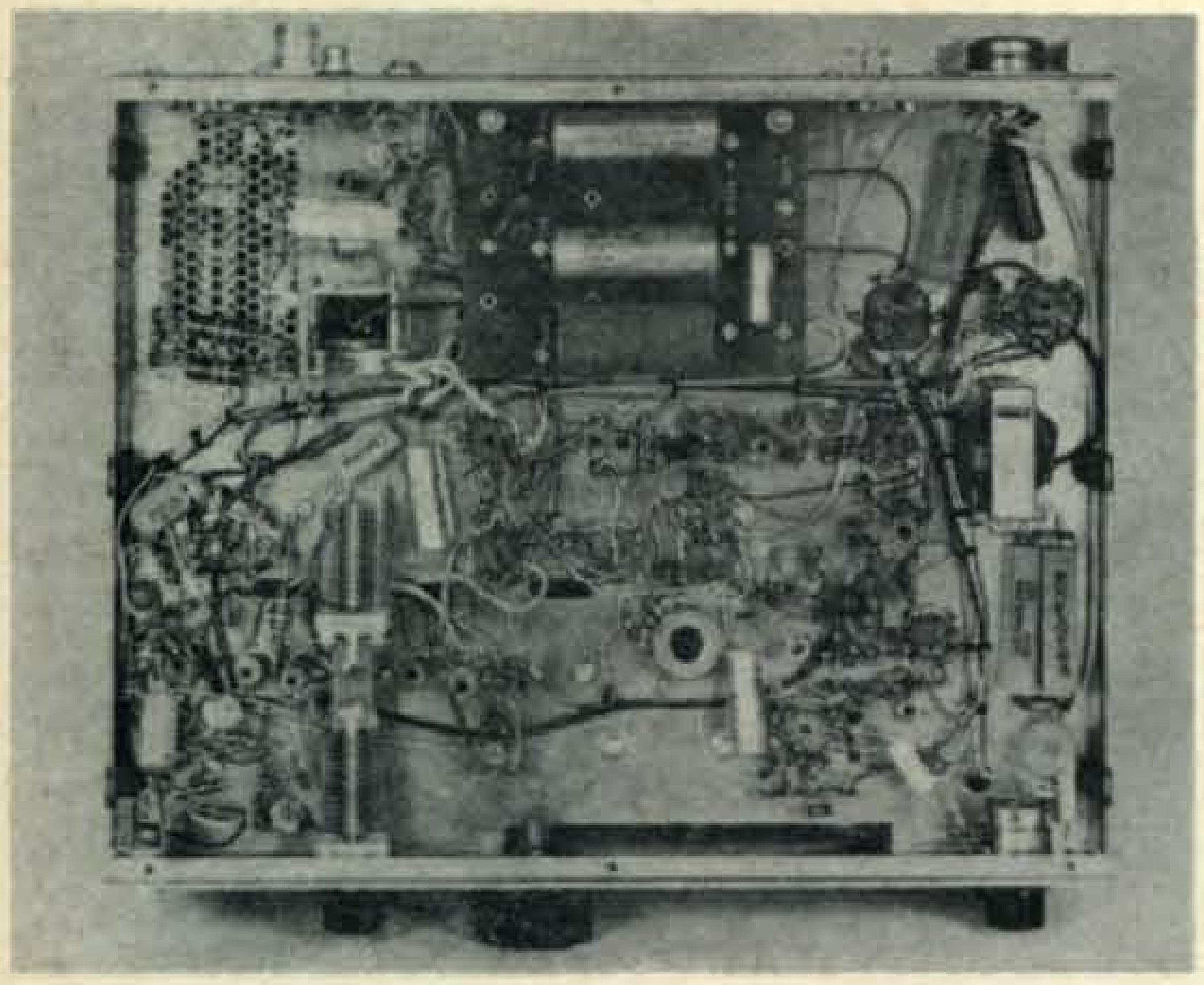
Technical Details

A block diagram for the Model 260 is shown at fig. 1 where it will be seen that the transceiver is a single-conversion job with a 5500 kc i.f. that employs a crystal lattice filter.

As mentioned earlier, the tuned circuits for the transmitter driver input and output are also used for the input and output of the receiver r.f. stage. The p.a. Pi-network provides an additional tuned circuit for the input of the r.f. stage. In earlier models of the 260, the recever r.f. input is tuned only by the Pi-network, but in order to obtain better selectivity and improved image rejection than that afforded by the Pi-network, later models

[1]A mic jack may be installed as follows: Disconnect the microphone leads from the tie strip under the chassis and remove the mic cable and the grommet. Using a round file, enlarge the cable hole to 3/8″ diameter to accomodate a 3-circuit jack (Switchcraft type 12B). The hole should be enlarged in the direction toward the chassis deck and center of the panel so that the jack may be positioned without interfering with the bottom plate and the side of the cabinet.

Install the jack and connect its sleeve (ground) lug to the 3rd terminal on the tie strip (counting from the panel-end). Connect the ring (mic out) lug of the jack to tie-strip terminal 2 and the tip (p.t.t.) lug to terminal 4: When the bottom plate is re-installed, use two flat washers under the head of the self-tapping screw near the jack, in order to prevent its hitting the jack.



Bottom view of the Swan 260. All parts are readily accessible.

of the set are modified to also make use of the tuned circuits at the transmitter-driver output. The modification is a simple job that can be easily installed by owners of the earlier units. The procedure is described at fig. 2.

V.F.O.

The v.f.o. unit is the same type as used in other Swan gear. It employs two transistors, one for the oscillator, the other as a buffer amplifier. These are powered by a zener- regulated potential of −12 v.

The v.f.o. unit is followed by a vacuum-tube amplifier which provides the necessary heterodyning-injection level for the mixers. For the 7, 21 and 28 mc bands this stage functions as a doubler, enabling the oscillator to operate at a lower frequency where better stability can more readily be ensured.

The injection frequencies for the 3.5 and 7 mc bands are the received-signal frequency *plus* 5500 kc, while for the 14, 21 and 28 mc bands they are the signal frequency *minus* 5500 kc. The carrier-oscillator frequency is 5500 kc and the nominal range of the sideband filter (a 4-crystal job) is 5500-5503 kc, with the result that the mixing sum or difference frequencies, required for the 5500 kc i.f., pass only the lower sideband on 3.5 and 7 mc and the upper sideband on the other bands.

The transistorized carrier oscillator is crystal-controlled. The product detector is a conventional triode type with the i.f. signal applied to the tube grid and the carrier-oscillator signal to the cathode. The receiver r.f. gain is controlled by varying a negative bias applied to the grids of the r.f. and mixer stages. The speaker is permanently connected to the a.f.-output transformer. There is no phone jack, but the manual contains instructions on how one may be installed in the speaker circuit.

Transmitter

The balanced modulator for the transmitter is a 6JH8 beam-deflection tube. Its carrier-balance control is a screw-driver-adjust type mounted on the rear apron of the set.

For c.w. transmissions and tuneup, a negative d.c. voltage unbalances the modulator to provide a carrier. At the same time, a 10 mmf capacitor is switched out of the crystal circuit of the carrier oscillator. This shifts the crystal frequency higher by about 800 c.p.s., placing it within the filter passband and thus permitting the carrier to pass unattenuated through the filter. This also provides the equivalent of receiver offset tuning which is desirable for transceiver operation with c.w.[2]

The grid-block keying is applied to the transmitter mixer. Another modification in late models of the 260 is a c.w. wave-shaping filter to minimize key clicks. It may be installed in unmodified units as shown at fig. 3.

The 6LQ6 in the p.a. is a TV-sweep type tube and functions as a class AB linear ampliled as does the 6GK6 driver. Both tubes are individually neutralized.

The tuning eye, for indicating the relative output power, is operated by a d.c. voltage obtained from a diode which rectifies a sample of the r.f. output from the p.a.

The cathode of the p.a. tube is grounded through a 1-ohm resistor during s.s.b. operation. On tuneup and for c.w., a 100-ohm resistor is also inserted in series with the cathode return. This adds some self bias, decreasing the cathode current and slightly lowering the plate voltage across the tube, thereby reducing the power level for holding down the plate dissipation to a safer amount during these steady-state (d.c.) conditions.

A phono jack on the rear of the set is connected across the 1-ohm resistor to enable an external 1 ma meter, with a 330-390 ohm resistor in series with it, to be used for determining the correct adjustment of the bias or for otherwise observing the p.a. cathode current. The manual has a chart for converting the meter readings to the actual cathode current in ma.

By plugging a low-range (1 v. or less full-

[2]The transmitter frequency is 800 c.p.s. *lower* than the frequency to which the receiver is tuned on the 3.5 and 7 mc bands. On 14, 21 and 28 mc the transmitter frequency is *higher* than that of the receiver.

See page 110 for New Reader Service

scale) voltmeter into the jack, the cathode current also may be determined by reading the voltage across the resistor in terms of amperes. Thus, an indication of .04 v. would be read as .04 a. ($I=E \div R=.04 \div 1=.04$ a.) or 40 ma which is the required current for the proper bias setting. Similarly, 0.3 v. would indicate 300 ma.

Transmit-receive transfer is conducted by a relay that switches a 215-volt supply potential between the receiver r.f., mixer and 2nd i.f. stage grids and the screens of the transmitter mixer, driver and p.a., as well as for the plates of the tuning eye and the mic amplifier. The 12 v.d.c. relay obtains its voltage from the heater supply through a diode rectifier and is actuated by the microphone p.t.t. switch or the function switch for c.w. and tuneup.

Power Supply

The power transformer has two primary windings. When one winding is used for 117 v.a.c. input the other winding acts as a secondary supplying 12 v.a.c. for the tube heaters. During 12 v.a.c. operation, the 117 v.a.c. primary is disconnected and the 12 v. winding is fed by power transistors functioning as a d.c. chopper in the conventional manner.

There are three high-voltage secondary windings. One is used for a −100 v.d.c. bias supply through a half-wave rectifier from which the −12 v.d.c. zener-regulated potential also is obtained. One of the other secondaries is used for a 250 v. source, while the third supplies 550 v. A silicon-diode bridge rectifier is used in each case. 800 volts for the p.a. plate are obtained with the 250- and 550-volt sources connected in series.

The necessary connections for either 117 v.a.c. or 12-14 v.d.c. operation are automatically made by jumpers on separate power- cable plugs provided for each type of service.

Operation

A function switch has two positions; one labelled REC, the other TUNE-CW. Tuneup, of course, is conducted in the TUNE-CW position and is simply accomplished in a matter of seconds, requiring that the DRIVE, P.A. PLATE and LOADING controls be adjusted for maximum output as shown by the tuning eye.[3]

As is the usual case when TV-sweep tubes are used in a p.a., care must be taken not to engage tuneup periods longer than about 20 seconds in order to preserve tube life, but due to the operating simplicity of the 260, longer tuneup periods should not be needed anyhow.

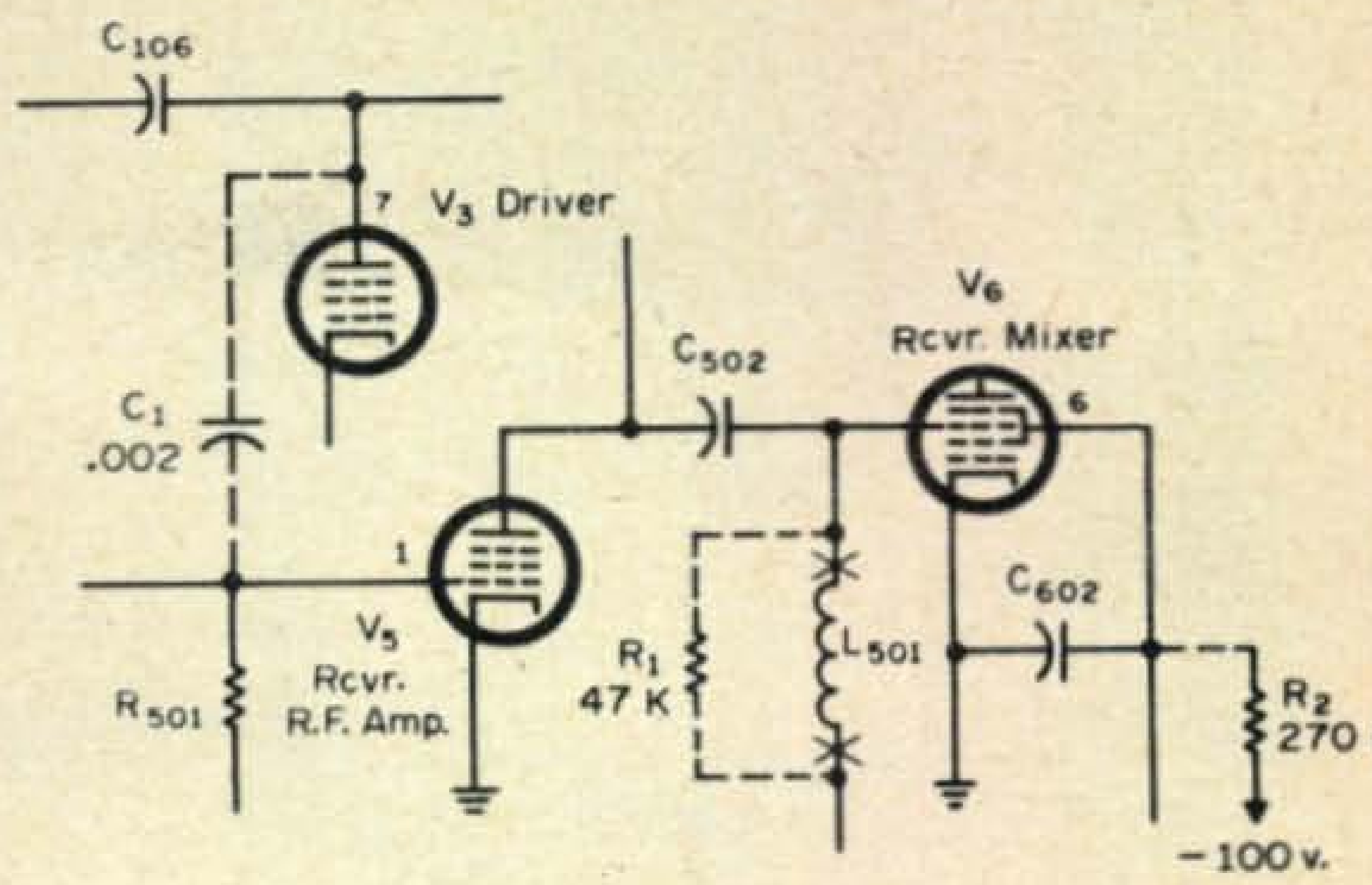
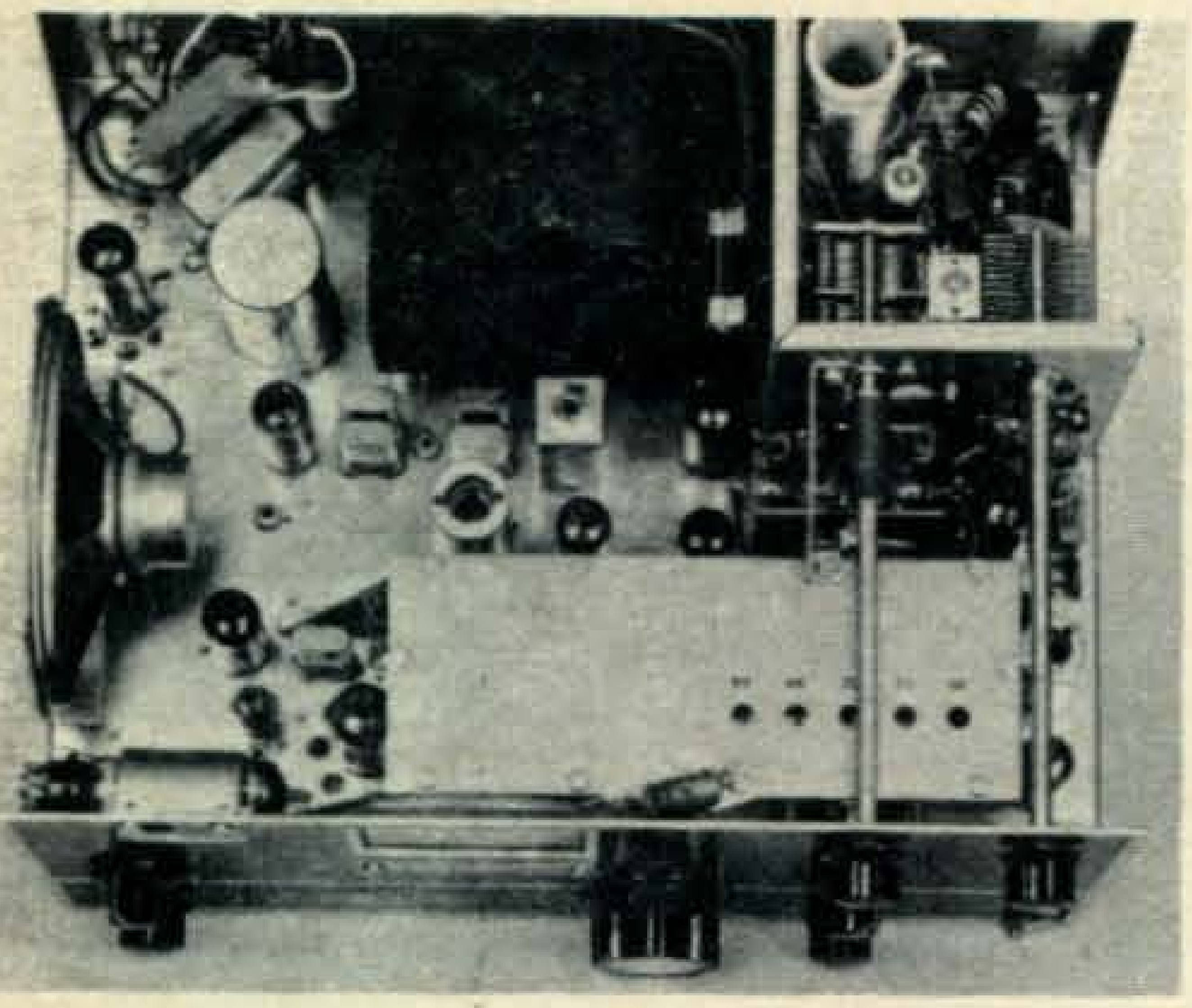


Fig. 2—Modification for improving the receiver front-end selectivity and stability of the 260. New components are added as per dashed lines. C_1 is a .002 mf disc ceramic that is to be installed between pin 1 of V_5 and pin 7 of V_3. The capacitor should be placed next to the chassis with insulated sleeving placed in its leads. R_1 should be installed in place of L_{501}. One end of R_2 should be connected to the r.f. gain-control end of the 470K resistor (R_{204}), the other end of which is connected to a tie point along with a 10K, 2-watt, resistor (R_{203}) that runs to the relay. The other end of R_2 goes to the tie-point end of the other 10K, 2-watt, resistor (R_{1612}) that goes to the relay. The driver-output inductors (L_{301}, etc.) should then be realigned as described in the manual.

Another important precaution is to make sure the bias is correctly set as described in the manual. Too high a bias will result in too low a cathode current and the s.s.b. signal will be distorted. Too low a bias will cause higher-than-normal cathode currents and degrade tube life.

Flipping the function switch to REC activates the receiver for which the desired level is adjusted with the r.f. gain control. Pushing the mic p.t.t. button then activates the transmitter for s.s.b. operation. For transmitting c.w., you plug in a key (at a rear jack) and set the function switch at TUNE-CW. Receiving c.w. requires setting the switch back to REC. To provide more convenient operation in a push-to-send manner, a connector could be

[3]If the s.w.r. is higher than 1:5:1 as a result of a load impedance greater than 75 ohms, the tuning eye may close all the way and thus obscure the maximum-output indication. In this case, it will be necessary to detune the drive to the point where the eye opens sufficiently to indicate the maximum-output condition while tuning up the p.a., after which the drive may be repeaked for additional output.



Top view of the Swan 260. The v.f.o. is in the box at the foreground. The p.a.. compartment is at upper right.

rigged up for operating the p.t.t. circuit with a footswitch.

Performance

The unit sent to us for evaluation was a late model with many of the modifications previously mentioned. In line with Swan's policy, data on possible modifications for improving their gear is always available for the asking.

Using Hi-Z mobile mics such as the Electro-Voice 600E dynamic unit and the Shure

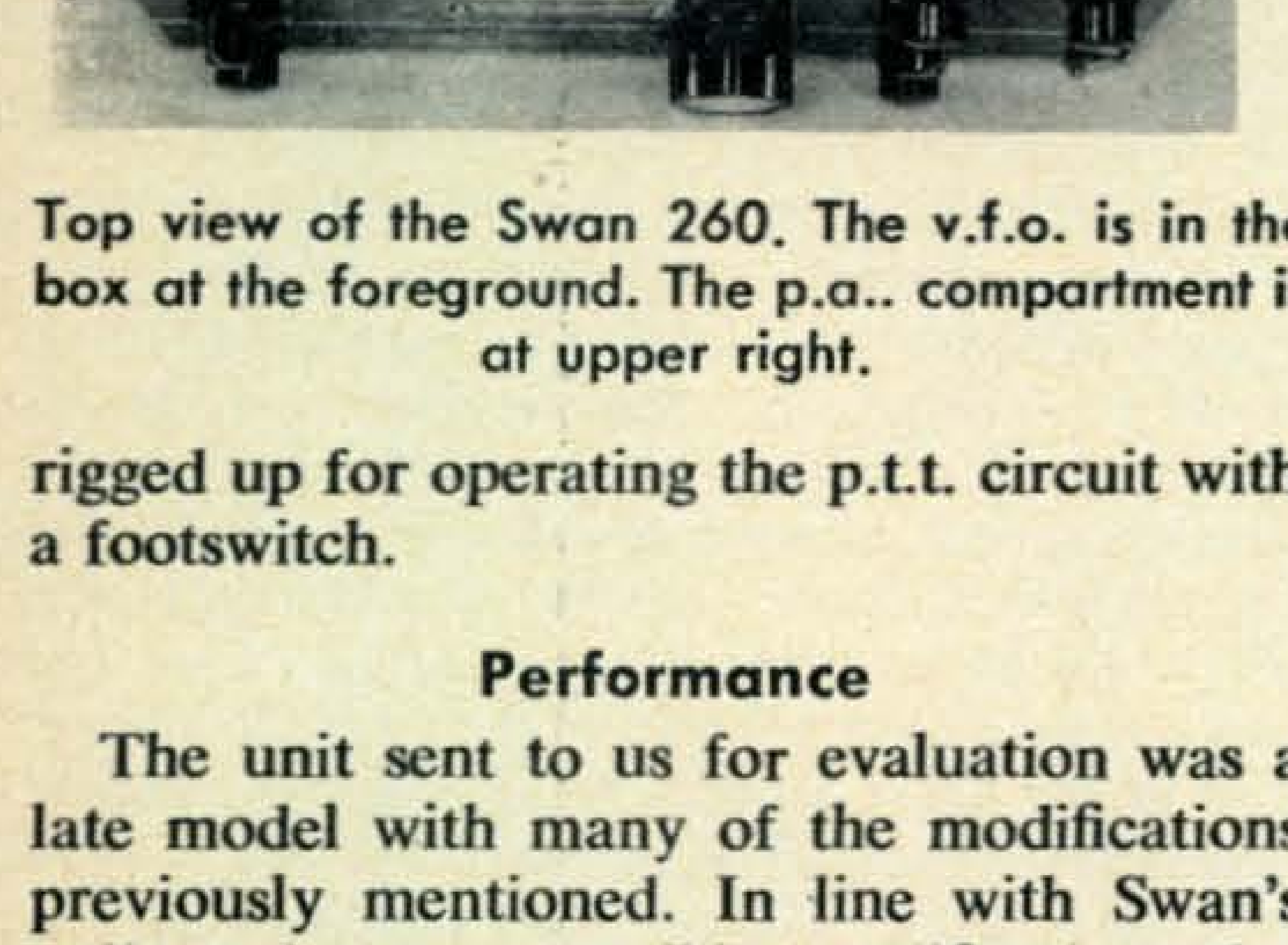


Fig. 3—C.w. wave-shaping filter modification for the 260. New components are added per dashed lines. Break present circuits at X. Installation may be made as follows: Locate R_{201} (27K) at pin 7 of V_2. Disconnect the other end of it from the tie strip and connect this end to the unused ground terminal on the tie strip. At the function switch disconnect the yellow-violet-white lead from the switch terminal. Then connect one end of R_3 to this switch terminal and the other end of the resistor to the yellow-violet-white lead. Install a ground lug at the rear of the speaker-mounting screw nearer the panel. Connect C_2 between the switch terminal (with R_3 connected to it) and the ground lug.

404C controlled magnetic job or stand-type mics such as the Shure 440SL and Electro-Voice 619, clean and excellent sounding s.s.b. quality was experienced both by our own listening tests in the lab and as reported with on-the-air QSO's. Of course, care must be taken not to overdrive the p.a., a precaution easily attained by observing the peak amplitudes with the tuning eye during s.s.b. transmissions. Outside of an oscilloscope, the tun-be a useful and inexpensive adjunct on any transmitter.

The c.w. keying was found to be clean without any adverse key clicks. To the critical ear a very slight chirp may be noted on some bands, but for the most part this will go unnoticed.

Although the receiver itself has a relatively flat passband equal to the rating of ±3 db at 300-3000 c.p.s., the a.f. quality with s.s.b. signals at first was quite harsh and unpleasant sounding due to a rising frequency characteristic in the loudspeaker. In order to obtain a more desirable overall response, including the speaker characteristics, a .0047 mf disc capacitor was connected between ground and the plate of the 1st a.f. ampliler. This can readily be done at the tie strip next to the a.f. output-tube socket where the .002 mf interstage coupling capacitor (C_{1001}) is connected. An alternate change is to add a .01 mf capacitor across the existing .0047 one (C_{1002}) that shunts the primary of the output transformer. C_{1002} is the molded job connected to pin 5 of V_{10} socket.

In addition, a cardboard baffle was installed on the loudspeaker. Besides producing a more pleasant sounding a.f. quality, these modifications also reduced background noise. It is understood that future models will come through with similar changes along these lines.

The only other complaint on the unit, which from our viewpoint might be a legitimate one, is that there is no a.g.c. the additional incorporation of which could be more involved than the other simple changes described herein. On the other hand, instructions for installing a simple partial or modified type of a.g.c. are available from the manufacturer.

The transceiver is so constructed that servicing or modifications can readily be conducted; however, during service work, including changing of tubes, one should be sure to disconnect the a.c. power cord from the set, since the a.c. fuse, which is held by clips, is

See page 110 for New Reader Service

located where it may easily be accidentally touched.

With the model we tested, the frequency stability varied somewhat on different bands with 30-minute warmup drift at normal room temperature amounted to 300-500 c.p.s., later settling down to 125-250 c.p.s. per hour with the greatest drift experienced on the 7 mc band. Line voltage variations of ±10% resulted in frequency changes of ±25-125 c.p.s.

The dial calibration accuracy and tracking held to within the width of the fiducial hairline over the phone portions of each band with only a slightly greater variation in other sections. In this respect, initial alignment is made near the center of each range. If closer alignment is required at the lower end of a band, this must be done against an external calibrating signal at which time the v.f.o. trimmer for the particular band must be reset, since the hairline is fixed.

The transmitter output power measured up to the tuneup-c.w. ratings of 100 watts on 3.5, 7 and 14 mc, 80 watts on 21 mc and 60 watts on 28 mc. The p.e.p. output with s.s.b. similarly was 190 watts on 3.5, 7 and 14 mc, 150 watts on 21 mc and 110 watts on 28 mc. Third-order distortion products were slightly under the rating of approximately 25 db down.

The receiver sensitivity on any band measured up to the rating of 0.5 μv for 10 db S+N/N. Image rejection, not rated, was 80, 100, 82, 90 and 110 db on the 3.5, 7, 14, 21 and 28 mc bands respectively. No internal spurious-response tweets were found on any band. Sideband suppression was 40 db at 1 kc and increased further out.

Although the Cygnet 260 is a compromise between price and operating facilities, it is a dandy unit that does a good job and well fulfills the purpose for which it is intended. It is priced at $435. A deluxe version of the Cygnet, the Model 270, has just been introduced and includes such additional features as a meter, a.g.c., a.l.c., crystal calibrator, dial set, an advanced filter, sideband selection, a.f. and r.f. gain controls, carrier-balance and mic-gain controls on panel, sockets for v.o.x. accessory and for external v.f.o. or crystal-oscillator accessories. The Model 270 is priced at $525. The manufacturer is Swan Electronics, 305 Airport Road, Oceanside, California 92054.

—W2AEF

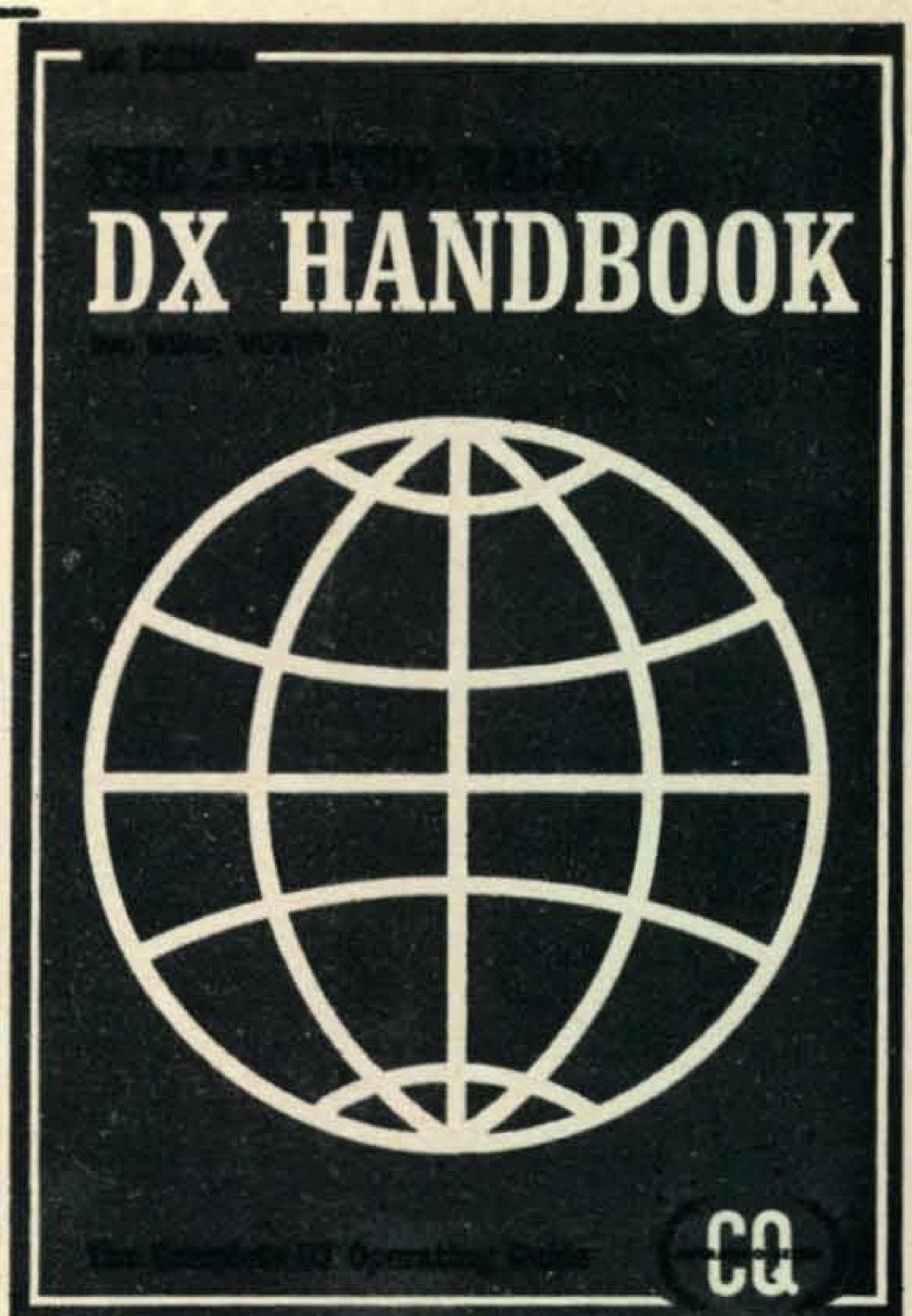
ELECTRONICS library

QUIET

THE AMATEUR RADIO DX HANDBOOK
By Don Miller, W9WNV

It would be unfair to any radio amateur chasing DX to tell him not to buy Don Miller's DX HANDBOOK. It's a good investment. The book is so jam-packed with vital information, miscellanea, and trivia that there is something for almost everyone. The list of contents includes just about every conceivable DX'ing situation and happenstance. However, if you're looking for more dirt about the Miller vs ARRL controversy, you will be wasting time and money—it isn't here. In fact, Miller goes out of his way to thank W1LVQ and W2NSD for "their inspiration and generous contribution of material."

Published by Cowan Publishing Corp., 14 Vanderventer Ave., Port Washington, N.Y. 11050. Soft cover. 200 pages. $5.00.



Popular Electronics reviewed our *Amateur DX Handbook* in their June issue. Why don't you see for yourself what people are talking about. Inspect a copy at your local distributor or use the coupon below to order one. By the way, it would make a great Christmas gift.

Cowan Publishing Corp., 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11050

THE AMATEUR RADIO DX HANDBOOK, $5.00 each, Postpaid

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See page 110 for New Reader Service

DX

BY JOHN A. ATTAWAY,* K4IIF

As announced in last month's news flash, the *CQ* S.S.B. DX Awards will not be terminated this year. Both the DX office in Winter Haven, Florida and *CQ*'s main office in Port Washington, New York received many letters protesting the abandonment of this part of the program. Most of those who wrote felt that the awards were too well established to drop, even though s.s.b. was now commonplace rather than a rare novelty as it was when the program began. Also, there has been a significant surge in applications. Accordingly, we bow to the will of the DXing public and extend the s.s.b. awards for another year. If interest continues to build during this time they will join WAZ and WPX as a permanent part of the system, so all of you who wrote in get busy and let's see you on the Honor Roll. There's still plenty of room.

Silent Keys

We regret to report the passing of two prominent DXers, Walt Knoop, W2LA (ex-W2PXR), and Russ Schilling, W2LAX. Both were very active members of the North Jersey DX Association.

De Extra

Plaudits to the League: The recent effort by the American Radio Relay League Board of Directors to implement the preparation of a country's list jointly with the IARU amateur societies has received commendation from the world's most prestigious single amateur DX group, the International DX Organization (IDXO). Gérard de Buren, HB9AW/WA6QAU and Coordinator of IDXO activities, strongly endorsed this action by the Director's of the world's largest national amateur radio society. His endorsement was contained in a news release from the Organization's Geneva, Switzerland headquarters.

The DXers of the world owe particular thanks for this forward step by the League

*P.O. Box 205, Winter Haven, Fl. 33880.

S.S.B. DX Honor Roll

WA2RAU	319	W6YMV	303	F2MO	292	G3WW	269
W2TP	318	WØQVZ	303	W2FXN	292	MP4BBW	267
W9ILW	316	XE1AE	302	K1IXG	288	W8BVF	266
VK3AHO	315	W2BXA	302	W2LV	286	G2PL	265
W3NKM	315	G3AWZ	301	W6EUF	286	G2BVN	264
TI2HP	314	G3DO	301	K8RTW	286	W2FXE	264
W2RGV	314	G6TA	301	W9EXY	284	WA6GLD	263
W8DE	314	WA2EOQ	301	SM6CAS	281	W2MJ	261
DL9OH	313	W3DJZ	301	W3KT	281	W9QLD	261
I1AMU	312	G3HDA	300	W1LLF	280	W6PTS	260
WA2IZS	312	K1SHN	300	W6UOU	280	W6WNE	259
K6LGF	312	W4IC	300	W3FWD	279	PJ2AA	258
G3FKM	310	W9JT	300	W4RLS	279	PAØEEM	256
KP4CL	310	W4SSU	299	K4OEI	279	CT1PK	254
W4NJF	310	5Z4ERR	298	DL3RK	278	W6BAF	254
WA8AJI	310	VE3ACD	297	DL1IN	276	K6CAZ	254
W4OPM	309	K2DX	297	K4HYL	276	HP1JC	252
K6YRA	309	W4QCW	297	W7DLR	276	PAØSNG	252
G8KS	307	W8BT	297	PZ1AX	274	K4GXO	252
W5KUC	307	KØUKN	297	K9EAB	273	VE6TP	251
SM5SB	305	K8IKB	296	K9LUI	273	W8ILC	251
W2ZX	305	W8EVZ	293	W6RKP	272	W1AOL	250
K6CYG	305	K8ONV	293	G3NUG	270		

to Mr. Sumner H. Foster, WØGQ, Director of Midwest Division. It was Mr. Foster who moved that this modernized country's list be prepared.

New WPNX Award Manager

Notice to all Novices: WPNX, the *CQ* DX Award for Novices only, is under new management. Future applications should be sent to Jerry Hagen, WA6GLD, who is Editor of the Southern California DX Club Bulletin and a DXer of unbounded enthusiasm. We are happy to welcome Jerry to the *CQ* DX team, and are certain that he will do a good job with the Novice DXers.

Activity from Rare Zones

Most of the reports on activity in Zones 17, 18, and 19 is courtesy of VE3EWY via *Long Skip,* the publication of the Canadian DX Association. All of the stations reported were heard on 20 meter c.w.

Zone 17: UJ8AC, Boris, at 0142Z; UJ8AZ,

Jerry Hagen, WA6GLD, longtime Editor of the Southern California DX Club Bulletin and one of the most enthusiastic DXers on the west coast. Jerry is our new WPNX Award Manager.

See page 110 for New Reader Service

Very neat station of JA2CLI, Yoshio Sameshima—outstanding Transpacific 160 meter DXer. Using two 6146s/120w into an inverted Vee, apex 105' at Microwave relay station site. Worked VK5KO, KH6IJ, W6s, W7s, VE7AKI, UAØOW and others. Heard W1BB/1 for "First Ever" Amateur Signal from East Coast USA. Congratulations your magnificent 160 meter performances "Jun." (Photo Via W1BB).

Victor, at 0153Z; UL7KDW, Sergei, at 0110Z; UM8BB, Gene, at 0207Z; UL7HV, Abdumarit, at 0232Z; UJ8AJ, Vlad, at 0213Z; UL7PV, Dima, at 0200Z; UL7KAD, Vlad, at 0249Z; UI8IK, Gen, at 0155Z; UA9DB, Costa, at 0201Z; and UA9ES, Vlad, at 0030Z.

Zone 18: UV9AC, Anatol, at 0230Z; UA-9US, Oscar, at 0126Z; UA9KHB, Slawa, at 0200Z; UA90K, Gera, at 2345Z; UV9UT, Igor, at 0105Z; UW9YO at 0135Z; UA9VB, Vic, at 0230Z; UAØSL, Vit, at 1230Z; and UA9KHL, Vlad, at 1235Z.

Zone 19: UVØEJ, Toly, at 1220Z; UAØC, Micha, at 1105Z; UWØIP, Adolph, at 1128Z; UWØFV, Victor, at 1233Z; UWØIW, Herman, at 1230Z; UAØGK, Valera, at 1240Z; UAØNS, 14203 s.s.b. at 1045Z; UAØER, Ed, at 1315Z; and UAØZB, Anatol, at 1345Z.

Zone 23: JT1AK, Radna, on 21055 c.w. QSL to P.O. Box 92, Ulan Bator, Mongolia.

Zone 24: VS6AL, 14247 s.s.b. at 1230Z; and VS6AA, 21382 s.s.b. at 1625Z.

Zone 26: XW8AL, 21220 s.s.b. at 1620Z.

Zone 34: SU1IM, 14200 at 0240Z and 14005 at 0330Z; ST2SA, 21085 at 1955Z, QSL to Box 125, Madani, Sudan; and 5A2TR, 14332 at 1920Z.

S.S.B. WAZ

715........K2DJD	720........W5RNG
716........YV5CIL	721........WAØOAH
717........JA1EZL	722........K7RLS
718........K9PPX	723........6Y5DW
719........OA4BS	724........FO8BS

C.W.—Phone WAZ

2750........K4IEX	2761........UQ2GA
2751........KØDYM	2762........UB5CK
2752........JA1IVV	2763........UD6BW
2753........W6EBO	2764........UA4KNA
2754........W2AMM	2765........W1BGD
2755........WA4UOE	2766........W9NVJ
2756........VE5XJ	2767........K7RLS
2757........K9WMV	2768........W6CS
2758........WB2RSW	2769........YU2OB
2759........WA2FQG	2770........K6HPZ
2760........UA3DI	

Phone WAZ

418........W2CNQ	422........W3AEV
419........F9MD	423........VK3LW
420........DL5SV	424........F8UM
421........CT1PK	

To obtain rules and application blank for WAZ send a self-addressed, stamped envelope to DX Editor, P.O. Box 205, Winter Haven, Fl. 33880.

New and Rare Prefixes

C31: This prefix is in full use in Andorra. This column doesn't understand this situation as Regulation 772.211 of Article 19, Section 3, Radio Regulations of ITU specifies the following construction for amateur call signs: "One or two letters and a *single* digit, followed by a group of not more than three letters."

EA8: EA8FO frequents 7045 kc c.w. around 0740Z.

EIØ: The permanent use of this prefix is limited to the Irish Radio Transmitters' Society club station, EIØRTS. However, the special stations EIØSI and EIØSR/mm were legal temporary operations. The station purporting to be EIØRO is a pirate. (Tnx EI9F, Secretary, Irish Radio Transmitters Soc.)

HA7: HA7LF was reported on 14180 at 0147Z.

HH9: HH9DL is very active on s.s.b. with a Swan 500. He likes 14245, 14255 and 21250.

HV3: HV3SJ is quite active around 14190 on s.s.b. QSL to WB2ETI.

JW7: JW7UH has been heard on 14002 at 0035Z and 14016 at 0130Z.

OY9: Try OY9LV, "Ole" in Torshavn, near 14201 at 1031Z. QSL to W3HNK.

PD3: This was a special prefix used by Dutch amateurs from Sept. 19-28, 1969.

VR6: Tom Christian, VR6TC, likes 21355, s.s.b. at 2155Z. QSL to Box 1, Pitcairn Is.

WC4: WC4GSC was a special station operated by the Georgia Southern College Ama-

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teur Radio Club during the State Fair, Oct. 11-19, 1969.

YK1: YK1WB, son of YK1AA, was worked on 14105 s.s.b. QSL to Box 35, Damascus.

ZA1: YU3AR/ZA1 was active Aug. 18 on 20 meter c.w. His beam heading was correct. QSL to YU3AR and hope.

ZM1-ZM5: This series can be used in place of ZL1-ZL5 by New Zealand amateurs between Oct. 1, 1969 and Dec. 31, 1970 as part of the Bi-Centenary Celebration of Captain James Cook's first landfall in the Pacific.

4LØ & 4JØ: 4LØCR and 4JØFR were a University of Moscow field trip in Zone 19.

6O1: 6O1GN was reported on 14255 at 1920Z.

7XØ: 7XØWW was heard on 21018 at 1825Z.

9X5: 9X5AA is Leo G. Cyr, U.S. Ambassador to Rwanda. Listen on 21345 at 1945Z.

Rare Countries on S.S.B.

Amsterdam Island: Gilbert, FB8ZZ, is active around 21257. QSL to F8US.

Andorra: C31CL likes 14 mc around 14220, QSL to W7CRT. C31CI frequents 14190, QSL to HB9SJ.

British Honduras: VP1DW is active around 21300-320 at 21-2200Z.

Cocos Keeling Island: VK9KY frequents 14196 around 1000Z.

Easter Island: Listen for CEØAE near 14225-230 at 0230-0300Z.

Faeroes Islands: OY9LV is active on 20 meters near 14225 around 2300Z.

French Somaliland: FL8MB likes 14220 at 0200Z.

Gabon: TR8DG (formerly TN8AA) has been worked on 21267, 14195, and 14203. QSL to P.O. Box 356, Libreville, Republic de Gabon.

Grenada: VP2GAL is often heard on 14198 at 0100-0200Z.

Indonesia: YBØAAD activates this country on 15 meters, 21342 is a reported frequency.

Kazakh: Try for UL7SG, 14228 at 0415Z; and UL7NW, 14213 at 0355Z.

Liechtenstein: HBØXWS operates around 14210.

Luxemburg: LX1BW on 21310 at 1925Z.

Nepal: Father Moran, 9N1MM, is very active on 20.

Saudi Arabia: HZ1AB has been active around 14240 at 0000-0100Z.

C.W. WPX

960........SM6DHU	964........UA3DB
961........DK1UP	965........UB5WL
962........OK2BCH	966........SP1ACA
963........UW3KBI	

S.S.B. WPX

445........JA5LI	451........G3XKV
446........CE6EF	452........WAØOAH
447........W7BJ	453........KØRTH
448........VK4MY	454........HB9AKJ
449........CX3BH	455........UA3AVV
450........W3CDL	

Mixed WPX

207........SM6DHU	209........GM5AHS
208........PY1HX	

VPX

Jorma Turunen—OH2-829

WPX Endorsements

S.S.B.: W4OPM—850, OK1MP—500, W4-DQD—400, VK4MY—350, W8GKM—350, CX3BH—300, WAØOAH—300, HB9AKJ—250, and UA3AVV—250.

C.W.: W8KPL—850, W2AIW—750, K2DDK—500, SM5BNX—500, DK1HP—350, OK2-BCH—350, SM6DHU—350, and UA3BS—350.

Mixed: PY1HX—500 and SM6DHU—450.

Europe: GM5AHS, OK2BCH, and OH2-829.

South America: DL1QT

80 Meters: UA3GO

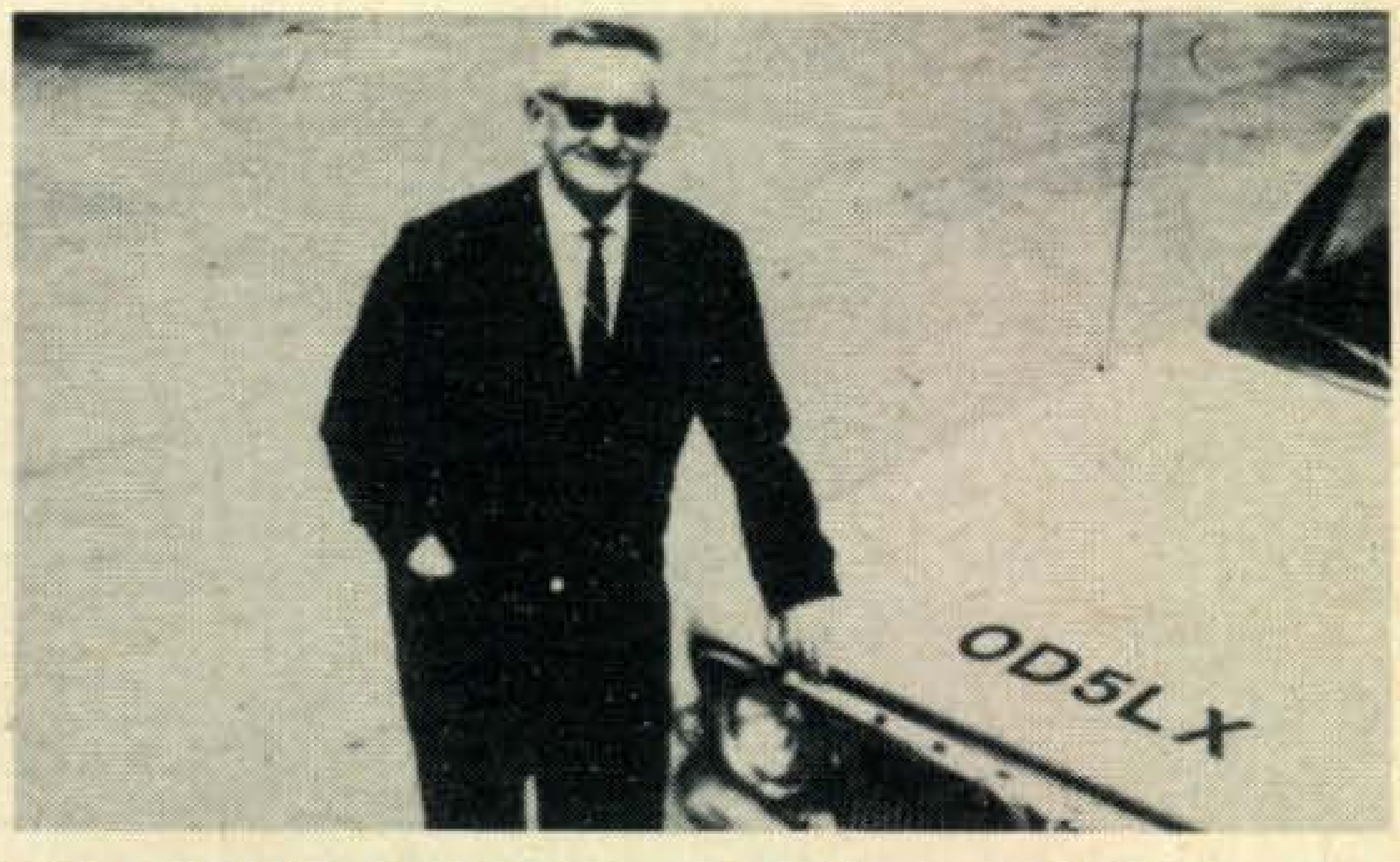
40 Meters: UT5CC

10 Meters: UA3AVV

To obtain rules and application blank for WPX send a self-addressed, stamped envelope to WPX Manager, 6563 Sapphire Drive, Jacksonville, Fl. 32208 or tto DX Editor, P.O. Box 205, Winter Haven, Fl. 33880.

Spanish Sahara: Angelo, EA9ER, works 15 and 20. Reports show 14240 at 2240Z and 21335 at 1600 and 1635Z.

Thailand: There should be plenty of oppor-



This OM has given many a happy DXer a new one. Ted, OD5LX, one of Lebanon's top operators. This photo was taken by Alex, VE2AFC, on his recent trip to the Middle East.

See page 110 for New Reader Service

tunities for legal contacts with Thailand now that the ban has been lifted.

Upper Volta: XT2AA, Jacques, appears regularly near 21277 around 1800Z.

VK9 Countries: Papua and the Territory of New Guinea are combined and have been assigned the call series VK9AA-VK9MZ. Norfolk Island will use VK9NA-VK9NZ, Christmas Island will use VK9XA-VK9XZ, and Cocos-Keeling Island will use VK9YA-VK9YZ. It is presumed that presently held calls will not be changed.

QSL Information

CR6IK—Via W8CNL
CR7DB—To CR6GO, Box 10408, Luanda, Angola.
CX2CO (From Jan. 1, 1969)—c/o W2GHK, P.O. Box 7388, Newark, N.J. 07107.
EA8FO—Box 860, Las Palmas, Canary Islands.
ET3USA—Via VE3IG, Vic N. Olacke, 287 Kathleen Ave., Sarnia, Ontario.
GD3KDB—To WB2YQH.
GD3LNS—c/o WB2YQH.
GD6UW (1969 DXpedition)—Via W2GHK.
KA1C—To WA8NZH.
KV4FZ(from June 1, 1969)—c/o W2GHK.
KX6GD—Via W2LRI.
KX6FN/KC6 (June, 1969 operation to W. Carolines)—To W2GHK.
KX6EQ/KC6 (June, 1969 operation to W. Carolines)—c/o W2GHK.
PA∅KOR—Via WB6YNK, 235 Mar Vista Drive, Monterey, Calif. 93940.
PQ2PA (1969 WPX Contest)—To W2GHK.
PT2PE (1969 WPX Contest)—c/o W2GHK.
TA2SC—Via K4EPI.
VE8RCS (from April 1, 1969)—To W2GHK.
VK2BKM/Lord Howe—c/o W2CTN.
VP5CS—K. D. Collins, RCA MTP, Grand Turk Comm, Patrick AFB, Fl. 32925.
VP7NS—To WA5OCG.
VP8JT—Via VE1ASJ, NOT to VE1AST.
VP8KF—To G3TWV, 2 Wyke Lane, Fardon, Newark, Notts., England. Not to G3LDA.
VS9MB—c/o G3KDB.
W4EXI/portable—Via W2GHK.
WF6NNW—To WA6AHF.
XT2AA—c/o WA5REU.
XW8CR—Via W2CTN.
YU3AR/ZA1—To YU3AR.
ZD3D—c/o WA9UVE.
ZD8AR (1969 WPX Contest)—Via W2GHK.
ZD8CS—K. D. Collins, RCA MTP, Grand Turk Comm, Patrick AFB, Fl. 32925.
ZD9BM (from May, 1969)—To W2GHK.
ZS4AK—Via WA∅KGD.
3V8MOL—c/o W2GHK.
3V8NC—Via G3TXF, Holt Cottage, Kingston Hill, Surrey, England.
4Z4NAI—NOT via W6TMP.
9E2USA—To VE3IG, 287 Kathleen Ave., Sarnia, Ontario, Canada.
9F3USA—c/o VE3IG, 287 Kathleen Ave., Sarnia, Ontario, Canada.
9V1PM—Colin R. McRae, 40 Jalan Chempaka Puteh, Singapore 16.

73, John, K4IIF

The S.S.B. DX Award Program

100 Countries

577........K3BYV	586........K8CMO
578........W6CYO	587........VK3JM
579........CT1PK	588........K4RTA
580........ZS6NM	589........K4TSJ
581........CE6EF	590........5Z4KN
582........W1DTY	591........W8GMK
583........K4FLP	592........UA3AVV
584........K4ELK	593........UA3KND
585........W6EBO	594........K6EDA

200 Countries

180........CT1PK	182........XE1OOL
181........ZS6DP	

300 Countries

45........WA2EOQ

Complete rules for the S.S.B. DX Award program and applications may be obtained by sending a self-addressed, stamped envelope to Award's Manager, 3785 Susanna Drive, Cincinnati, Ohio 45239.

WPX HONOR ROLL

The WPX Honor Roll is based on confirmed current prefixes. Stations are listed with both net and gross prefix credits. The Honor Roll is based on the current net regardless of an operator's all-time gross prefix count.

Mixed

W4OPM	Joe Hiller	880/1000
W8LY	Michael Bakos	733/733
K1SHN	Chuck Banta	685/702
I1SF	Serafino Franchi	657/657
W4IC	George A. Mack	626/657
W8KSR	Jon Hodgin	612/612
WA6GLD	Jerry Hagen	575/600
DL1MD	Herbert Recht	557/557

SSB

W4OPM	Joe Hiller	746/850
W4NJF	Gay E. Milius	712/712
DL9OH	Karl Muller	611/611
WA5LOB	James Edwards	601/601
K1SHN	Chuck Banta	586/601
HP1JC	Juan Chen	552/552
I1AMU	Alfonso Porrettta	526/563

CW

W4OPM	Joe Hiller	800/850
W8KPL	William Simpson	741/853
VK3THQ	Henry Denver	706/706
DL1QT	Helmut Baumert	700/700
W8GMK	John Marhefka	578/578
K1SHN	Chuck Banta	572/671
I1SF	Serafino Franchi	554/554

Phone

I1SF	Serafino Franchi	526/526

Application forms for the *CQ* WPX Honor Roll may be obtained by sending a self-addressed, stamped envelope to WPX Manager, Howard Kelley, K4DSN, 6563 Sapphire Drive, Jacksonville, Florida 32208.

See page 110 for New Reader Service

VHF TODAY

BY ALLEN KATZ,* K2UYH

CONSIDERING the importance of the ear in the reception of weak signals, it is surprising that hams and engineers both know so little about its operation. It is after all your ears which do the ultimate detecting of the radio signals you copy.

One to One Signal-to-Noise Ratio

The normal frequency range of hearing is roughly from 50 to 18,000 c.p.s. It is interesting to observe what occurs when an audio tone and noise (spread uniformly over this frequency range) are mixed together (see Figure 1) and then listened to. Most amateurs believe that a 1:1 *S/N* represents the threshold of signal detectability. They may be quite surprised. At a *S/N* of 1:1, the tone actually sounds loud in comparison to the noise. Some hams can detect the presence of a signal buried in as much as 20 db of Noise. This ability to detect the presence of a signal in noise varies from person to person and has been used as the basis for contests at hamfests and like occasions.

Critical Bandpass Effect

The acute ability of people to detect signals in the presence of noise has lead researchers in the field of hearing to postulate the concept of critical bandpasses. This theory pictures the ear as being composed of a series of bandpass filters as illustrated in Figure 2. When receiving a weak signal, the filter in which the signal is centered is assumed to eliminate the out-of-band noise. Using the results of threshold measurements, the equivalent bandpass of the ear as a function of frequency has been determined.[1] An average result is shown in Figure 3.

*66 Skytop Road, Cedar Grove, N.J. 07009.

[1]French and Steinburg, *J. Acoust. Soc. Amer.* Vol. 19, 90-119 (1947).

One must be careful in interpreting the critical bandpass theory. It has been shown by numerous experiments that the ear does not always function in the fashion figure 2 would predict. In the case of listening to weak signals with a variable bandpass receiver, however, the picture of the hearing system supplied by the critical bandpass theory does indeed seem to apply. As you narrow the bandpass of a receiver, you experience the feeling of lessening the noise. This feeling of lessening of the noise may make the copying of weak signal seem more comfortable, but careful observations will show that the actual signal copy has improved very little, if at all. In some instances signal copy can be degraded by going to a narrower filter due to a narrow filter's ringing characteristics.

Systems Consideration

Figure 3 gives us some insight as to what is the minimum *S/N* needed to copy a signal It shows that the presence of a signal can be just discerned at a 1:1 *S/N* with an equivalent 50 c.p.s. bandwidth. What this means is that when evaluating system performance, as discussed in previous columns, one should not use the receiver bandpass, but use the equivalent hearing bandpass of about 50 c.p.s.[2] If this is done, then at a 1:1 *S/N*, a signal should be just discernable by the average person. In practice a bare discerning of the presence of a signal is not adequate for the copy of a c.w. signal. A *S/N* of from 6 to 10 db or even more may be required depending on the operator.

Binaural Effects

From Figure 3 it may be seen that two ears are better than one. An improvement of about 1 db is obtained in signal detectability in the presence of noise by the use of both ears. There are other "two ear" or binaural effects which could have possible interest to

[2]VHF Today, *CQ*, April, Aug. (1968) and Mar. (1969).

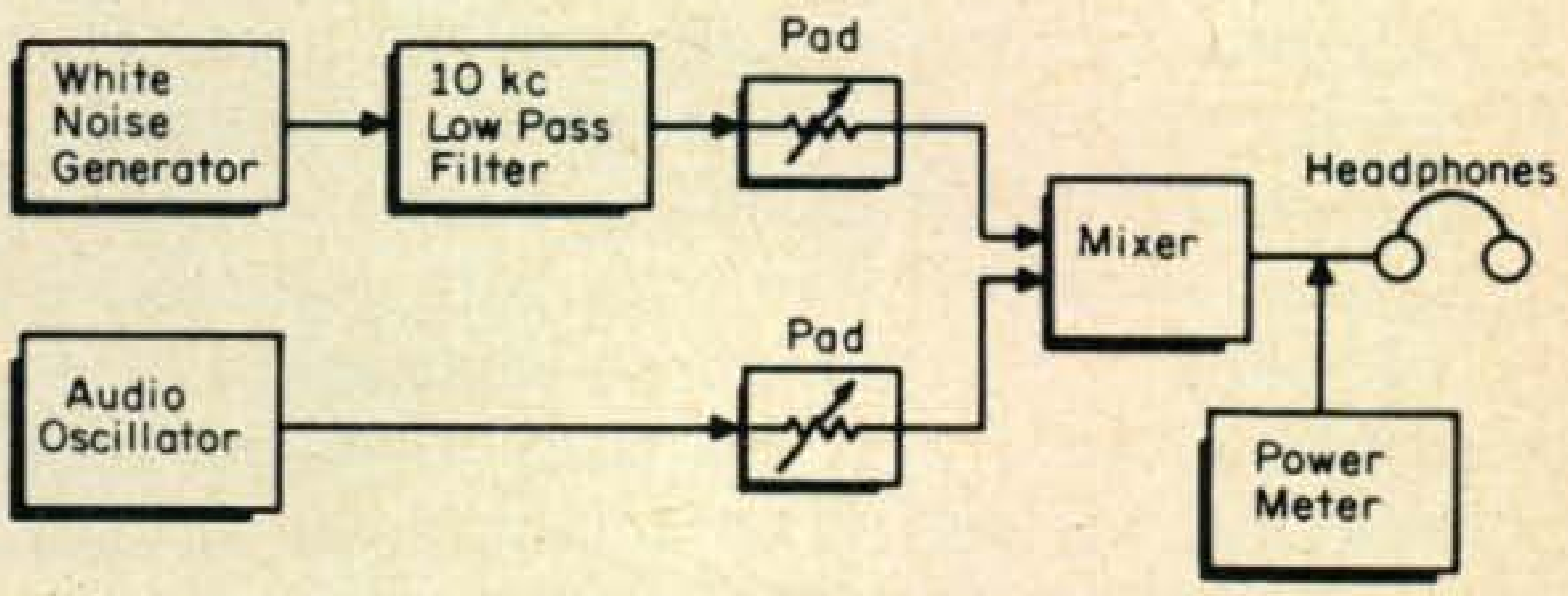


Fig. 1—Apparatus for determining the *S/N* of the hearing system for threshold signal detection.

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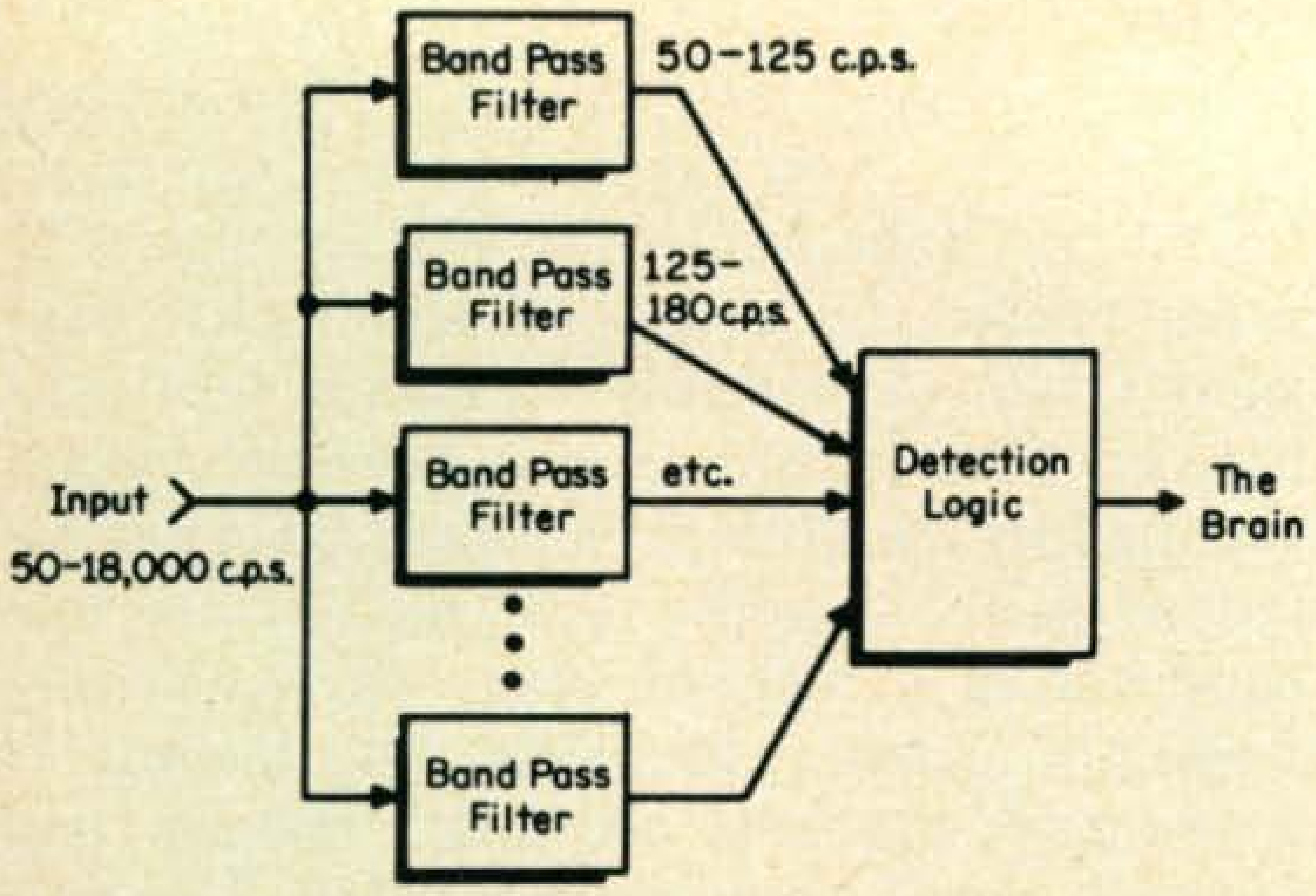

Fig. 2—The hearing system as might be conceived from the point of view of the critical bandpass theory.

radio amateurs.[3] For instance, as much as a 12 db improvement in signal detectability can be obtained if noise is fed in phase to both ears while the signal is 90° out of phase at one ear with respect to the other.

Similarly, our two ear hearing system offers possible application to diversity techniques. What happens at one ear appears almost completely uncoupled with respect to noise from that which occurs at the other. Thus the outputs of two signal channels could be applied respectively to two ears; and the hearing systems could be used to combine the signals in an optimum manner.

Hearing Weak Signals

The above discussion suggests the following practices for successful weak signal copy. (A) You do not necessarily want to use a very narrow receiver bandpass (this is especially the case when you are not sure of the frequency of the signal you wish to receive); (B) adjust the b.f.o. frequency of your receiver such that when the signal is centered in the receiver bandpass, the pitch produced yields best copy. From Figure 3 you would expect this frequency to be about 400 cycles. However, remember that Figure 3 represents the response of the "average" person. The frequency you receive best may be quite different. (C) Use both your ears. (D) Do not run your receiver audio output up too high. The hearing system can overload too. (E) Finally, keep in mind that receiving weak signals is a learned art which improves with practice.

I hope from the above discussion it is clear that your ears are truly a magnificent receiving system. Consequently, it is not

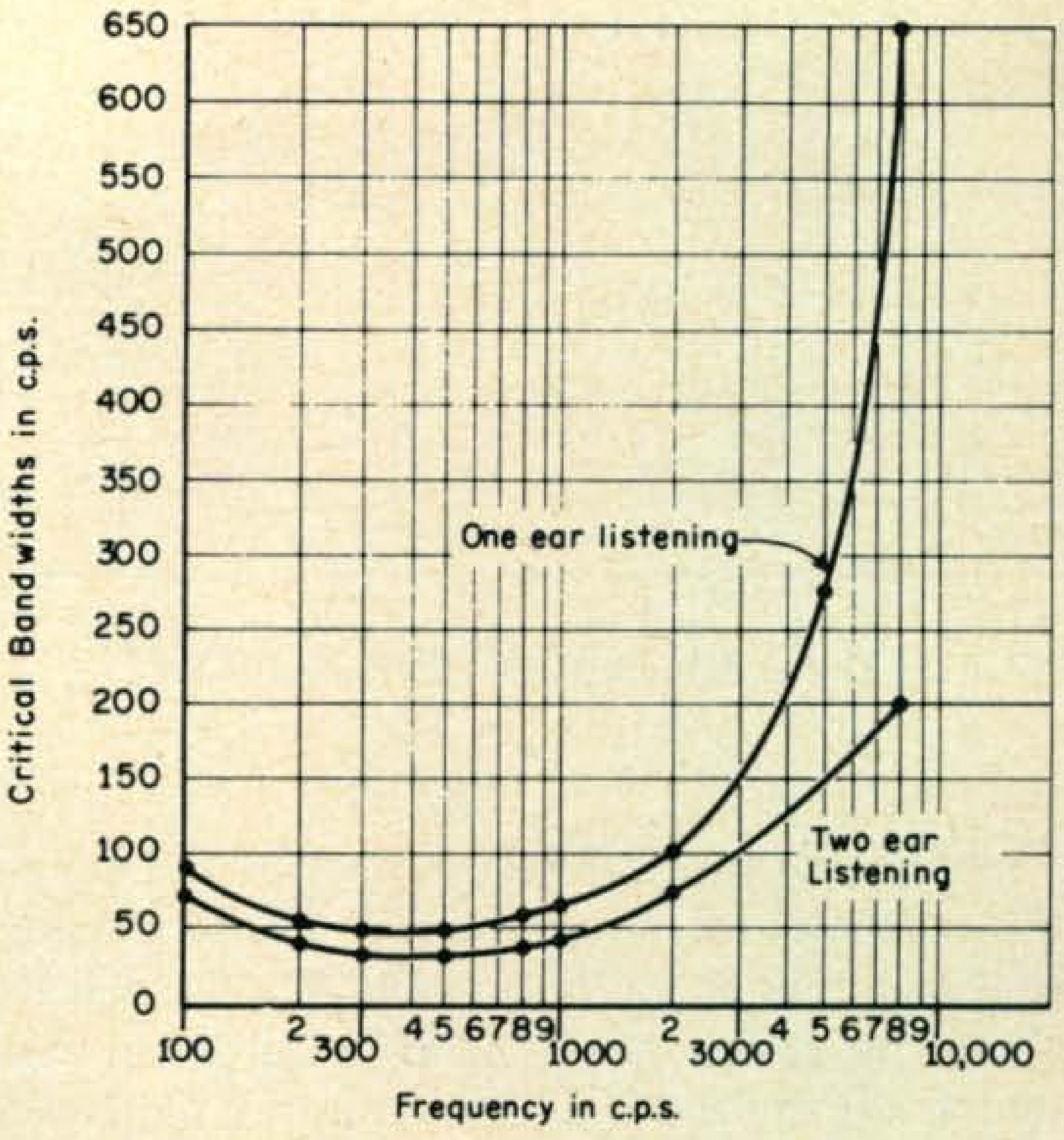

Fig. 3—Critical Bandpasses for "average" listener as a function of frequency.

surprising that schemes which do not rely on the ears to separate signal from noise have been found of little value by amateurs. Perhaps by understanding more clearly how the ears operate, we may someday discover how to improve on them.

73, Allen, K2UYH

[3]D. McFadden, *J. Acoust. Soc. Amer.* Vol. 40, 1414-1419 (1966).

RARE BLOOD CLUB

LAST February the National Rare Blood Club launched a successful appeal to the amateur fraternity for members who have a rare type blood (B+, O−, A−, AB+, B−, and AB−)[1]. The club's policy is to make every effort to provide rare blood when it is needed, whether the recipient is a member of the club or not. Such blood is always made available free of charge.

They would now like to expand their coverage to include college and university amateur radio stations in hopes of interesting their respective school populations to participate in a rare blood program.

Anyone who can possibly take part or assist in the program should contact: Lou Goldberg, WB2SSM, 566 Conway Road, Elmont, N.Y. 11003.

[1]"National Rare Blood Club," *CQ,* February 1969, p. 76.

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Propagation

BY GEORGE JACOBS,* W3ASK

THE c.w. section of the 1969 *CQ* World Wide DX Contest will take place during the weekend of November 29-30. Last month's column contained special DX Propagation Charts for use during the c.w. section. If you plan to participate in the Contest be sure to check the band opening predictions, work plans, and other propagation data appearing in last month's column; these could be helpful in piling up contacts and points during the c.w. section. For a day-to-day forecast of propagation "weather" expected during November, including the Contest period, see the "Last Minute Forecast" appearing at the beginning of this column.

Sunspot Cycle

The peak of the present sunspot cycle appears to have occurred exactly a year ago, with a smoothed sunspot number of 111. Solar activity is now declining slowly, but steadily. The Zurich Solar Observatory reports a monthly average number of 91 for August, 1969. This results in a smoothed sunspot number of 108, centered on February. A smoothed sunspot number of 98 is forecast for this November.

This drop in solar activity is not expected to make a great deal of difference during the 1969 c.w. Contest period. Propagation conditions this year are expected to be much the same as they were during similar periods of the 1968 and 1969 Contests, providing a sudden ionospheric storm does not occur. For a more comprehensive discussion of sunspots and the solar cycle, including a long-range prediction for the remainder of the present cycle, see "A Sunspot Story-Cycle 20: The Declining Years", appearing in this special Propagation issue of *CQ*.

Contest Tips

Here are some propagaton rules of thumb

*11307 Clara Street, Silver Spring, Md. 20902.

LAST MINUTE FORECAST

Day-to-Day Conditions and Quality for Nov. 1, through Dec. 15, 1969

	Forecast Rating & Quality			
Days	(2)	(1)	(4)	(3)
Above Normal: 5, 10, 19, 21-22; Dec. 1, 15	B	B-C	A	A-B
Normal: 3-4, 6-7, 11-12, 15, 17-18, 20, 23-24, 29-31; Dec. 2-3, 5-8, 11, 13-14	C	D	A-B	B
Below Normal: 2, 8, 13-14, 16, 25, 28; Dec. 4, 9-10	D	E	B-C	C-D
Disturbed: 1, 26-27; Dec. 12	E	E	C-D	D-E

HOW TO USE THESE CHARTS

The following is an explanation of the symbols shown above, and instructions for the use of the *CQ* propagation predictions:

1—Enter Propagation Charts on following pages under appropriate band and distance or geographical area columns. Read predicted times of band openings at intersection of both columns.

2—Following each predicted time of band opening is a forecast rating which indicates the relative number of days the band is expected to open during each month of the forecast period. The higher the rating, the more frequent the opening, as follows: (4) band open more than 22 days each month; (3) between 14 and 22 days; (2) between 2 and 13 days; (1) less than 7 days.

On the "Short-Skip" Chart where two numerals are shown within a single set of parenthesis, the first applies to the shorter distance for which the forecat is made, and the second to the greater distance. Note the forecast rating for later use.

3—With the forecast rating noted above, start with the numbers in parenthese at the top of the "Last Minute Forecast" appearing above. Read down the table for a day-to-day forecast of propagation conditions in terms of Above Normal (WWV rating higher than 6); Normal (WWV rating 5-6); Below Normal (WWV rating 4); Disturbed (WWV rating less than 4). The letter symbols (A-E) describe reception conditions (signal quality, noise and fading levels) expected for each day of the month and have the following meaning: (A—excellent opening with strong, steady signals; B—good opening, moderately strong signals, little fading and noise; C—fair opening, signals fluctuating between moderately strong and weak; D—poor opening, signals generally weak and considerable fading and noise; E—poor opening, or none at all.

4—This month's Propagation Charts are based upon a transmitter power of 75 watts c.w.; 150 watts s.s.b., or 300 watts d.s.b., into a dipole antenna one quarter-wave above ground on 160, 80 and 40 meters and a half-wave above ground on 20, 15 and 10 meters. For each 10 db increase above these reference levels, reception quality shown in the "Last Minute Forecast" will improve by one level; for each 10 db loss reception will become poorer by one level.

5—Local Standard Time for these predictions is based on the 24-hour system.

6—These Propagation Charts are valid through Jan. 15, 1970. These Charts are prepared from basic propagation, data published monthly by the Institute for Telecommunication Sciences And Aeronomy of the U.S. Dept. of Commerce, Boulder, Colorado.

that should be helpful in working DX during November, especially during the c.w. Contest period.

During and shortly after *sunrise*, excellent DX conditions are forecast for 20 meters, in practically all directions. Also check reception at this time from the south and west on 40, 80 and 160 meters.

From a few hours *after sunrise* until *late afternoon*, 15 meters is expected to be the optimum band for world-wide DX, with 10 meters a close runner-up. Excellent conditions are ex-

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pected on 15 meters, with good-to-excellent conditions on 10 meters.

During the *late afternoon* and *early evening* hours, check 15 meters for signals arriving from the south, west and north, while 20 meters is expected to be optimum for reception from an easterly direction. Fairly good DX reception from the east and south should also be possible on 40 meters during the early evening hours.

During the *late evening* and *early morning* hours, 20 meters should open for DX to the south, west and northwest, with strong signals. Good openings to almost all areas of the world are also forecast for 40 meters during this time period. Some 80 and 160 meter DX openings should also be possible during the hours of darkness.

Signal levels on most DX openings should be noticeably stronger than during the summer and early fall months, as a result of a seasonal decrease in static and solar absorption that is expected to take place during November.

Short-Skip Charts

This month's column contains a Short-Skip Propagation Chart for use in the continental United States for predicting one-hop openings between distances of approximately 50 and 2300 miles. Special propagation Charts centered on Hawaii and Alaska are also included. These Charts are valid through January, 1970.

The following are two typical examples illustrating the use of these short-Skip Charts:

Example 1: What is the best time to work between New York City and Denver on 15 meters?

a. Determine the great circle distance between both points from a map or globe. In this case, the distance is approximately 1600 miles.

b. Enter the Short-Skip Chart at the line marked "15", under the Band (Meter) heading. Go to the right until you intersect the "1300-2300" column under the Distance From Transmitter (Miles) heading. The highest quality rating (the numbers between 1 and 4 shown in the parenthesis after the time of opening) indicates the time that signals will be the strongest and most reliable. In this case, the highest rating is a (4), between 11 and 16 local standard time at the path mid-point.

c. New York City is in the Eastern Time Zone and Denver is in the Mountain Zone. The mid-point of the path is approximately 800 miles from either end of the circuit, and falls in the Centra Time Zone. The 11-16 time period found in (b), should be expressed in CST. This corresponds to 11 A.M. to 4 P.M. CST, which is the same as 12 Noon to 5 P.M. in N.Y.C., or 10 A.M. to 3 P.M. in Denver. Arranging a schedule anytime within this period should result in an excellent 15 meter opening between N.Y.C. and Denver.

Example 2: What is the best *band* to use on a schedule between Seattle and Los Angeles, at 4 P.M. Seattle time?

a. The great circle distance is found from a map to be approximately 1,100 miles.

b. Seattle is in the Pacific Standard Time Zone, and so is Los Angeles. The mid-point of the path must also fall in the Pacific Zone. Times in the Chart are given in the 24-hour system, and 4 P.M. corresponds tto 16. No further time correction is required.

c. Enter the Chart under the column marked "750-1300 Miles". Check the quality ratings for each band at 16 hours. Since the distance between both points is nearer to 1300 than 750 miles, the second of the two quality figures appearing in the parenthesis will apply.

d. At 16 hours a quality figure of (2) is found for 10 meters; (4) for 15 meters; (4) for 20 meters; (2) for 40 meters; (1) for 80 meters and (0) for 160 meters. Either 15 or 20 meters would be the best band to use between Seattle and Los Angeles at 4 P.M. PST.

V.H.F. Ionospheric Openings

Some auroral-type v.h.f. ionospheric openings are likely to occur during the month, especially when ionospheric conditions on the h.f. bands are below normal or disturbed. Check the "Last Minute Forecast" at the beginning of this column for the days that are most likely to be in these categories during November.

Solar activity is still high enough that an occasional F-2 layer opening may be possible across the United States, between Hawaii and the mainland, and between the USA and Latin America. The best time to check for 6 meter F-2 layer openings is from just before noon, through the late afternoon hours.

Several meteor showers are expected during November, which should produce some meteor-type openings on the v.h.f. bands. Check November 5 and 12 when the *Taurids* shower is expected to peak, November 14 when the *Bielid* shower should peak, and between Novmber 14-18 when the *Leonids*, the biggest shower of the month, is forecast. *Leonids* should reach its peak intensity during the evening hours of November 17.

November should be a good month for trans-equatorial, or TE scatter openings between the USA and Latin America. The evening hours are the best time to check for TE openings, between approximately *8 and* 11 P.M., local standard time at the path mid-point.

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Be sure to read the article "V.H.F. Ionospheric Propagation" appearing elsewhere in this special issue of *CQ* for a more comprehensive review of the various modes of ionospheric propagation that may occur in the v.h.f. bands.

Good luck in the c.w. Contest, and please let me know how the DX Propagation forecast for the Contest turns out.

73, George, W3ASK

November 15, 1969-January 15, 1970

Local Standard Time at Path Mid-Point

(24-Hour Time System)

Distance From Transmitter (Miles)

Band (Meters)	*50-250*	*250-750*	*750-1300*	*1300-2300*
10	*Nil*	*Nil*	07-09 (0-1) 09-11 (0-2) 11-15 (0-3) 15-16 (0-2) 16-18 (0-1)	07-08 (1) 08-09 (1-2) 09-11 (2-3) 11-15 (3-4) 15-16 (2-3) 16-17 (1-3) 17-18 (1-2) 18-20 (0-1)
15	*Nil*	08-10 (0-1) 10-16 (0-2) 16-18 (0-1)	07-08 (0-1) 08-09 (1-2) 09-10 (1-3) 10-11 (2-3) 11-16 (2-4) 16-18 (1-2) 18-20 (0-1)	07-08 (1) 08-09 (2) 09-11 (3) 11-16 (4) 16-18 (2-3) 18-20 (1-2) 20-22 (0-1)
20	09-11 (0-1) 11-15 (1-2) 15-17 (0-1)	07-09 (0-2) 09-11 (1-3) 11-15 (2-4) 15-17 (1-4) 17-18 (0-3) 18-20 (0-2) 20-07 (0-1)	07-09 (2-3) 09-11 (3-4) 11-17 (4) 17-18 (3-4) 18-20 (2-3) 20-22 (1-2) 22-07 (1)	07-09 (3) 09-15 (4-3) 15-18 (4) 18-19 (3-4) 19-20 (3) 20-21 (2-3) 21-22 (2) 22-00 (1-2) 00-06 (1) 06-07 (1-2)
40	07-08 (0-2) 08-09 (1-3) 09-17 (4) 17-19 (2-3) 19-21 (1-2) 21-07 (0-1)	07-08 (2-3) 08-09 (3) 09-15 (4-3) 15-17 (4) 17-19 (3-4) 19-20 (2-4) 20-21 (2-3) 21-06 (1-2) 06-07 (1-3)	06-08 (3) 08-09 (3-2) 09-15 (3-1) 15-17 (4-2) 17-20 (4) 20-21 (3-4) 21-03 (2-4) 03-06 (2-3)	06-08 (3-2) 08-09 (2-1) 09-15 (1-0) 15-17 (2-0) 17-19 (4-3) 19-03 (4) 03-06 (3) (3)
80	08-21 (4) 21-00 (3-4) 00-04 (2-3) 04-07 (2) 07-08 (3-4)	08-09 (4-2) 09-16 (4-1) 16-18 (4-3) 18-00 (4) 00-04 (3-4) 04-07 (2-3) 07-08 (4-3)	08-09 (2-1) 09-16 (1-0) 16-18 (3-1) 18-20 (4-3) 20-04 (4-3) 04-07 (3) 07-08 (3-1)	08-09 (1-0) 09-16 (0) 16-18 (1-0) 18-20 (3-1) 20-04 (4) 04-06 (3-2) 06-07 (3-1) 07-08 (1)
160	07-09 (3-2) 09-11 (2-0) 11-17 (1-0) 17-19 (3-2) 19-07 (4)	07-09 (2-1) 09-17 (0) 17-19 (2-1) 19-04 (4) 04-07 (3-2)	07-09 (1-0) 09-17 (0) 17-19 (1-0) 19-21 (4-2) 21-04 (4) 04-06 (2) 06-07 (2-1)	07-19 (0) 19-21 (2-1) 21-04 (4-3) 04-06 (2-1) 06-07 (1-0)

*Indicates predicted 80 meter openings. Openings on 160 Meters are also likely to occur during those times when 80 Meter openings are shown with a forecast rating of (2) or higher.

ALASKA

Openings Given In GMT‡

To:	*10 Meters*	*15 Meters*	*20 Meters*	*40/80 Meters*
Eastern USA	16-18 (1) 18-23 (2) 23-01 (1)	15-17 (1) 17-20 (2) 20-23 (3) 23-00 (2) 00-02 (1)	12-16 (1) 16-18 (2) 18-21 (1) 21-23 (2) 23-01 (3) 01-03 (2) 03-05 (1)	06-12 (1) 07-11 (1)*
Central USA	18-20 (1) 20-23 (2) 23-01 (1)	16-18 (1) 18-20 (2) 20-00 (3) 00-02 (2) 02-03 (1)	12-17 (1) 17-18 (2) 18 21 (1) 21-23 (2) 23-03 (3) 03-04 (2) 04-06 (1)	06-08 (1) 08-13 (2) 13-14 (1) 07-12 (1)*
Western USA	18-20 (1) 20-21 (2) 21-22 (3) 22-00 (2) 00-02 (1)	17-19 (1) 19-21 (2) 21-22 (3) 22-00 (4) 00-02 (3) 02-03 (2) 03-04 (1)	12-17 (1) 17-20 (2) 20-22 (3) 22-01 (4) 01-03 (3) 03-05 (2) 05-07 (1)	02-03 (1) 03-05 (2) 05-14 (3) 14-15 (2) 15-16 (1) 04-06 (1)* 06-14 (2)* 14-16 (1)*

HAWAII

Openings Given In Hawaiian Standard Time†

To:	*10 Meters*	*15 Meters*	*20 Meters*	*40/80 Meters*
Eastern USA	06-07 (1) 07-10 (2) 10-11 (3) 11-13 (4) 13-14 (3) 14-15 (2) 15-16 (1)	06-07 (1) 07-12 (2) 12-13 (3) 13-15 (4) 15-16 (3) 16-17 (2) 17-18 (1)	13-15 (1) 15-17 (4) 17-21 (3) 21-00 (2) 00-06 (1) 06-08 (2) 08-13 (1)	18-19 (1) 19-20 (1) 20-01 (3) 01-02 (2) 02-04 (1) 19-20 (1)* 20-01 (2)* 01-03 (1)*
Central USA	06-07 (1) 07-09 (2) 09-10 (3) 10-14 (4) 14-16 (3) 16-17 (2) 17-18 (1)	06-07 (1) 07-08 (2) 08-09 (3) 09-11 (2) 11-13 (3) 13-16 (4) 16-17 (3) 17-18 (2) 18-19 (1)	07-09 (3) 09-14 (2) 14-16 (3) 16-18 (4) 18-22 (3) 22-00 (2) 00-06 (1) 06-07 (2)	18-19 (1) 19-20 (2) 20-02 (3) 02-03 (2) 03-05 (1) 19-21 (1)* 21-02 (2)* 02-04 (1)*
Western USA	07-08 (1) 08-09 (2) 09-10 (3) 10-12 (4) 12-15 (3) 15-17 (4) 17-18 (3) 18-19 (2) 19-20 (1)	06-07 (1) 07-08 (2) 08-13 (3) 13-18 (4) 18-19 (3) 19-20 (2) 20-21 (1)	08-10 (4) 10-16 (3) 16-22 (4) 22-00 (3) 00-03 (2) 03-06 (1) 06-08 (2)	18-19 (1) 19-20 (2) 20-03 (4) 03-05 (3) 05-06 (2) 06-07 (1) 19-20 (1)* 20-21 (2)* 21-04 (3)* 04-05 (2)* 05-06 (1)*

‡To convert to Local Standard Time in Alaska, *subtract* 8 hours in the Pacific Standard Time Zone; 9 hours in the Yukon Zone and 10 hours in the Alaskan Standard Time Zone, from the GMT times shown in the Chart. GMT is 5 hours *ahead* of EST; 6 hours *ahead* of CST; 7 hours *ahead* of MST and 8 hours *ahead* of PST. For example, when it is 18 GMT it is 13 or 1 P.M. EST in NYC.

†Hawaiian Standard Time is 5 hours *behind* EST; 4 hours *behind* CST; 3 hours *behind* MST; 2 hours *behind* PST and 10 hours *behind* GMT or Z time. For example when it is Noon in Honolulu, it is 17 or 5 P.M. EST, in NYC.

See page 110 for New Reader Service

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YOU probably have several very near and dear friends who are Hams, for whom expensive and elaborate Christmas gifts this year are out of the question.

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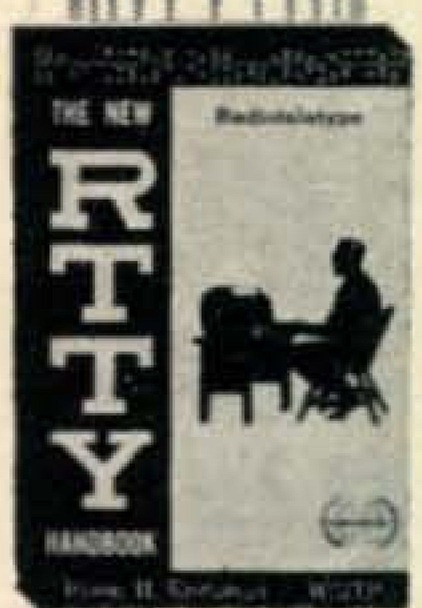

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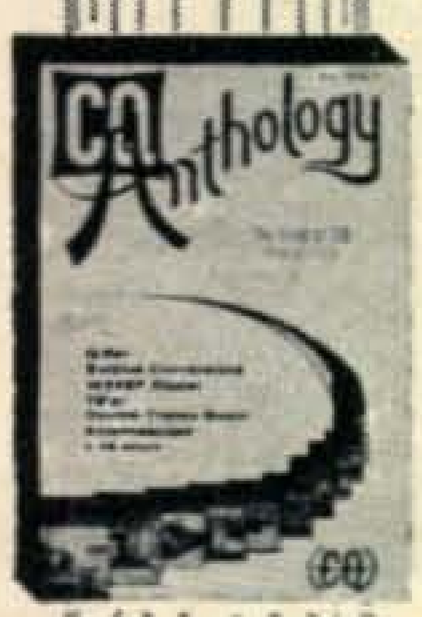

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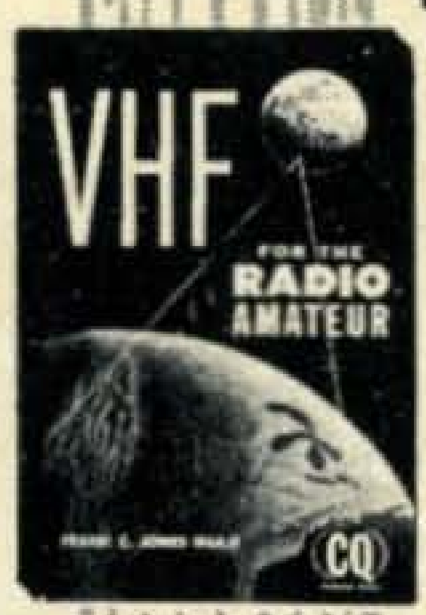

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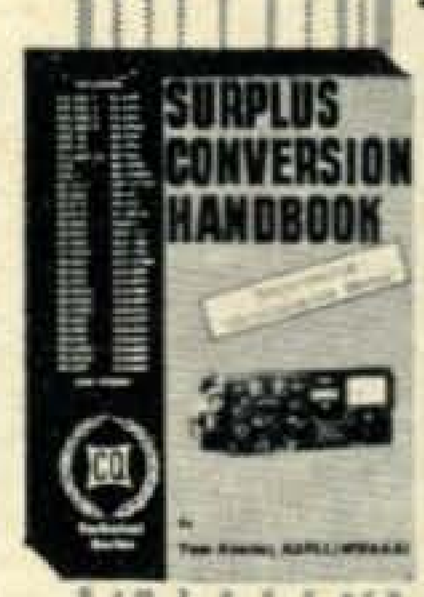

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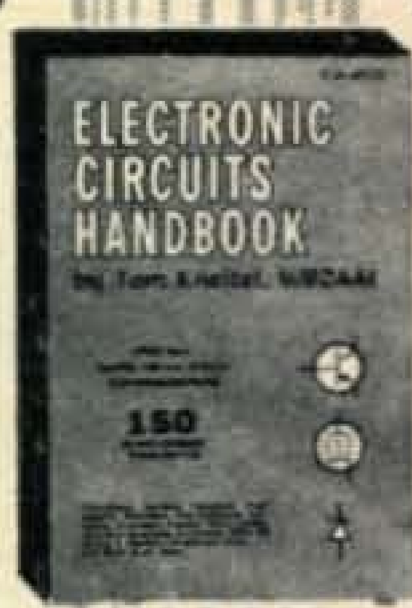

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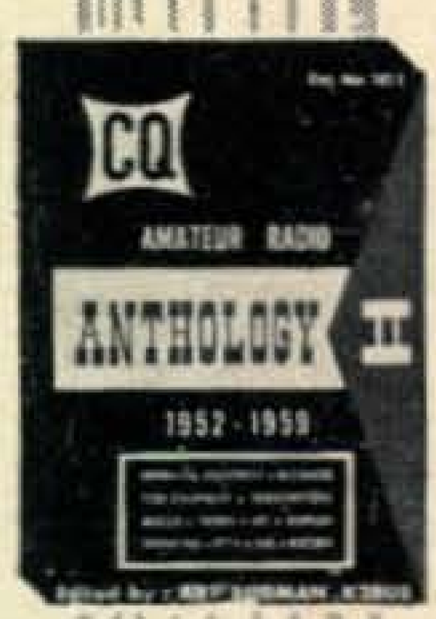

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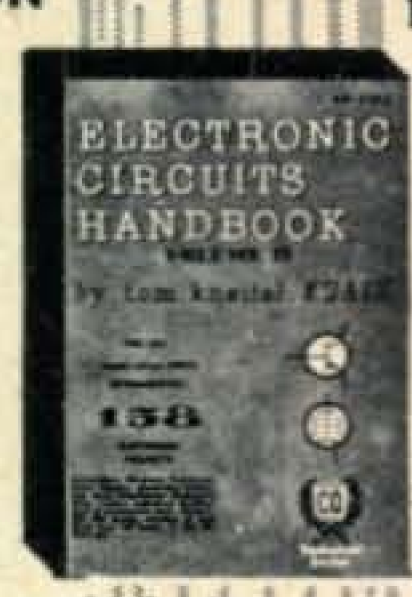

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Q AND A

BY WILFRED M: SCHERER,*
W2AEF

TXI Problems and Solutions

THIS month's column will be devoted to the growing menace of TXI. If you don't know what TXI is all about and its possible implication for amateur-radio operation, we suggest you first read the editorial page and the introduction to the Q & A Column in the August 1969 issue of *CQ*.

For those who are or may in the future be plagued with TXI, the following information supplied by several readers should be of important interest.

The first of such correspondence is from Sam E. Parker, W6ZWK, 3651 Ligget Drive, San Diego, California 92106. It particularly reflects the poor performance and attitude to be expected on the part of manufacturers of solid-state or other-type appliances.

"Your concern for the growing problem of TXI is timely and highly commendable. Along with your Q & A Column, I was glad to see *CQ* Magazine take a strong editorial position on this increasing troublesome form of radio interference in the issue dated August, 1969.

"As requested in your column, I am enclosing a copy of my letter to the FCC on May 6, 1969, giving an account of our experience with a portable solid-state stereo phonograph.

"I have been assured that the FCC is genuinely interested in this serious problem."

W6ZWK's letter to the Secretary of the FCC contains the following:

"I hope the Commission will take effective action to alleviate the growing problem of radio interference to poorly designed and inadequately shielded solid-state devices now being manufactured and distributed in this country.

"Being an electronics engineer for many years, I have had considerable experience with problems of electromagnetic incompatibility, some of which is described in my letter on Solid-State Susceptibility on page 45 of the October 1967 issue of *QST*.

"Mr. George Grammer, Technical Director of ARRL (the publishers of *QST*) in commenting on my letter, suggested that the owners of solid-state audio devices persuade the dealer to apply the necessary remedies. My efforts to follow his advice in the case of severe interference in our daughter's General Electric stereo phonograph were time consuming and futile.

"The local G.E. service center referred me to the Audio Products Department, Decatur Ill. My first letter, dated August 27, 1967, was ignored. When the amplifier became inoperative early this year, I wrote a second letter on January 25, 1969, and a third on February 5, 1969. After all three of my letters were ignored, I requested assistance from Mr. Fred J. Borch, President of General Electric, in a letter dated February 13, 1969.

"On March 3, 1969 I received a most cooperative letter from a specialist in consumer relations in the Audio Products Department. A complimentary copy of a technical service manual was provided. No mention was made of the radio interference problem, but I was referred to the Manager of the local service center for any additional repairs that may be necessary so that your phonograph will operate according to factory specifications,' and I was told there would be no additional charge for this service. The service center subsequently repaired the equipment *to satisfy factory specifications,* as promised, but the interference problem persists.

"I have discussed this matter with Mr. J.M. Winfrey, Manager of the local service center, and with some of his technicians. At first they clearly implied that my radio transmitter was at fault. Later, Mr. Winfrey admitted that the equipment was not designed to prevent this type of interference and he estimated that the required shielding and other changes might increase the cost of the equipment by $50-$60. He emphasized that *all* guarantees and warranties on the phonograph and his work became *void* if I or anyone else made unauthorized modifications or changes of any kind.

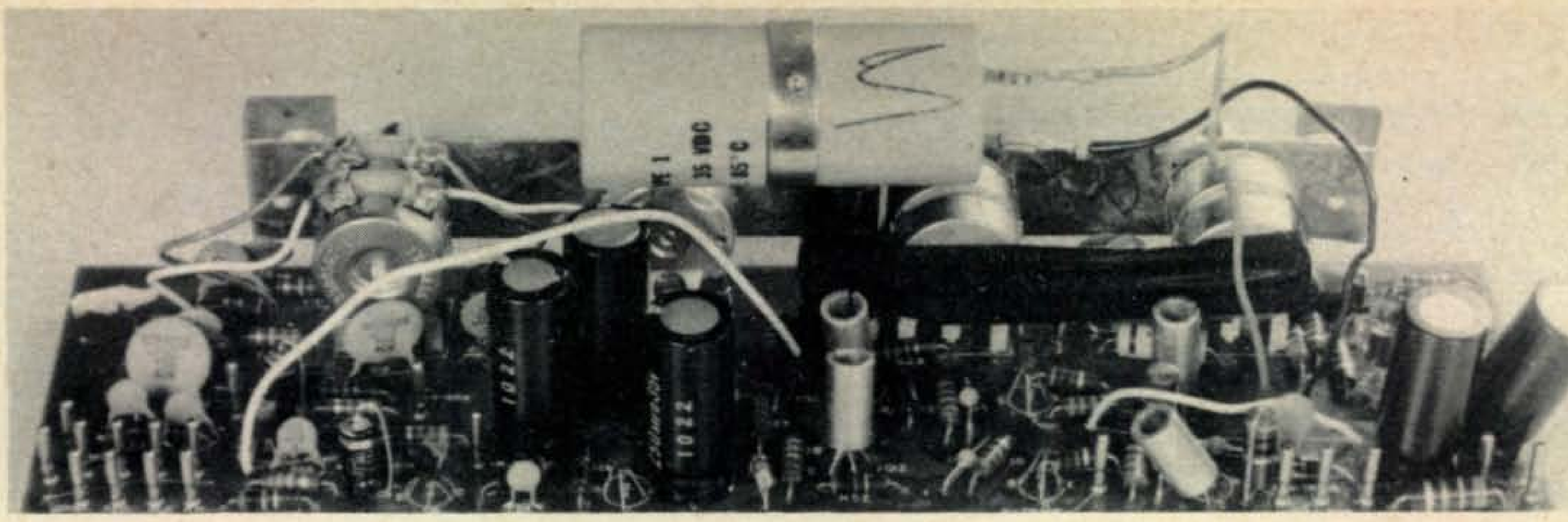
"Obviously, this growing interference problem is not limited to solid-state audio devices, nor to products of a single manufacturer. Moreover, from recent conversation with Mr. Clarence Spillman, Radio Technician in Charge of your San Diego Office, I understand that my experiences with phonograph and recording devices, intercom sets, electric guitars, TV-booster amplifiers, etc., are quite common and widespread.

"In view of the foregoing, I recommend that the Commission take appropriate steps to correct or greatly alleviate these broad problems of elecromagnetic incompatibility. I personally feel that these basic problems should be corrected at the source during design and manufacture and *not* by add-on devices or other retrofit measures. And, of course, *all manufacturers* should be required to satisfy specific standards, inspections and tests which substantially reduce the magnitude and incidence of these annoying problems."

A Successful Solution

Now for a letter from Chuck Edwards, K7UIS/W3CTA, 1717 150th S.E., Bellevue, Washington 98004. In it, Chuck describes preventive measures he has found to be ef-

*Technical Director, *CQ*.



The printed-circuit board assembly for a G.E. T7N stereo amplifier. Its final installation is made without the benefit of shielding. Note the long wire leads which in themselves or in resonance with circuit capacitances could easily be susceptable to r.f. pickup and induce TXI, even if no external leads were connected. From the TXI reports on hand, the problem often is related to only one amateur band, thus indicating the possibility of circuit resonances in the affected equipment.

fective in combating TXI.

"Your article on TXI was thoroughly enjoyed, particularly so, because I recently experienced several exposures to this 'horrendous monster.'

"I first tried all sorts of things, hoping to find a solution. I soldered and unsoldered filter capacitors, chokes, resistors and you-name-it to incoming a.c. lines, input circuits, speaker leads, etc.; all to no avail. I almost gave up until I tried the hard way. It seems that about 99.9 percent of the so-called expensive Hi-Fi tape recorders, record playbacks, intercoms, radios, etc., have only partial shielding. Probably the only reason these equipments have even partial shielding is because the manufacturer needed a rigid mount for his transistorized components. Most, even the most expensive, have open bottoms and at least one side of their chassis completely exposed. Of course, these open sides are esthetically by beautiful and exotic rare woods which, as we all know, are useless as r.f. shields. So the solution becomes obvious as follows:

"(a) Solder and attach with sheet-metal screws a contiguous metal screen (screen-door variety) to the bottom of each chassis. The same must be done to the side or sides, if unprotected. Many of the record players will have a large hole where the turntable shaft comes through the chassis. This must be shielded. In addition, carefully examine each chassis for any hole or opening that is larger than 3/16" and screen them too.

"(b) Solder one filter capacitor to each side of the incoming 120 v.a.c. bus (on the inside of the chassis) to chassis ground. This capacitor should be a minimum of .01 to 0.1 mf at 500 v.d.c. The NPO disc variety seem to be satisfactory

"(c) Solder one capacitor to each ungrounded speaker lead and to chassis ground. These capacitors should be approximately .002 at 200 v. The disc type are satisfactory here too.

"(d) Connect all chassis together with at least #14 size copper wire and tie this wire to a suitable ground, such as a cold-water pipe. Incidentally, the screen must be soldered around its perimeter to be contiguous."

A Similar Solution

Now for the solutions described by Joseph A. Kramer, WA9DJR, 5631 S. Oak Park, Chicago 38, Illinois. Joe's TXI problem involved a Motorola Quasar color-TV set wherein the audio components of his 160-meter signals, from either a Drake TX-4 on s.s.b. or a Heath DX-100 on a.m., were reproduced in the a.f. section of the TV set; a situation not experienced with his other conventional black-and-white TV sets. The TXI, incidentally, was experienced with transmitter operation on only the 160-meter band. His letter, which follows, is in response to remedial suggestions we had previously forwarded to him.

"I tried the following, at least one of which 'did it':

"1. Installed a Hi-pass filter.

"2. Installed a line filter consisting of a three-wire grounded cable, 4-feet long, covered with a braid from a piece of coax and terminated in a brute-force filter.

"3. Pulled out the 'drawer' of the set and removed the inside-track hardware. Then installed a shield, made up of aluminum screening, tacked at top, bottom and cabinet side and folded around the remaining side when the TV receiver was back in the cabinet. Also cut a piece for the back.

The TV set is only a few feet from the transmitting system and no TXI is now experienced."

Other Considerations

The installation of the preventitive measures described in the two preceding communications should similarly turn out to be effective in many other cases; however, from W6ZWK's experiences, it should be apparent that such attempts at eliminating TXI or modifying equipment other than your own, could well meet considerable resistance on the part of the owner in view of the possible voidance of guarantees. As for your own appliances, we'd say, "to heck with the guarantee," since as also noted from W6ZWK's

[*Continued on page 92*]

Contest Calendar

BY FRANK ANZALONE,* W1WY

Calendar of Events

Nov.	1-3	ZERO District QSO Party
Nov.	5-6	YLAP Phone Contest
Nov.	8-9	OK DX C.W. Contest
Nov.	8-9	RSGB 7 mc Phone Contest
Nov.	8-9	YV "El Dorado" SSB Contest
Nov.	8-9	ARRL SS Phone Contest
Nov.	15-16	ARRL SS C.W. Contest
Nov.	22-24	Trilliums' Memorial Week
Nov.	**29-30**	**CQ WW DX C.W. Contest**
Dec.	6-7	Alexander Volta RTTY
Dec.	6-7	CHC International C.W.
Dec.	6-8	Nevada QSO Party
Dec.	13-14	CHC International SSB
Jan.	17-18	Louisiana QSO Party
Jan.	**24-25**	**CQ WW DX 160 Contest**
Jan. 30–	Feb. 2	Old Timers QSO Party

ZERO District QSO Party

Two Periods (GMT)
0000-0400 Saturday, November 1
0000 Sun. Nov. 2 to 0400 Mon. Nov. 3

The Roosevelt H.S. ARS of Des Moines got this announcement to us much too late to make last month's issue. However the following rules may help you in preparing your log before submitting it.

*14 Sherwood Road, Stamford, Conn. 06905.

Michael Bazley, G3HDA (left) was presented the W4BVV Operators 1967 European Phone Trophy by Dr. John Allaway, G3FKM DX Editor for *Radio Communication* the RSGB bulletin. The occasion was a "farewell party" for Mick by the West Midland DX Club. Mick is now in Australia and will soon be signing a VK6 call.

Exchange: QSO nr., RS/RST and QTH; county and state for ZERO stations; ARRL section or country for all others.

Scoring: *For ZERO stations:* ARRL sections and DX countries × ZERO district counties × total QSOs for final score.
For all others: ZERO district counties × ZERO states × total QSOs for final score.

The same station may be worked on each band and mode. ZERO stations may work other ZERO stations.

Frequencies: 3575, 3975, 7075, 7275, 14075, 14300, 21075, 21300, 28600. Novices, 3720, 7170, 21120.

Awards: Certificates to the top scorer in each ZERO county, ARRL section, foreign country.

Mailing for your log is December 1st and they go to: Roosevelt H. S. ARC, WAØQJX, 45th and Chamberlain, Des Moines, Iowa 50312. Include a s.a.s.e. for copy of results.

YV "El Dorado" SSB Contest

Starts: 0000 GMT Saturday, November 8
Ends: 2400 GMT Sunday, November 9

This contest has been organized to commemorate the 1st anniversary of the Guri Dam, a huge project located in the Guayana region.

Following rules are for all stations other than YVs.

Exchange: Five figures, RS report plus a progressive 3 figure QSO number starting with 001.

Points: Stations in North and South America are permitted to work all stations. Each QSO counts 1 point, 2 points if its with a YV.

Stations on other continents are limited to working American countries and YVs only. Each QSO counts 1 point, 2 points if its with a YV, 3 points if the YV is on 40 meters.

Multiplier: Sum of different countries, YV prefixes (9) and club station YV5AJ and each YV6 station worked.

Final Score: Total QSO points times the

See page 110 for New Reader Service

countries and YV prefixes on each band. The final overall score is the sum of the scores from each band.

Awards: Certificates will be awarded to stations meeting following requirements. Stations in the Americas: Work 20 YV stations, 10 other countries and 1 official station. (YV5AJ or any YV6) Stations on other continents: Work 5 YVs and 5 American countries. SWLs: Report 50 stations working contest.

There are also many special awards, trophies and medals for the top scorers in many catagories.

A remittance of $1.00 or its equivalent in IRC's is requested with your log if it meets any of the above requirements for a certificate.

Logs must be received before March 15, 1970 and go to: Radio Club Venezolano, "El Dorado" Contest, Apartado 2285, Caracas, Venezuela.

Trillium Memorial Week

Starts: 0030 GMT Saturday, November 22
Ends: 0030 GMT Monday, November 24

The object of this party is to work as many Trilliums (a VE YL organization) as possible during this week-end. The non-member with the highest score will be presented with a plaque, and will also have his name and call enscribed on the Albert Theodor Jensen Memorial Trophy.

Exchange: Signal report, name and QTH. The club members will also give their club number and identify themselves by calling CQ TMW. Non-members will call CQ TOT.

Scoring: C.W. contacts count 2 points, phone 1 point. There is a low power multiplier of 1.25 for stations running 150 watts or less on c.w. or a.m. and 300 watts p.e.p. on s.s.b. (Each Trillium station may be worked only once regardless of band or mode.)

Frequencies and times: 3685 on the 22nd at 19:00, 23rd at 02:00 and 22:15. 3855 on the 22nd at 16:00, 23rd at 00:00 and 19:45. 7030 on the 22nd at 15:00 and 23:00, 23rd at 18:30. 7240 on the 22nd at 20:00, 23rd at 15:00 and 23:30. 14035 on the 22nd at 02:00 and 22:00, 23rd 17:15. 14140 on the 22nd at 17:00, 23rd at 01:00 and 21:00. 14240 on the 22nd at 00:30 and 21:00, 23rd at 16:00. (All GMT)

Mailing deadline December 31st and logs go to: Bubbles Timlick, VE4ST, 1317 Magnus Ave., Winnipeg 14, Manitoba, Canada.

For the past few years Gene Krehbiel, VE6TP has donated a Trophy to the highest scoring Canadian in our contest. Here is Gordon Russell, VE3-LV President of the Kitchner Radio Club, presenting the 1968 WPX SSB Cup to Doc Hallatz, VE3FHO and Garry Hammond, VE3GCO who operated the station.

CHC International Contest

C.W.–Dec. 6-7 S.S.B.–Dec. 13-14
Starts: 0001 GMT Saturday
Ends: 2400 GMT Sunday

This is the second annual contest sponsored by the CHC International. The c.w. section is administered by Chapter #73, the s.s.b. by Chapter #88.

Exchange: The usual 5 or 6 figures, signal report plus a progressive QSO number starting with 001. Then followed by entrant's catagory, CHC or HTH and 73 or 88 if a Chapter member.

Points: One point per QSO, 2 points if its with a CHCer, 3 points if it's with a 73 or 88 Chapter member. A bonus of 50 points may be added to each 100 QSO points made on 80

[*Continued on page 91*]

The 1967 USA Phone championship Trophy donated by the Potomac Valley Radio Club was finally presented to Doug Gaines, W4AXE (left) by our own DX Editor John Attaway, K4IIF at the Orlando Hamfest last April.

THE awards PROGRAM

BY ED HOPPER,* W2GT

FLASH!
Joseph P. Skutnik, W2JWK
Has Qualified for #12
USA-3079-CA All Counties Plaque!
SEE W2JWK "STORY" NOV. 1967 CQ

FLASH #2
Eddie Palmer, K4LSP
Has Qualified for #13
USA-3079-CA All Counties Plaque!
SEE K4LSP "STORY" DEC. 1969 CQ

THE November, "Story of The Month" about Paul, W4YXW, after this interesting information.

Joe Skutnik, W2JWK qualified for #12 Plaque for All 3079 Counties, and Eddie Palmer, K4LSP qualified for Plaque #13 for All 3079 Counties!. Al Pulling, K1WQU received a Mixed, USA-CA-3000 award, as did Paul Newberry, W4YWX. Eddie Palmer, K4LSP held out until he made All 3079, then received Mixed USA-CA-3000 and 2500 awards, *and* All 14 mc A3A 2000, 1500, 1000, and 500 awards. Wilberta "Willie" Longwell won a Mixed USA-CA-2500 award (congrats Grandma). John Ochmann, WA8-NDL qualified for All 14 mc 2× SSB 2500, 2000, 1000, and 500 awards. Al Lane, K5-MWV was issued a USA-CA-2000 award endorsed All A-3. Corwin Arndt, WAØLRQ received a USA-CA-2000 and a 1500 award, both endorsed All A3A. John Coe, WB2-TWM qualified for USA-CA-2000 Mixed award; USA-CA-1500 and 1000 awards endorsed All 20 M SSB and a USA-CA-500 award endorsed All 20 M SSB and All 80 M SSB. Bob Blakemore, WA3APO/4 received USA-CA-2000 and 1500 awards endorsed All 14 mc, All 2 × SSB, All Mobile. Jim Perry, K4WVX qualified for Mixed USA-CA-1500 and 1000 awards. Nick Arms, WA-ØVDQ (ex-WA5HSU) received Mixed USA-CA-1500, 1000 and 500 awards. Clarence Blalock, K4EO also received a Mixed USA-CA-1500 award. Garry Hammond, VE3GCO qualified for a USA-CA-1000 Mixed award and a USA-CA-500 award endorsed Mixed, All 14 mc SSB, All Mobile; as far as I can check, Garry is the first s.w.l. to receive our award and then later *work* 500 or more counties and receive an award as an amateur. Dick Bently, K2UFT won a USA-CA-

*103 Whitman St., Rochelle Park, N.J. 07662.

Paul Newberry, W4YWX.

USA-CA HONOR ROLL

3000	K1WQU	23
3000	W4YWX	24
3000	K4LSP	25
2500	WA7IRD	52
2500	WA8NDL	53
2500	K4LSP	54
2000	K5MWV	72
2000	WAØLRQ	73
2000	WA8NDL	74
2000	WB2TWM	75
2000	K4LSP	76
2000	WA3APO/4	77
1500	K4WVX	102
1500	WAØLRQ	103
1500	WA8NDL	104
1500	WB2TWM	105
1500	WAØVDQ	106
1500	K4LSP	107
1500	K4EO	108
1500	WA3APO/4	109
1000	W4WVX	165
1000	VE3GCO	166
1000	K2UFT	167
1000	WA8NDL	168
1000	WB2TWM	169
1000	K3ZMI	170
1000	WB6SVV	171
1000	WAØVDQ	172
1000	K4LSP	173
1000	WA3APO/4	174
500	VE3GCO	731
500	WA4DOT	732
500	K2UFT	733
500	WA8NDL	734
500	WB2TWM	735
500	K3MGQ	736
500	K3ZMI	737
500	WAØVDQ	738
500	W7DVQ	739
500	G2MI	740
500	K4LSP	741

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1000 award All A-1 and a USA-CA-500 award endorsed All 7 mc A-1. Van Hodgden, K3ZMI qualified for USA-CA-1000 and 500 awards endorsed All 7 mc A-1. A Mixed USA-CA-1000 award went to Ben De Piazza, WB6SVV. Bob Sparrow, WA4DOT was issued a USA-CA-500 award endorsed All 80 M, All SSB. Greg Weiler, K3MGQ received a Mixed USA-CA-500 award. Phil Chaney, W7DVQ, was sent a USA-CA-500 award endorsed All SSB. My friend, Arthur Milne, G2MI finally found time to work on his Record Book and thus qualified for a Mixed USA-CA-500 award.

Paul H. Newberry, Jr., W4YWX

Although it is not difficult to have a wonderful QSO with Paul and get a QSL from W4YWX, it is most difficult to get Paul to talk about himself. Here is the information I was able to pry from him.

An interest in ham radio was acquired while a Junior in high school. A short time later, in January 1953, WN4YWX appeared, mostly on 21 mc c.w.

DX hunting became a habit after putting up a home-made 4 element beam. Except for a few years spent as a Radioman with the Navy, Paul has been active almost every day on some band.

In 1958 he again joined the massive pile-ups of a mad DX world. Ten years later, after 337 countries, Paul said—"he about had it", with only about four spots left.

Paul travels about 50,000 miles a year in his work, so accidentally finding the County Hunters was really a pleasure.

Much time was spent giving out *many* counties over the bottom half of Georgia before Paul decided to see how many he could collect. As this is being written, 3063 have been worked and 3061 have been confirmed.

Paul has had the pleasure of meeting many of the County Hunters in the past year and a half at Jackson, Mississippi and Mountain Home, Arkansas. (See fotos June and October *CQ* 1969). Also quite a few have visited Paul in Macon, Georgia, including: WØKZZ, K8VZW, W1EQ, W4EHN, WB4LDK (OX-5BA), W4QBM (WB9BAD), WB4KGJ, K4-ARF, WA4FGX and WA4VWV. Paul insists that the fraternalism that exists among the County Hunters is something that is rare anywhere today.

An Extra Class Ticket was acquired in March 1968, but it is of little use as Paul is

W4YWX Georgia Mobile Award.

usually on 14336.

Among the 240 certificates/awards from 37 countries received by W4YWX are WPX (400), DXCC, WAZ, WAS and WAC. Paul and John Laney, K4BAI hold the World Record for North America for TGØAA in the 1967 CQ WW DX (CW) Contest, Multi-operator, Single Transmitter Class.

Our records show that Paul waited until April 1969 to apply and then received All 14 mc SSB endorsed USA-CA-500 award #707, 1000 #154, 1500 #92, 2000 #62 as well as Mixed 2500 #44. On August 16, 1969 a Mixed USA-CA-3000 award #24 went to W4YWX.

It is next to impossible to figure the number of QSOs and counties Paul has given to so *many many* County Hunters.

His mobile rig is a TR-3 and a pair of Hustler antennas. The "home" equipment includes Drake R-4A, T-4XB and Thunderbolt Linear. Antennas are 2 el. 40M over 3 el. 15M over 3 el. 20M.

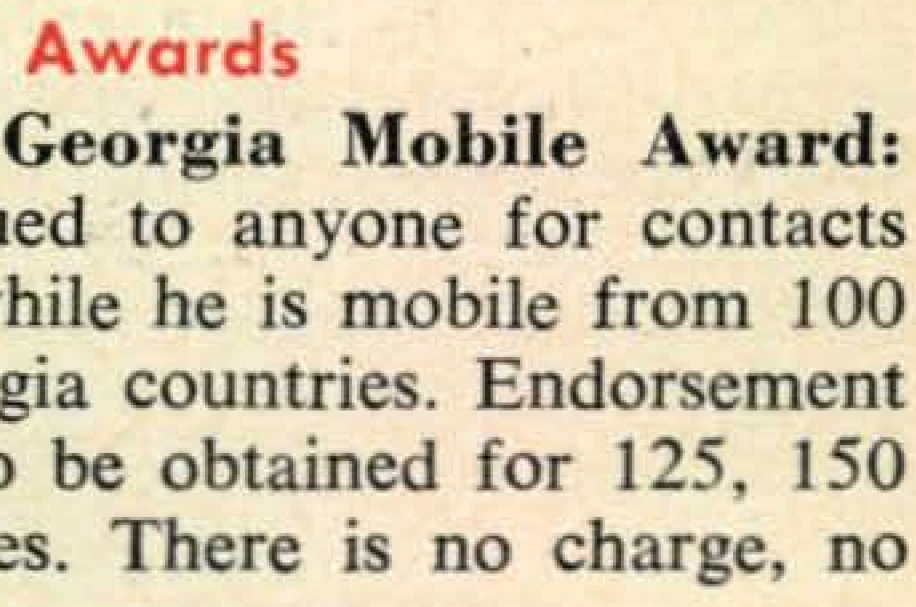
Any County Hunter who has not worked W4YWX must need a new receiver as Paul is one of the most active and loudest mobiles on the Independent County Hunter Net on 14336!

Awards

The W4YWX Georgia Mobile Award: This will be issued to anyone for contacts with W4YWX while he is mobile from 100 of the 159 Georgia countries. Endorsement stickers may also be obtained for 125, 150 and 159 countries. There is no charge, no

[*Continued on page 90*]

NJDXA Award.



SURPLUS sidelights

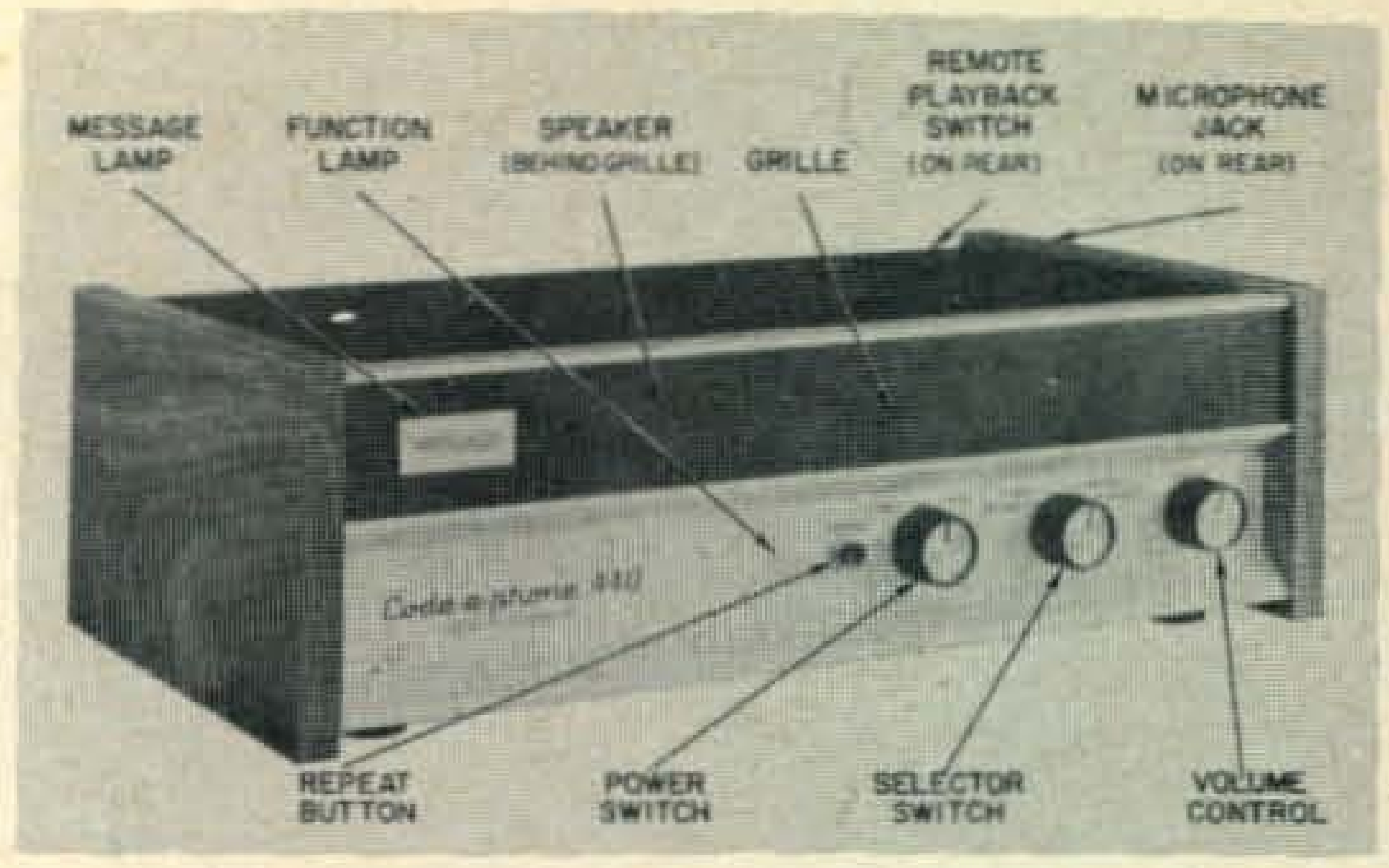


Fig. 2—Exterior view of the #440 Code-A-Phone recorder.

THE silly season has been upon us this fall, with a Drew Pearson column claiming that the Pentagon was selling, surplus, Titan III-C intercontinental ballistic missiles, which some militant could buy and aim at Washington. As anyone who is familiar with the government's surplus policies can attest this is impossible because (1) the missiles and most of their delicate equipment will be left in the open during the wettest months of the year, while the bidding is held; (2) the cables to the units, consisting of 2,000 pairs of wire with $1,000 special plugs, will be sold in Nome, Alaska, as copper scrap; (3) the fifth grade shop class of Galesville School will be given first crack at the guidance sections, with wire-cutters, for a week as part of a "science project," and, finally, Chief Bosun's Mate William Cumshaw will "requisition" the stainless steel hardware to dress up the Admiral's Barge at Shallowater Naval Base.

This of course is typical treatment for the most expensive electronic gear coming out of the Pentagon's surplus factories these days. It has gotten so bad recently that NAV-2, the Marine Corps Military Affiliate Radio System (MARS) station in Washington has had to beg parts from area amateurs, to keep certain equipment going. The nearby NavComStation MARS unit, while better off, has had to have some outside help in recent months, and so on. There is one favored MARS unit on the east coast which gets all kinds of goodies, including nearly 50 Tektronix 'scopes, which the Central Intelligence Agency tried unsuccessfully to requisition while they were being screened as "excess."

Actually Surplus has been an on-again, off-again business in recent months, as the war in Viet Nam drags on, and only the certified junk filters out to the friendly surplus dealers. Truckloads of test gear and other goodies roll off to state agencies, most of it to be utterly wasted, and other material skips off to the gray market which has grown up in surplus.

This is not meant as a bitter comment, only a tongue-in-cheek version of reality. Someday, probably soon, war surplus will be with us again, but this fall it is the commercial surplus which is of most interest.

Two items have shown up recently which I think worth covering. One is the German-made HELL system of teleprinted transmission, a sort of TTY/FAX mating. The other is the Code-a-Phone, a telephone answering device which has been popular among the commercial phone companies recently. Some of these, made by Ford Industries, Box 06459, Portland, Oregon, 97206 have begun to show as surplus.

Dave Hyde, WA7LVY, out at Ford Industries, was most helpful in furnishing data on an incomplete Code-A-Phone unit that turned up in salvage in North Carolina. The Model 440, for example, has a nice compact tape deck that can be used independently to send CQ's over voice transmitters, or tone or voice identification for a.m., s.s.b., or RTTY bands, or any of a number of possible ham applications. (fig. 1)

The entire 440 Code-a-Phone unit *(fig. 2)* was used to answer incoming telephone calls with a pre-recorded message of up to 18 sec-

*5716 N. King's Hway., Alexandria, Va. 22303.

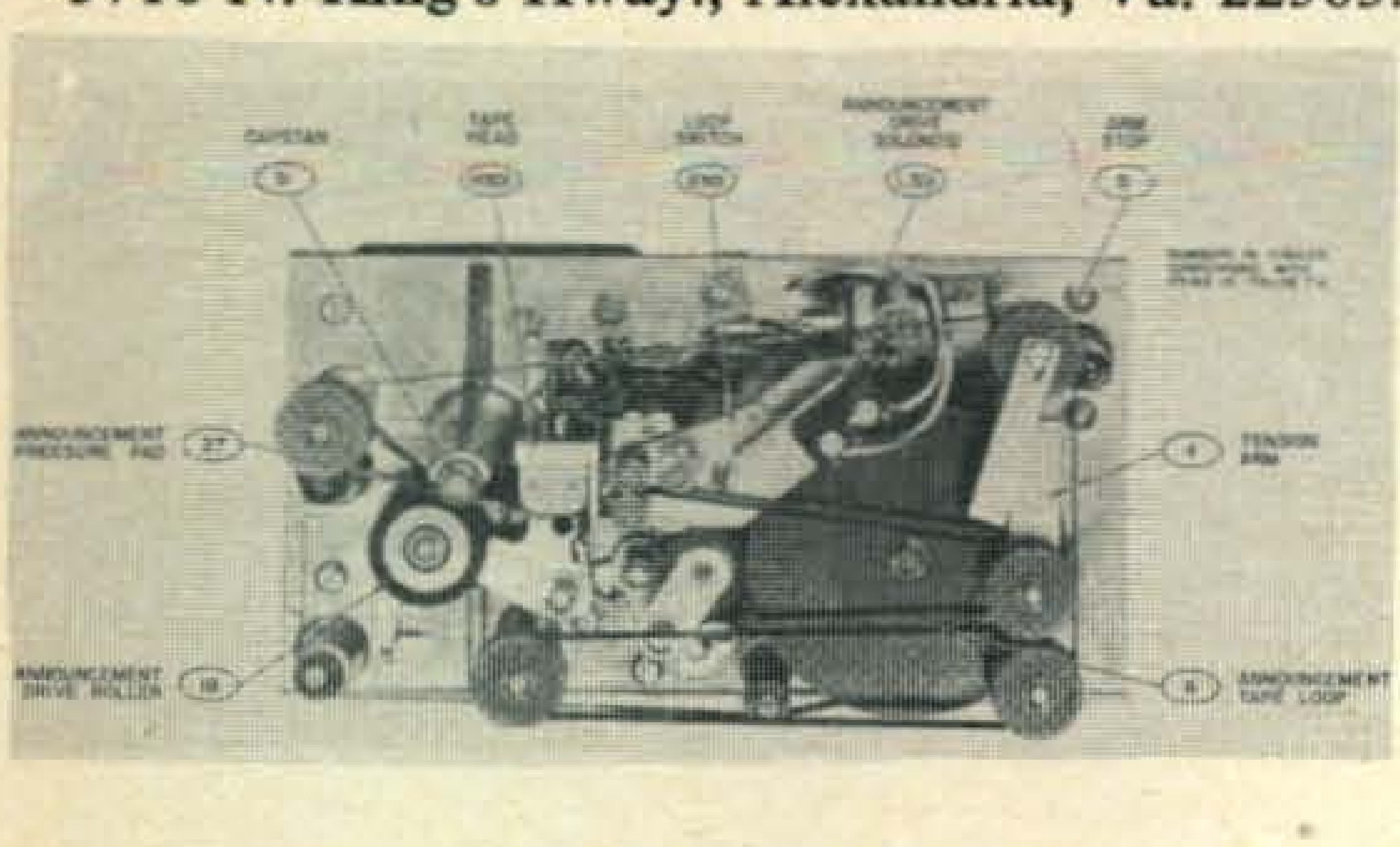


Fig. 1—Tape deck from Ford Industries' #440 Code-A-Phone, which lends itself to conversion for use in the ham shack.

See page 110 for New Reader Service

onds duration, then record individual messages from callers, up to a 20 minute aggregate maximum. The messages can be replayed from the unit itself, or from a remote phone, using a two-tone audio code to activate the playback (the code provides security from unauthorized listeners). There are several other Code-A-Phone units, but the 440 is representative.

The entire #440 weighs 17 pounds and measures 14 inches long by 9 inches deep and 4½ inches high. It draws 10 watts in standby and 30 watts in use, standard 117 volt a.c. of course.

The tape speed in the deck is 1½ inches per second, with a rated frequency response of plus or minus 4 DB between 350-2500 c.p.s. Wow and flutter are rated at less than 1% cumulative, from 3 to 120 c.p.s. Signal to noise ratio is at least 35 DB.

Code tones range from 697 c.p.s. (low) to 1,805 c.p.s. (high) with ten tone pairs to choose from. This does not offer exactly cosmic security, but for ordinary protection

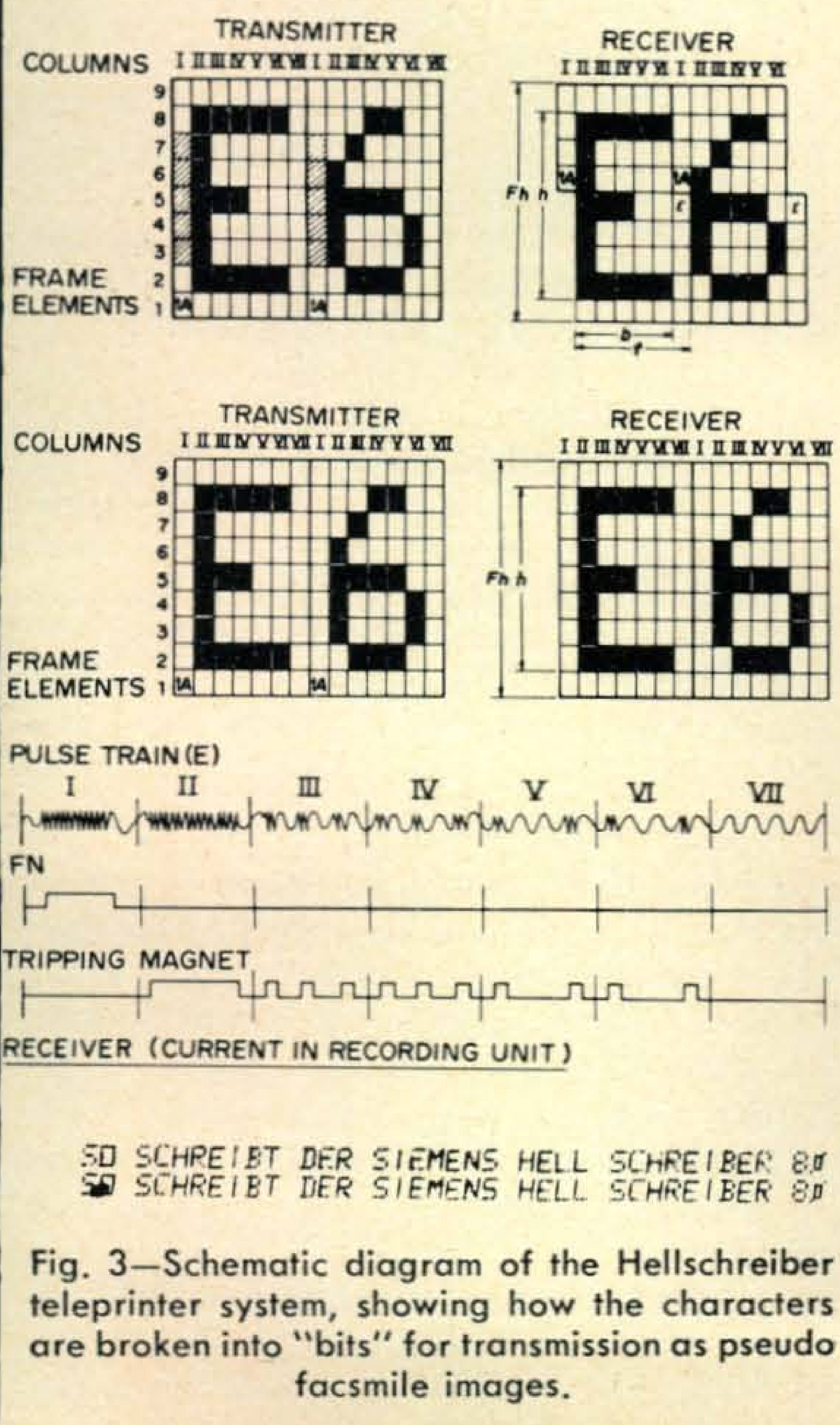


Fig. 3—Schematic diagram of the Hellschreiber teleprinter system, showing how the characters are broken into "bits" for transmission as pseudo facsmile images.

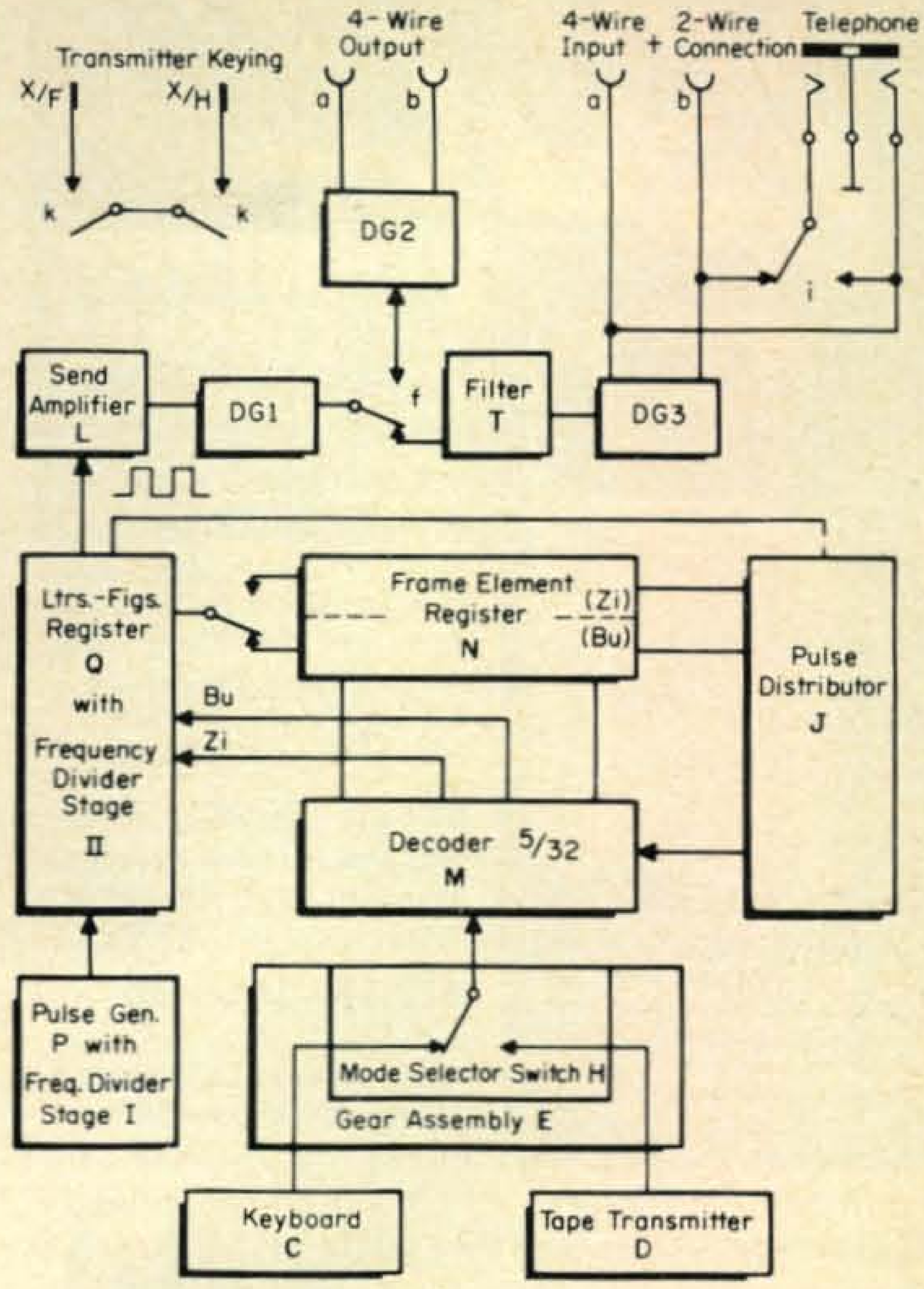


Fig. 4—Block diagram of the Hell transmitter unit.

against casual listening-in, it seems sufficient. Any dedicated audio man coud "break" the code in a few minutes, but who would bother, in most cases?

Another Code-A-Phone unit that might be of interest is the 210DC, a 19 inch rack-mounted recorder that is designed to put out a repeated 3-minute message to phone lines, public address systems, etc. This is simpler than the 440, and is of obvious use in a ham shack. It puts out a 1 watt audio signal.

The *Hell* system of teleprinter operation is a matrix-type TTY device which is a transmission mode much favored by the more far-out designers in telecommunications these days. Heat-printing and other semi-solid-state printers have been developed by contractors for the Air Force and secret agencies, and, lately, for certain of our more important submarines.

Figure 3 shows graphically how the Hellschreiber system works, via breaking the character into bits, which are separately transmitted. This is actually a form of facsimile, whereby the picture of the letter or symbol is broken down into a series of black and white frame elements and transmitted in the

See page 110 for New Reader Service

form of current pulses. Since the character is printed dot by dot, rather than as a single impression, "hits" or noise on the transmission circuit may impair the legibility, but seldom destroys the entire character. In addition, the standard stop-start synchronism is not upset, causing more than one error, as may happen on conventional machines.

A magnetically-controlled blade presses a paper tape against an inked printing helix, and two lines of copy are recorded at the same time (this allows reception, in synchronous mode, even if the sending and receiving speeds are improperly phased.).

The telegraph speed of the standard Hell printer is 315 Baud, while printing runs about 300 characters per minute. By contrast, 60 w.p.m. conventional teleprinters put down 360 characters (or blanks, spaces, *etc.*) per minute for a 45.5 Baud speed. This difference indicates the effect of the many more bits being transmitted by the Hell machine. A 900 c.p.s. bandwidth is required for the Hell system, not appreciably more than standard 850 c.p.s. RTTY. The obvious rub though is that narrow-shift (170 c.p.s.) operation probably would not be possible: the penalty for sending all those bits is a wider bandwidth requirement, at the same approximate speed. The Hell printer accepts tones, commonly, of 1625 and 1925 c.p.s., much narrower than the available 900 c.p.s. but of course a more than 300 c.p.s. passband is needed.

Figure 4 is a diagram of the overall system. The tape perforator and tape transmitter sections of the Siemens-Hell machines are compatible with standard 5-level RTTY practice, but as may be seen, the transmitted tone or frequency shift keying signal is not. The characters in the system are produced by computer techniques in the decoder and frame register sections. ■

USA-CA [*from page 87*]

time nor band limitations. Send a list of counties and time and date worked to, Paul H. Newberry, Jr., W4YWX, Box 2344, Macon, Georgia 31203. The award may be endorsed for all one band or mode.

NJDXA Achievement Award: This Achievement Award is issued by the North Jersey DX Association for contacts with members. U.S. stations work 25 members, others work 15. Send log data, not QSLs, to Hayden Evans, K2BZT, 11 Holly Tree Lane, Little Silver, N.J. 07739. Cost to U.S. stations

See page 110 for New Reader Service

1.00, no charge to others. Members are: (2BZT, DCA, KER, KUR, QHL, W2AGW, AIW, BHM, BOK, BXA, CQX, CWK, DEC, DEW, DXX, EQS, FZY, GHK, GT, GUM, GZZ, HH (ex-DNG), HTI, HZY, LH, JVU, LNB, LV, MJ, MOF, MS (ex-YTH, MZV, NQ (ex-JAE), ODO, OEH, OKM, QM ex-SHC), QT (ex-ZFA), RGV, TP, TQC, YD (ex-K2SUX), YY (ex-MES), ZTV, WA2DIG, WA2ELS and W2ZGB/9.

Notes

Thanks to Mr. Lynn C. Benjamin of Newport, Ky for sending along that Callbook which will go to a worthy oversea amateur.

An error or two appeared in the USA-CA Honor Roll in May 1969 *CQ*, under 1000, WA8YSQ was left out. It should have listed W3NB as #148, W5-10353 as #149 and WA8YSQ as #150.

Many complaints from mobile stations to the effect that many are forgetting to send them filler-in QSLs and postage, for New County Hunters, please remember if YOU want a QSL from a mobile (or even a fixed station) who works hundreds of stations, you better get some County Hunting QSLs from WA2AMM (500 for $3.50) and use them all completed and send postage and self-addressed envelope.

Now that vacations (holidays) are all over, time for you to get all antennas, equipment in shape and send those QSLs, also write and tell me—How was your month?

73, Ed., W2GT

Contest Calendar [*from page 85*]

and 160 meter bands. Take double QSO point credit if QSO is with a station outside your own continent. Work Hq. Station K6BX and get two extra points.

Multiplier: Total number of different ARRL countries worked on each band.

Scoring: Sum of QSO and bonus points on each band, times the multiplier on that band. The final all band score is the sum of the scores from each band. A station is elegible for single or all band score but not both.

Frequencies: *C.W.*—3575, 7030, 14075, 21090, 28090. Novices: 3710, 7160, 21140. *S.S.B.*—3960, 3943, 7260, 7210, 14320, 14340, 21360, 21440, 28620, 28690. Listen for DX on 3790, 3775, 7060, 7090.

Awards: Certificates to the high scorers in each country and call areas of W/K, VE, JA and VK on all band and each single band. The first 3 places in each continent will also

See page 110 for New Reader Service

be awarded certificates. There are also World Trophies for the top scorers in 3 catagories, single operator, club station (single transmitter only) and portable operation. Special recognition will also be given to novice and s.w.l. entries.

Logs must show date/time in GMT, station worked, exchange sent/received, band and QSO points. A summary sheet is also a must, showing the scoring on each band (add totals for all band score) and name, address and zip in BLOCK LETTERS.

Contest logs may be used in lieu of QSL cards for the many CHC awards. (Get list from K6BX)

Logs for both contests go to: Joe Stauhs, WA2BNF, 105 Carpenter Street, Belleville, N.J. 07109. Mailing deadline Jan. 31, 1970.

Editor's Notes

The score of PJ0MM was inadvertently left out of the Multi Operator—Multi Transmitter All Time Phone records in the September issue.

The list should have read as follows:

AF	ZS5JY ('68)	3,458,007	2886	123	296
AS	HS1MD ('68)	851,480	1298	110	210
EU	**OH2AM ('68)**	**10,074,120**	**5882**	**159**	**511**
NA	PJ0MM ('68)	7,037,658	6406	134	343
O	KX6AF ('58)	306,642	711	59	88
SA	4M5A ('67)	7,468,117	5033	134	393

Mailing deadline for your phone entries is December 1st and January 15th for the c.w. contest. Send to: CQ Contest Committee, 14 Vanderventer Avenue, Port Washington, L.I. N.Y. 11050.

Good luck, see you in the pile-ups.

73 for now, Frank W1WY

Contest Calendar [*from page 83*]

information, considerable difficulty and delays may be found in obtaining satisfaction from a guarantee for any reason and if it were easily attained, you'd still be stuck with TXI which is not spelled out in a guarantee. Furthermore, from what we've experienced in many fields, guarantees *in practice* often are worthless anyway.

As for the additional cost of $50-$60 for properly designed appliances with preventitive measures against TXI, this cost as estimated by G.E. personel, appears to be out of line. From the success described by K7UIS and WA9DJR, such measures might consist in a few well placed bypasses, shielded leads plus complete shielding of the equipment.

See page 110 for New Reader Service

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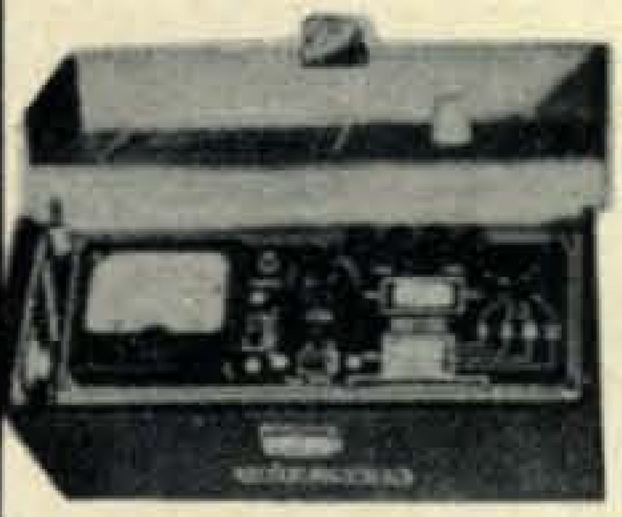

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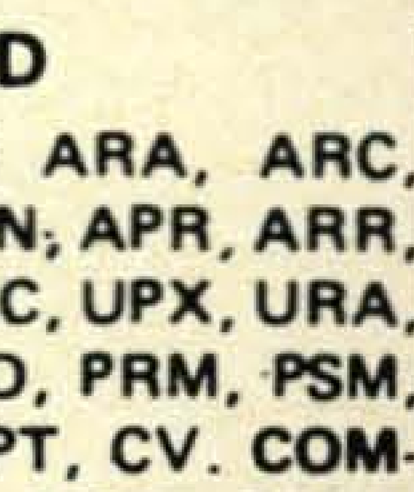

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See page 110 for New Reader Service

Admittedly, the latter could be the most costly item, but an effective and inexpensive method of shielding might be a coating of metallic or conductive paint on the interior of the "beautiful and exotic rare-wood" cabinets used to house the equipment.

As an example of solid-state apparatus asking for TXI, W6ZWK forwarded the photograph shown herein.

In respect to the preventitive measures themselves, a paramount requisite evidently is adequate shielding. It is questionable as to whether or not bypassing alone always will be effective, although there have been situations where simply internally bypassing loudspeaker leads has been a successful measure. In such cases, complimentary transistors in the output stage were involved where the speaker is driven directly from the emitters. Feedback from this point back to an earlier stage also is sometimes employed. Consequently, r.f. picked by by the speaker leads can be fed to either the output transistors or preceding ones, be rectified therein and producing an a.f. output. Another expedient in these cases is shielding of external speaker leads.

Where bypassing is employed on low-impedance circuits, such as for loudspeakers, we suggest as large a value as possible be used, consistent without otherwise impairing the response or operation of the equipment. Since large value capacitors (which usually are paper-molded types) often are not good r.f. by-passes, the addition of ceramic or mica capacitors, of even a lower value, could provide better overall bypassing.

Also, bypasses on the 120 v.a.c. circuits should not exceed 0.1 mf, otherwise a shock hazard may be introduced due to the lower reactance of large-value capacitors that would pass a higher a.c. current.

Another consideration is the external ground returns. These should be made as short as possible and of large-size conductors, preferably wide copper strap. They should be made directly to earth or a cold-water copper pipe; however, where the same ground system also is used for the transmitting equipment, r.f. potentials could exist thereon and introduce difficulties. In such cases, an independent ground system may be needed for the radio gear and for the TXI-affected equipment. Also make sure your s.w.r. is low (an antenna balun also may be helpful), that the transmitter is effectively grounded and that there is no stray r.f. on mic cords, etc. R.f.

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See page 110 for New Reader Service

on these parts may be observed as a glow in a neon bulb in contact with the particular element. When checking a ground lead, move the neon bulb along it to determine if standing waves or r.f.-voltage loops are being indicated.

Another method of shielding, particularly for the "do-it-yourselfer," would be use of one or more layers of aluminum foil tacked or glued to the interior of the equipment enclosure. This may be installed as a continuous wrapping with overlapping at any required joints.

Conclusion

In conclusion we stress the following: TXI is an industry-wide problem wherewith manufacturers may feel that the additional cost (even a small one) of preventive measures is not justified in the present highly competitive market. Furthermore, the radio amateur usually is not in a position to adequately deal with the problem, at least as far as appliances other than his own are involved.

As mentioned in our commentary in the Q & A Column referred to earlier, the only other possible way of relief lies in effective action by the FCC or other regulatory agency, requiring that certain specifications be met for manufactured electronic appliances either from a design standpoint or in the way of appropriate labelling of its susceptability to radio interference or TXI.

Therefore, it is suggested that where unresolved problems have arisen with TXI, you forward a letter of complaint to Ben F. Waple, Secretary of the FCC (Federal Communications Commission, Washington, D.C. 20552), for which that of W6ZWK may serve as a guide line on "how-to-do-it." A similar letter might also be forwarded to the EIA (Electronic Industries Association, Attn: Mr. L. M. Rundlett, 2001 Eye Street N.W., Washington, D.C. 20006).

In your letter also give specific details as to the exact nature of the TXI, the affected appliance (type, manufacturer, relative location, etc.), your transmitting setup (type of gear, power, antenna, etc.), any attempted corrective measures and the result of such.

Finally, we wish to thank our three correspondents and others who have likewise written to us on the subject. It is hoped that when similar situations arise with TXI, those involved will follow suit to provide helpful data that may benefit others.

Thanks & 73, Bill, W2AEF

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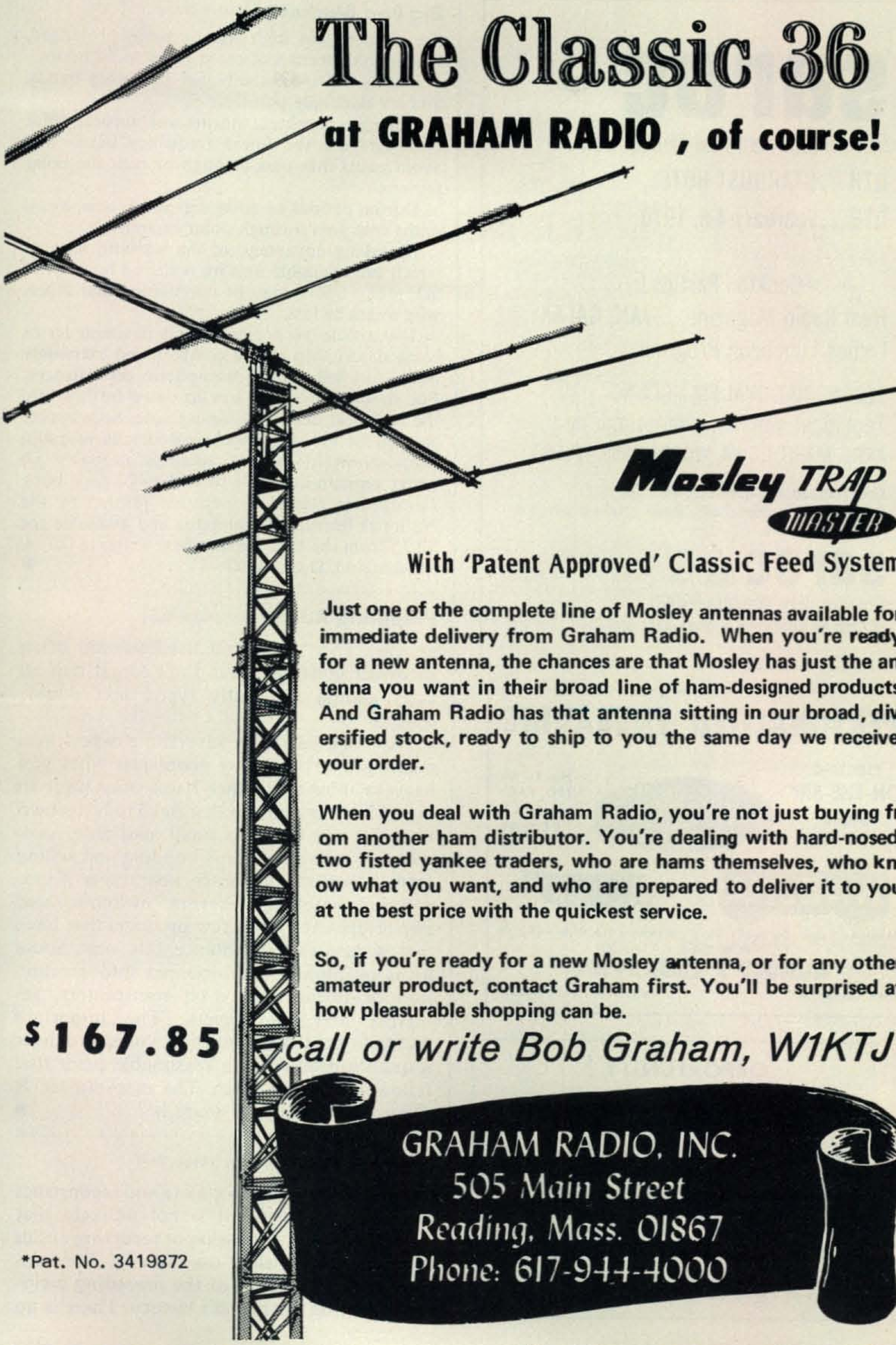

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Big Bad Blackout [*from page 35*]

the chances are high that a more prolonged, widespread storm will occur in 18 to 36 hours.

During SIDs, use the higher frequency bands, and try dark-side paths.

During ionospheric storms and auroral polar blackouts use the lower frequency bands and avoid paths that pass through or near the polar regions.

During periods of polar cap absorption, avoid paths that pass through polar regions.

By taking advantage of the warning services which are available and by realizing how to react, many QSO's may be maintained that otherwise might be lost.

This article has presented only in simple terms some description of the complex and extremely interesting subject of ionospheric disturbances. For those who would like to delve further into the technical details of ionospheric disturbances as well as the more technical details of radio propagation in general, there is probably no better bargain available than the 470 page book *Ionospheric Radio Propagation* printed by the National Bureau of Standards and available for $2.75 from the U.S. Government Printing Office, Washington, D.C. 20402 ■

Preparing Ads [*from page 62*]

appear. This will avoid needless and often incorrect guessing. And don't forget that all copy should be neatly typed and double spaced.

Now that you're an advertising expert, you ought to start thinking about just what you have to offer that other hams may want to buy. Many companies that have today grown to major size began as small mail-order ventures by individual hams building and selling from basement or garage operations. Compression amplifiers, keyers, switches, and swr bridges are just a few products that have met widespread acceptance this way. Some firms eventually mushroomed into production of linears and even transmitters, receivers and transceivers. The important factor to consider is whether you can deliver a quality product at a reasonable price that fellow hams will meet. The marketplace is there. What will your share be? ■

Interstellar DX [*from page 60*]

25 million souls to repopulate and reconstruct a shattered society. It is not unlikely that there could be a succession or recurring cycles of civilizations, each one arising, *Phoenix*-like, out of the ashes of the preceding civilization during the planet's history. There is no

See page 110 for New Reader Service

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SPECIFICATIONS: **Power Input:** 260 watts P.E.P. in SSB voice mode, and 180 watts in CW mode ● **Frequency Range:** 3.5-4.0 mc, 7.0-7.3 mc, 14.0-14.35 mc, 21.0-21.45 mc, 28.0-29.7 mc ● **C.F. Networks:** Crystal Lattice Filter. Same as used in the Swan 500 C. 2.7 kc band width at 6 db down. 4.6 kc wide at 60 db down. Ultimate rejection exceeds 100db ● **Unwanted** sideband suppressed. 50 db. **Carrier** suppressed 60 db. 3rd order distortion down approx. 30 db ● **Audio Response:** flat within 3 db from 300 to 3000 cycles in both transmit and receive modes ● **Pi Antenna coupler** for 52 or 75 ohm coaxial cable ● **Grid Block CW keying** with off-set transmit frequency ● **Solid state VFO circuit** temperature and voltage stabilized ● **Receiver sensitivity** better than ½ microvolt at 50 ohms for signal-plus-noise to noise ratio of 10 db ● **100 kc Crystal Calibrator** and dial-set control ● **S-meter** for receiver, P.A. Cathode meter for transmitter tuning ● **Improved** AGC and ALC circuit. Separate **R.F.** and **A.F.** gain controls ● **Sideband selector** ● Provision for **plug in of VOX** accessory, as well as headphones and/or Cygnet Linear ● **Tube complement:** 12BA6 VFO amp, 12BE6 trans. mixer, 6GK6 driver, 6LQ6 pwr. amp., 6BZ6 rec. R.F., 12BE6 rec. mixer, 12BA6 1st I.F. amp., 12BA6 2nd I.F. amp., 12AX7 prod. det. A.F. amp., 6AQ5 A.F. output, 12AX7 mic. amp., 6JH8 bal. mod., 12AV6 AGC-ALC amp. **Dimensions:** 5½ in. high, 13 in. wide, 11 in. deep. **Weight: 24 pounds.**

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assurance that the prevailing good sense of even a superior intelligence will be able to control its own destiny indefinitely, but if such a space community exists, the sooner we get in touch with it, the better will be our chances of survival in the expectation that we can profit from their experiences. My own optimistic guess for the longevity of the communicative phase is 500,000 years. Using the Earth as a sample, on the basis of collected scientific evidence, we take the duration of a habitable planet during its biological stage of development to be 3 billion years. The factor, L, is, therefore, equal to the ratio 500,000 to 3,000,000,000 or 0.000167.

Finally, we find the number of communicative, technologically advanced galactic societies to be

$$N = 5 \times 10^{10} \times 1 \times 1 \times 1 \times 0.5 \times 1.67 \times 10^{-4} = 4.2 \times 10^{6} \qquad (2)$$

We conclude that there ought to be at least four million civilizations in our Galaxy able and willing to communicate with each other. Even if their cultures do not peak att the same time, there should be sufficient overlapping during the civilized periods to make interstellar communication worthwhile. Since most of the primordial hydrogen in the Galaxy has already condensed into the stars, star formation and its attendant planetary development, are, some ten billion years later, proceeding at a decelerated pace.

Electromagnetic Communications

The decision as to which micro-wave spectral region to employ for interstellar intercourse is not a difficult one to make. Radio astronomy dictates that the best choice of wavelengths lies between 3 and 30 centimeters where the effects of atmospheric absorption and general cosmic background are at a minimum. A logical frequency would be in the vicinity of 1420 mc, which is the emitting frequency of the dark, neutral hydrogen clouds outlining the spiral arms of the Galaxy on the assumption that other galactic inhabitants are conducting surveys of the hydrogen distribution. With both our and their receivers tuned to the same spectral region, the receipt of coded transmissions by either side would insure the best chance of successful detection. It would be more advantageous for us to listen to extra-terrestrial signals than to send them since, presumably, the mes-

See page 110 for New Reader Service

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COLLINS		HALLICRAFTERS		VHF 1	$ 99.00
KWM2 w/Qmult. No. 12226		SX 73	$199.00	V	
& 516F2	$775.00	SR 42 A w/mike	$129.00	TX 1 & SB 10	$129.00
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sages which older, more advanced cultures have been transmitting for centuries have by now possibly reached our solar system. The first and only serious attempt, so far, to detect intelligent transmissions from another world known as the Ozma Project (1960), resulted in failure after 150 hours of listening in the vicinity of Tau Ceti and Epsilon Eridani, the two nearest solar type stars at a distance of eleven light years. At some future time, when radio astronomers, employing more sensitive equipment and improved techniques of reception, have extra time to spare on a problem whose odds against success are overwhelming, careful listening will once more be resumed out to distances of hundreds of light years. It has been suggested that the total output from all the u.h.f. stations beaming programs from the United States during the last decade might be detected as a point source of radio emission reaching a daily crescendo for a few hours at distances up to ten light years, if it were possible to filter out the much stronger radio noise from the sun. The 1000 foot dish in Arecibo, Puerto Rico, is said to be capable of transmitting a series of radio pulses powerful enough to be detected at a distance of 1400 light years. Even if communication were initiated with another world, it might take centuries to exchange messages.

Once electromagnetic intercourse is instituted between ourselves and a galactic community, it would be possible to transmit all the world's knowledge in a matter of days. About 10 million books are estimated to have been written by mankind. If the average book contains 250 pages and each page has 2000 characters, the total volume of man's cultural output equals 5×10^{12} signs. If our language is made up of 100 different symbols, which may be represented by slightly less than seven binary digits ($2^7 = 128$), and if each sign were coded in the binary system, the total number of bits to be transmitted amounts to about 4×10^{14} with room to spare for an explanatory preface. A bandpass of 100 mc centered on 1400 mc would suffice for the transmission of all of man's works to a distant stellar outpost in about 46 days. Given enough time, social, biological, and technological information could be exchanged between ourselves and an older, wiser civilization for the betterment of Earthlings who have not, as yet, been able to alleviate some of their own miseries on the most beautiful planet in the solar system. ■

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Ham Shop

Advertising Rates: Non-commercial ads 10¢ per word including abbreviations and addresses. Commercial and organization ads, 35¢ per word. **Minimum Charge $1.00.** No ad will be printed unless accompanied by full remittance. **Closing Date:** The 10th day in the second month preceding date of publication.

Because the advertisers and equipment contained in Ham Shop have not been investigated, the publishers of CQ cannot vouch for the merchandise listed therein.

Direct All Correspondence & Copy to: **CQ Ham Shop, 14 Vanderventer Ave., Port Washington, L.I., N.Y. 11050.**

DX-PEDITION XYL-APPROVED? VP2M-QTH. Deluxe station. Universal-power supply, 6-160 antennas. You supply transceiver. Beautiful house and garden overlooking Caribbean. Swimming pool. K. Hollatz, VE3FHO, Box 1178, Elmira, Ontario, Canada.

WIRELESS SHOP: New and reconditioned equipment. Write, call or stop for free estimate. 1305 Tennessee, Valleso, Cal. 707-643-2797.

NOVICE THREE-BAND DOUBLE INVERTED VEE: Tuned assembled, ready-to-erect SWR under 1/5-1 15-40-80 Novice bands $15.75. Triangle Antennas, Box 276, Warrington, Pa. 18976.

SELL: Collins 75S-3B with 0.5, 2.1, 6.0 & 12.0 kc filter extra crystals for 14.4-14.6 mc for v.h.f. Collins 32S-3 with 516F-2 power supply. All like new. Asking $1,250. K2UMM, 914-241-1310 (days) 212-231-7151 (eves).

GET YOUR "FIRST!" Memorize, study—Command's "Tests-Answers": for FCC First Class License. Plus Commands "Self-Study Ability Test". Proven. $5.00. Command, Box 26348-H, San Francisco. 94126.

BC-348R. (110 VRC) very good, sale or trade, best offer. Leonard Watkins, Box 188, El Dorado, Kansas.

MANUALS: TS-323/UR, TS-173/UR, R-274/FRR, $5.00 each. Hundreds more. List 20¢. S. Consalvo, 4905 Roanne Drive, Washington, D.C. 20021.

WRL's used gear has trial-terms-guarantee! 75S1—$299.95; G50 — $159.95; SR150 — $299.95; HW12 — $89.95; Swan 250—$279.95; Duobander 84—$199.95; NC200 — $249.95; SB34 — $299.95; Valiant — $149.95; Ranger—$99.95; Galaxy 300—$139.95; Galaxy Vmk2—$299.95; many more. Free "blue-book" list from WRL, Box 919, Council Bluffs, Iowa. 51501.

AEROMETER TOWER 85' four legs; 35' masting; gin pole; prop pitch rotor; Antennas; Mosley S402 and TA36; Telrex 11 el. 6M; Ranger II, HX30; T/R switch. Will ship. Joe Engressia, 9050 S.W. 117 Ave., Miami, Fla. 33156.

WANTED: Collins or Drake line transceivers or separate R and T. Must be in A-1 condition with manuals and S-N's. Also any related station accessories. Have HQ-170 w. Noise immunizer and Johnson Ranger. Both in excellent condition. May also buy complete dead-key station. Will swap, trade or pay good cash. Send inquiries to P.O. Box 7531, Longview, Texas 75601.

FOR SALE: Duo bander 84 $125 and AC48A AC supply $25 excellent condx. Also 384A Mobile supply minus secondary cables $70. J. G. Swaney, NSGA, Box 253, Ft. Meade, Md. 20755.

FOR SALE: Drake R-4A- mint condition with 4 extra crystals and speaker $200.00. Sid Levinson, 3406 Church Ave., Brooklyn 11206, Phone 856-9862.

WANTED: Poly-Comm-2 perfect cond. All wire A.C. & D.C. and mike. WA3LGC, 136 Lamont Ave., Glenolden, Pa. 19036.

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SELL: NCX-3 good condition, without power supply, $165, call 215-692-7547 or write 518 Nottingham Drive. Westchester, Penna. W3CAW.

CYCLONE SR-400 xcvr PS500AC—cost $950.00. Sell $599.95. Prefer local pickup deal or you pay shipping. Certified check. Ronald Nagata, W6RQZ, 1330 Curtis Street, Berkeley, Calif. 94702. Tel.: (415) 526-7345.

TR-1Q8 Knight 2 meter transceiver, AC-DC—complete new wired neatly—excellent—cost $100; CN-144 factory wired Ameco 2 meter Cadillac converter, just factory aligned — perfect — cost $49.95; Realistic DX-150 GC receiver—DC pack—new—perfect—stable—sensitive—cost $127.90; Heath GD-125 Q Multiplier for above DX-150—new—perfect—cost $14.95; Galaxy Rejector — perfect — cost; $39 95; EV727SR ceramic mike, stand—near new—cost $13.95; Eico 710 Grid Dip Meter — all coils — neatly wired — perfect — cost $34.95; All manuals—Best reasonable offer on any above—FOB Creston, Iowa, 50801, Box 466, W0RJZ.

FOR SALE: CQ's complete sets; 1954-1957, 1959-1964, 1967-1968. Nearly complete sets: 1950, 1958, 1965, 1966. Electronics World complete sets: 1957, 1960-1961, 1963-1965; assorted issues of 1959, 1962. Popular Electronics assorted issues 1959-1966. Make offers. Paul Capitolo, W6RQG, 1735 LeRoy Avenue, Berkeley, Calif. 94709.

EASTERN MASSACHUSETTS CB'ers. Finally obtain your popular CB equipment at discount and get competent service all under one roof. Call or visit North-lantic Electronics, 462A Main St., Medford, Mass. 02155, (617) 395-4700.

WANTED: Plans for Good 432 mc Varactor tripler. Howard J. Eich, 5950 Kedron Street, Springfield, Va. 22150.

BEEN DRAFTED: HT-37 $195; very good condition, HQ-170C $170 needs work on 80 meters, otherwise very good. W0HBH, 711 N. Taylor, Kirkwood, Mo. 63122. Tel.: 314-965-2310.

FOR SALE: Collins 75S-3B Excellent condition. $325. John McFarlin, 919 E. Jones Street. Apt. 4S, Santa Maria, Calif. 93454. Tel.: 805 WA 5-0257.

INSTRUCTION WANTED for fee by beginner in theory and code in Manhattan, N.Y.C. Eves. (212) 724-1738. Mr. Edgar.

TEST EQUIPMENT: HP 524D counter $495; HP400 Dr VTVM $45; Dumont 401 BR $150; Tektronix RM15 $400. All equipment in excellent condition. D. G. Wilson, W6GOT, 2036 Briarwood, Santa Maria, Calif. 93454. 805-WA 5-0754.

RTTY gear for sale. List issued monthly. 88 or 44 Mhy toroids, uncased, five for $2.50 postpaid. Elliott Buchanan and Associates, Inc., 1067 Mandana Blvd., Oakland, Calif. 94610.

3 PLASTIC HOLDERS will frame and protect 60 cards, $1.00, or 10 holders $3.00. Prepaid and guaranteed. Patent 3309805. Tepabco, Box 198Q, Gallatin, Tenn. 37066.

POLICE - FIRE - AIRCRAFT - MARINE - AMATEUR - CB CALLS on your Broadcast radio with Tunaverter. Tunable-Crystal controlled. Guaranteed. Free catalog. Salch Company, Woodsboro 9, Texas 78393.

REI can train you for the First Class Radio Telephone License in only five weeks. Approved for Veterans training. REI has schools in Sarasota, Florida; Glendale, Calif; Fredericksburg, Va., and Kansas City, Missouri. For free brochure write REI, 1336 Main St., Sarasota Fla. 33577 or call 813-955-6922.

REPAIRS—Modifications on all types of equipment. For details write: Interstate Electronics Service, P.O. Box 71, Park Ridge, New Jersey 07656.

SELL: Lafayette HA-350, speaker, $85; Gonset GSB-100, $150; 600L Linear, $115. Ship except linear. Thurber, W7DZW, 8556 Elm, Fairchild AFB, Wash. 99011.

GALAXY GT-550. New. W4UHO, 1300 Milton Street, Clearwater, Fla. 33516.

SURPLUS GEAR WANTED: Frequency shift converter CV-182; frequency shift exciter 0-39C/TRA-7; antenna tuning unit BC-9390B; power supply RA-870A; radioteletypewriter control C-808/GRC-26A. Advise condition, price first letter. All inquiries answered. Carlton D. Trotman, W3BRX, c/o Upward Bound, Lincoln University, Penna. 19352.

32-S3 SN #11607 with matching power supply, all modifications with factory re-alignment, mint condition, $525. Mosley Classic 33, TR-33, 10 foot top section Rohn Tower with 40 foot each rotor cable & RG8/U $130. Johnson 250w match box w/o bridge $40. Terms: freight collect, cash, certified check, or money order. Contact Ed Lauster, WA2MXW, Tele: 9 to 5—212-867-8484, Ext. 216, after 212 HO 5-3836.

WILL PAY CASH for Ancient Broadcast Mikes — carbon, condenser, ribbon or dynamic: H. F. Gray, 122 Woodland Terrace, W. Lafayette, Indiana 47906.

NOVICES: Need help for general ticket? Complete recorded audio-visual theory instruction. Easy no electronic background necessary. Write for free information. Amateur License, Box 6015, Norfolk, Va. 23508.

FOR SALE: Swan 250 & 117 power supply $350. or best offer. Henry Darrell, 2506 64th, Kansas City, Kansas K0LXU.

COLLINS 51J-4 exceptionally good condition. 3 and 6 kc filters. $575. W0WLR/5, Warren Amfahr. 3100 Brookview, Plano, Texas 75074.

SELL: MILLEN Grid-dip 90651 wt. coils $50; Turner Crystal mike 533X wt. switch & adjustable desk stand $15. ACD Jack Panels 3/44 x 19, one each: 52 #P J203 jacks (single circuit make/break) $25, #PJ338 jacks (same. wt. aux break circuit) $15, 32 #PJ338 & 16 #PJ338 jacks $20. Robert Rose, 6 Philips Street, Boston, Mass. 02114.

OLD OLD TIMERS CLUB solicits your membership. Qualifications are 40 years on the air. Send QSL card to Chas. W. Boegel, Jr., W0CVU, 1500 Center Point Road, N.E., Cedar Rapids, Iowa 52402.

APOLLO 11 STAMP: First day of issue cacheted envelope. $1.00. K6RSL, 20137 Newburgh, Glendora, Calif. 91740.

SALE: SCR522 Transceiver $35 complete. New tubes: RCA 806 $15, 5BPI $12, 5CPI $16, 7VPI $25. K1VTW, Box 103, Sherborn, Mass. 01770.

WANTED: Looking for inexpensive 500 or 800 M.H. Toroid coils—Harold S. Roth, 615 E. 20th S. Sioux City, Neb. 68776.

WANTED: Digital counter info kits. To 30 MHz. W0IBZ, 936 Dontaos Dr., St. Louis, Mo. 63131.

SELL: Drake MN2000 matching network, 2 MO. OLD. Manual and original cartons. $150 will ship. K6TVL, 10 San Joaquin Pl., Novato, Calif. 94947.

SWAP: New 3CX100A5 tubes for 572B (1 for 1), or 6HF5 (1 for 2). Also have 4D32 tubes. W9TKR, 505 So. Elmwood, Waukegan, Illinois 60085.

SALE: Heath DX-60B $60., Lafayette HA-350 $90., both in A-1 cond. Will ship extra. Nick Radetzky, 8632 Garden View, South Gate, Calif. 90280. (213) 567-2949.

SALE: Art/26 400 to 450 Mz. TV Video transmitters 2 at $50 ea. 1 at $100 w/ps ready to go. Ed—WA6UAS, 1962 14th St., San Pablo, Calif. 94806.

SALE: 16 MM. Bell & Howell model 195 sound projector. Very good condition. Extra heavy speaker. Includes 2000 ft. "Varieties" sound movie, $145. W2FZE, 1269 Chestnut St., Roselle, N.J. 07203.

WANTED: ARRL Handbooks. 1945, 1950, 1965. Will pay $2.00 each. Should be reasonably in good shape. M. Bae, Box 9, Kingston, N.J. 08528.

WANTED: Collins 6 KCS. filter for 75A4. Gary Yantis, K0BHM, 10809 Johnson Dr., Shawnee, Kansas 66203.

SWAP ONLY: Vacuum Variable, UCS400 + GCS100. Calrad Mike, Model 100C. B + W filament choke, f.c. 30., KW. Roller coil. All in good condition. What have you? Write WA6HYB, 624 First Ave., Chula Vista, California 92010.

SALE OR TRADE: KE-93 all pwr. supplies $100. Hickcock 288X AM-FM signal generator $55. W6QV, 10912 Sherman Grove, Sunland, Calif. 91040.

SALE: Digital counter, Berkeley 510 $125. Heath DX-100 w/FSK $75. AA-50 Stereo Amp $40. PT-1 AM/FM $40. Tunnel Dipper $22. W9TKR, 505 South Elmwood, Waukegan, Ill. 60085.

SELL: Valiant Xmtr, $95. Eico 720 Xmtr., $25. Heath HG-10 VFO, $20. Heath Balun, $3. Guaranteed, with manuals. Coley, 3208 Yanceyville, Greensboro, N.C. 27405.

SALE: Vibroplex Champion Key — $17.00 — prepaid. New, used once. WA2NND, 367 W. Broadway Ave., Watertown, N.Y. 13601.

SALE: (7) 715B 500 Watt detrodes with data, $8. each. WA0VFY, 1414-16th St., Bismarck, N.D. 58501.

SELL: H/P 560A Digitac printers—$100 each counter units—$41 each, UCS-300 vacuum variables—$25. Stamp brings large list. G. Trammell, 1507 White Oak Ct., Martinsville, Va. 24112.

SALE: Heath "Twoer", unmodified in excellent condition with halo ant. for $35. W2DYS, W. Farone, 586 Palisade Ave., Teaneck, N.J. 07666.

SALE: 432 MC—Motorola T44AAV—excellent operating condition—complete with all accessories $50. Write: K2HSQ, Don Rimmer; 109-10 Queens Blvd., Forest Hills, N.Y. 11375.

WANTED: To buy for cash, Heath SB620 spectrum analyzer. Sell HQ110 $85., S40B $35. Tom Dornback, K9MKX, 19W167 21st Place, Lombard, Illinois 60148.

SALE: Antique Chevrolet Pickup $125.00. Gon Set Super Six & Mobile Receiver with TNS Squelch & S-Meter. $40.00. W40HM, 743 Berryville Ave., Winchester, Va. 22601.

SALE: Tapetone 2 mtr. conv. mint cond. Purchased new & never used—$25. W3AEV, John Ferguson, 336 Brookside Blvd., Pittsburgh, Pa. 15241.

SALE: Telex Headphones model HTX-2 "Twinset", $12.00. Never used. J. N. Brunst, 249 Myra, Neptune Beach, Fla. 32233.

SALE: Know The Golden Age of Radio. 5 vols. Beitman's diagrams, 1926-1942. $10.50 list. Best offer. D. Moran, 3800 Cabot, Detroit, Mich. 48210.

SALE: Galaxy V, AC35, Xtal Calib., Spkr. Console—like new—$275.00. Shipped REA prepaid in 48. WA5D2P, 314 E. Main, Ada, Okla. 74820.

SALE: Ameco 6, 2 and 1¼ mtr. converters, swr. bridge, Harvey—Wells TBS-50D XMTR, signal generator and cobra cam88 CB XCVR. Sendstamp for list. A. Savicky, 105 Nursery Lane, Lancaster, Pa. 17603.

SALE: Collins S Line, Exc. cond. Late Serial Numbers. WA0GUN, 231 S. Jasmine, Denver, Colo. 80222.

SALE: New Mosley TA-33 in unopened carton, $90.00. Manning Jeter, W4HVR, 668 S. McDonough Street, Montgomery, Ala.

WANTED: Antique speaker—vintage 1927 for Radiola 17. 226 or 326 tubes with good filament, light bulb shaped glass. R. Mendelson, 27 Somerset Pl., Murray Hill, N.J. 07971.

WANTED: Early wireless magazines books, catalogs, call books, early handbooks. Will pay cash or trade QST's, CQ's, Electrical Experimenter & Modern Electrics. Erv Rasmussen, 164 Lowell, Redwood City, Calif. 94062.

SALE: Wheatstone oiled 15/32" perferator tape for Boehme tape equipment. P. L. Lemon, 3154 Stony Point Road, Santa Rosa, Calif. 95401.

SALE: National 200 transceiver and power supply (115vac). Both mint condx in original cartons. $275. or best offer. W2EHB, 32 Bryant, Blackwood, N.J. 08012.

SALE: UTC-BMI-750 Hz band pass filter OK for CW $2.50. Triad HSM-315 10 Hy .2 amp choke $5. .5 Henry 30 Ohm toroid cased $2.50. W0KPZ, Box 1038, Boulder, Colo. 80302.

WANTED: Old Crosley model X or XJ battery receiver. Also signal generator and 4X250B tubes. W7KE, 1109 S. 2nd., Hamilton, Mont. 59840.

SALE: HT-40 XMTR. Like new. Best offer over $85.00. WN2HDY, Rick, RD#3, Clay, N.Y. 13041.

SALE: Collins F455 filter 3.1 kc. tubes—5894, 6883, 2E26, 2E24, 5R4GY, make offer. J. Wasiewicz, 229 Sarles Lane, Pleasantville, N.Y. 10570.

SALE: Approximately 100 ft. broadcast service co-ax cable, unused, RG9A/U 51 OAM impedance. Morris Rosen, W2KNP, 240 First Ave., N.Y.C. 10009.

SALE: Nat. 200 XCVR ,200w SSB, pwr. sply., manuals —$290. RME 69 gen. cov. rcvr. Best offer. WA2FFZ, 186 West Ave., Pitman, N.J. 08071.

SALE: Swan 140, power supply, speaker, all in excellant condition, $150. Aeronautical Center Amateur Radio Club, Postal Station 18, Oklahoma City, Okla. 73169.

SALE: 75S3-B #85530, 1.5, 2.1 KCS, $625. 2K-2, SPARE 3-400-Z, $575. TR-4, RV-4, AC-4, DC-4, $625. T4X, R4-A, AC-4, MS-4, $625. James W. Craig, W1FBG, 29 Sherburne Ave., Portsmouth, N.H. 03801. 603-436-9062.

WANTED: Conv. prop pitch motor; indicator. Also 500 cycle filter for 75S-3. F. Higson, 14 Foster Rd., Bedford, Mass. 01730.

SALE: 6M Tunaverter—$20., Ranger—$80., VF-1-$15. Tapetone, 40 MHZ converter—$25. Marty Feeney, K1OYB, 38 Howard St., Portland, Maine 04101.

SALE: 80 M. Mobile XMTR—$20. P & H 600A, 6M Transverter—$30. W2EWL SSB XMTR—$25. Marty Feeney, K1OYB, 38 Howard St., Portland, Maine 04101.

MAINE HAMS! The Portland Amateur Wireless Association Meets Each Tuesday at 7:30 P.M., 227 Spring Street, Portland, Maine.

SALE: Bab 6mtr xvtr, NC300 w/cal, spkr, 6 & 2 convt. Also, ART-13, Eico 753/751. Make offers. K5ZUV, 911 S. Liberty, Okmulgee, Okla. 74447.

SALE: SB-300 with little use $225 in great condx. HW-32A with 6 mos. use—$75. Exc. condx. K. T. Coit, W1UOZ, 13905 Bethpage Lane, Wheaton, Md., 20906. 871-8503.

WANTED: KWS-1 & KWM1 in good condition. John L. Schwartz, 43 Vernon Pkwy., Mt. Vernon, N.Y. 10552.

SALE: SB-34 Transceiver, late model, includes mike, calibrator mobile mount and manuals, $275. W1MIJ, 58 Felch Road, Natick, Ma. 01760.

WANTED: 32S3 and power supplies, no junk. L. Beyer, 10 W. 35, Holland, Mich. 49423.

WANTED: Electric train STD GA (2⅛ wide track). Trade for radio parts/epqt. or purchase. H. Deacon, W6TDK, 872 Santa Rita Ave., Los Altos, Calif.

SELL OR TRADE Collins R-388—$375.00, Ranger—$60.00, Prop-pitch Motor — $30.00, Tri-Band beam — $25.00, NCX-5 MK II with all extras—$490.00. WANT: Ranger II, SR-160, 75A2, 75A3, or 75A4. J. Shank, 21 Terrace Lane, Elizabethtown, Pa. 17022.

75A4, extra-mint, No. 2598, used 10 hours, all modifica., manual, first $390 takes. S. A. Tucker, 51-10 Little Neck Pkwy., Little Neck, N.Y. 11362.

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FOR SALE: HA-4 Keyer & Key $27.50, Swant 350 & 406 VFO AC & DC & Mob Mic $380.00, Drake 2B & spkr. $150.00. W6EUF, 2301 Canehill, Long Beach, Calif. 90815.

TUBES 5894—new $5.00 ea. 811 A new $3. ea. K4JK, 2804 Broadview Dr., Hunsville, Ala. 35810.

LATE MODEL TR-4 SN #27770 new trade for R4B and T4XB. Also have SW-240 and AC $150.00. Roy Morris, 214 Beverly Drive, Charlotte, N.C. 28207.

FOR SALE: SR-160, like new, $160.00. Drake 1-A, $85.00. F.O.B. Lancaster, Jim Simmons, WA8PLJ, 121 N. High Street, Lancaster, Ohio 43130.

FOR SALE: Swan 250, $225. Hallicrafters SR42 w/HA26 VFO and Knight KNH515 Mike, $165. 6M and 2M Beams, Steve Martin, 6031 N. Lawndale, Chicago.

SP600 JX R-274A/FRR TM-11-897, manual wanted. W. F. Montgomery, Jr., P.O. Box 27, Gatun Canal Zone.

SELL: Johnson Viking SSB Adapter like new, also conversion kit, Harper K. Richards, East Street, Argyle, New York.

CANADIANS—Like new Wollensak Model 1500 Tape recorder with approx. $100.00 Scotch brand tape all for $125.00. Veish, Box 418, Sackville, N.B.

WILL BUY CW Helix circa 1920-25, 1289 Glen Eyrie Ave., San Jose, Calif. 95125.

CALAXY V MKz with VOX, AC-35 power, F-3 CW filter, top condition, first certified check $250. Brooks Carter, W4FQ, Rt. 1, Box 239D, Irmo, S.C. 29063.

FOR SALE: Mint condx. National 200 xcvr with A-C supply in orig. ctns. $275 or best offer. W2EHB, 32 Bryant, Blackwood, N.J. 08012.

FOR SALE: FLdx 2000 KW Linear, not a scratch. Sacrifice for $215.00. Keith Neighbors, 121 Johnson Street, Garner, N.C. 27529.

MM-2 analyzer with receiver adapter. Practically new. $75 prepaid. Now cost $135. K4PXY, 5930 Denver Street, N.E., St. Petersburg, Fla. 33703.

WANTED: Two-meter "high-band"—FM equipment to start an emergency weather net. Donations accepted. Robert Rossi, WA0OTF, 44111-55th Street, N.W., Rochester, Minn. 55901.

WANTED: Eimac Chimney SK-506, Socket SK-510. Variac's, 110 volt 3 amp, 220 volt 10 or 15 amp. W0AIH, Rev. Paul Bittner, 814 4th Street S, Virginia, Minn. 55792.

SELL: Hallicrafters recvr. and manual, Globe Scout xmitter and all-band dipole. Make offer. S. Bigelow, 1381 Penrose Drive, s.l.c., Utah 84103.

FOR SALE: HW22A, 40 mtr. Xcvr, $80; HD20, 100 Kc Calib, $10. S. P. Carroll, 907 S.E. 48th Street, Olympia, Wa. 98501.

SB-34, very clean, with mike, cables, manual, prepaid for $250.00. Alan Rutz, WA9GKA, RR2, Laporte, Ind. 46350.

GALAXY V SSB/CW transceiver, 300 watts, 5 bands, with AC-35 power supply. Mint condition. $250. WB4BZE, Box 306, Ramseur, N.C. 27316.

HV MICA CAPACITORS: 800 uuf 5KV DC, 50 uuf 3.75 KVDC, Freq. meter TS-33 & many others. M. Bae, Box 9, Kingston, N.J. 08528.

SB-300 with all filters and Heath HO-13 panadapter $200.00; Ameco model CN converters for 50, 144, 220 mc, $15.00. each. T. Rutherford, 28810 Covecrest Dr., Palos Verdes Peninsula, Calif. 90247.

SALE: Telrex 5 element triband-beam #TC-99D. Immediate shipping. $120.00. Will bargain. Elliot Levin, 415 Sheffield Rd., Cherry Hill, N.J. 08034.

EARLY RADIO BOOKS, Magazines, catalogues, etc., wanted. Sell or swap duplicates. K8IKO, Box 222, Worthington, Ohio 43085.

FOR SALE: Knight T-150 xmtr, 6 thru 80 meters, Heath Seneca 2 & 6M, Model VHF-1 mint condition. Price $235.00. Charles J. Jacobs, 8720 Ditman Street, Phila., Pa. 19136.

LOOKING FOR COLLINS 312B-4 or 312B-5. State condition and price. G. K. O'Brien, 8401 N. Atlantic Ave., B20, Cape Canaveral, Fla. 32920.

MUST SELL: College expenses KWM-2, 30L-1, A.C. supply 5F12-1 $1,155.00. John Sypek, 28 Mercedes Street, Chicopee Falls, Mass. 01020.

FOR SALE: Hammarlund HQ105 TR full coverage receiver, with built in 5-watt CB or ten meter transmitter. Good appearance & condition. No shipping. Local deal preferred. $85. J. Dubinsky, W2LVR, P.O. Box 482, Flushing, N.Y. 11352.

L-4B Linear: Fac. cartons $450. Mint SX-100, HT-37, $85, $150. Works $600. H. R. Lewis, K3RKJ, Rd. #2, Doylestown, Pa. 18901.

SALE TS-382F/U in case $145; TS-383A RTTY Distortion test set $125; TS-658 RTTY test set $16.95; TTY Page printer winder $14.95; want good Bug H. Brown, 45434 N. Fig. Ave., Lancaster, Calif. 93534.

FOR SALE: Lysco Model 600S xmtr VFO or xtal 160 to 10 meters. 65 watts CW—35 watts phone. Make offer. K8WN0, 2760 Blue Rock Rd., Cin., Oh. 45239.

SELL: NW-Tronics Cliff-Dweller, 80-40 M. Dipole $35.00. Prop pitch motor-unconverted, $45. No shipping. WB6TFA. Bill Brooks, 11818 Julius, Downey, Calif. 90241.

FOR SALE: National 303 rcvr, $180. HW-12 xcvr, 75M, $60. R/45/ARR-7. Built in AC power supply. .55 to 42 MCS. $75. All F.O.B. J. F. Jones, 931 National Street, Vicksburg, Miss. 39180.

WANTED TO BUY: AN/APR-4 chassis or similar. Tuner connectors must be in good shape. $4.00 plus shipping. Jim Kimbrell, 106 Thompson Street, Pullman, Washington, 99163.

WANTED: Portable typewriter & case. Military model. All capital letters. 1 and 0. R. P. Zettler, 327 6th Street, N.W., Canton, Ohio 44702.

SELL: R. F. Distortion Indicator P & H Electronics model D1-1 with two tone oscillator. Like new, $75.00. G. W. Richie, 643 Diamond Rd., Salem, Virginia. 24153.

GALAXY V Mk2, AC-400, $300, needs a little work. Remote VFO $50. VOX $15 cw filter $15. Bill Walker, WB4EYX, 1730 Woodmere Dr., Jacksonville, Fla. 32210.

SX-140 $45.00., HT-40 $45.00, B & K Picture tube testor/rejuvenator $32.00. WANTED: Tri-band beam, radio books. K4WWL, G. Manning, Rt. 2, Rocky Face, Ga. 30740.

SELL: Hallicrafters SR150 transceiver and PS-150 AC supply. Just factory aligned and in excellent condition. $325.00. Have two Telrex 6 element 6 meter beams $20.00 each—you pick up. WA9HRN, Craig Pitcher, 580 Crooked Lane, Barrington, Ill. 60010.

WORK YOUR "S LINE" Mobile, Collins 512 E1 D.C. P.S. with cables $85. Ameco 2 meter C.N. Converter. $25/ plus shipping. S. P. Hess, 800 Old Kenisco Rd., Thornwood, N.Y. 10594.

WANTED: Old battery operated radios of the early 1920's, need not be in working condition. Also want early wireless equipment and CQ and QST binders. David McKenzie, K0SVU, 1200 West Euclid, Indianola, Iowa. 50125.

WANTED: Wish to buy accessory crystals for Drake R-4B. Advise freq., manufacturer, and price. Clyde F. Gilmore, K0JPJ, 560 S. Warren Ave., Springfield, Mo. 65806.

FOR SALE: GE Pacer converter to 2 meter FM crystals for 146.94 price $60. R. Dorough, W5DPN, 117 Pecan Street, Terrell, Tex. 75160.

See page 110 for New Reader Service

SELL 2 Non-Linear Systems DVM model 351 need some repair $70; $90; with manual; H-P 187B plug-in $40; 525B $125; Robert Ireland, Pleasant Valley, N.Y. 12569.

WANTED: Audio Xfmr for freshman masterpiece BC Recvr. Vintage about 1924. F. Pritchard, 75 Allerton Rd., Naugatuck, Conn. 06770.

SALE: DX-60 $40.00; Hallicrafters SX-110, $80.00; Heathkit assembled EK-2A-2B Radio Course (cabinet, textbooks and all parts, $25.00. All like new.) Carl E. Poston, P.O. Box 627, Shelby, N.C. 28150.

OLD OLD TIMERS CLUB WELCOMES YOU. Send QSL card if you have been on the air forty years. Chas. W. Boegel, Jr., WOCVU, 1500 Center Point Road, N.E., Cedar Rapids, Iowa. 52402.

7-Year Forecast [*from page 57*]

Winter: In spite of minimum sunspot conditions, solar absorption rules out any skip during the daylight hours. Around sunset, the band will open for DX to many areas of the world.

Equinox: Propagation conditions on this band may be at their best during this season of low solar activity. Some fairly good openings are expected to many areas of the world during the hours of darkness and the pre-dawn period. Solar absorption rules out openings during the daylight hours.

Summary

The present sunspot cycle, the 20th observed since records have been kept, reached a peak during November 1968, after which a slow but steady decline in solar activity began. This decline will continue for approximately six to seven years, until the cycle reaches its minimum value, sometime around the middle of 1975.

As a result of decreasing sunspot activity, conditions on the 6, 10, 15 and 20 meter bands will deteriorate steadily, while conditions on 40, 80 and 160 meters should improve correspondingly. ■

R-388/URR By Collins original condition. $395.00 or trade. Wanted MN2000. Trade W4-F.E. Coble, 251 Collier Ave., Nashville, Tenn. 37211.

WANTED: Gud 250-500 wt trx for CW rpt CW wid VFO. CW rcvr. 75A4 or equip. W6AT, 606 Buckeye, Vacaville, Cal. 95688.

HAMMARLUND variable capacitors. New, Type MCD-100-M (1), MC-100M (2), and MC-250M (1). WB6RMZ, 14 N. Avena, Lodi. Calif.

FOR SALE: Lafayette HE-45A, six meter transceiver in very good condition. $50.00. J. A. Edwards, 7517 Sunview Drive, Columbia, S.C. 29209.

FOR SALE: VFO 80 mtr described in Dec. 67 CQ $15, Eddystone Slide Rule Dial #893, $12, 14 mc Linear Described in Apr. 64 CQ $75. W6BLZ, 528 Colima Street, La Jolla, Calif. 92037.

FOR SALE: 2B/2BQ, HT-44, Swan Mark 1 linear amplifier. William Gioia, WB2DZZ, 14-04 154th Street, Whitestone, N.Y. 11357.

SELL: Heath DX-60 $55 So. Cal. only. W6RLN, K. C. Jones, 6172 Gumm Dr., Huntington Beach, Calif.

FOR SALE: Hy Gain 6 mtr, 6 element beam with AR22 rotor—100' wire—$29.95. Good condition. Geffner, 48 Park Avenue East, Merrick, L.I., N.Y.

BADGES ENGRAVED, Handle & Call, 1 Line $1.00. Various sizes and colors. Club rates. Inquiries invited, WA6BSP, 1225 Rosalia Ave., San Jose, Calif.

WANTED TO BUY: 14-117 Swan DC power supply in good condition. Dorough, W5DPN, 117 Pecan Street, Terrell, Tex. 75160.

WANTED: Swan VOX model VX-2. Will buy or trade for 3 el. 15 meter beam. WA3JRA, 3919 Bancroft Rd., Balto., Md. 21215.

VALIENT w/manuals very god condx. $125.00; Lysco 600 w/VFO & Homebrew modulator will make FB Novice or CN rig $45.00. 14AVQ with 80 meter coil $?0.00. K4RTA, 105 Freshrun Drive, Hendersonville, Tenn. 37075.

EICO 723 Xmttr: 60 W CW, mint condx, with manual plus 4 novice xtals—$30 or best offer. WA1J4U, 27 Blue Ribbon, Westport, Conn. 06880.

LIKE NEW 312B-5 station control for sale $250.00. R. Morris, 2214 Beverly Drive, Charlotte, N.C.

BOUND "73" Magazines—1960 thru 1966. $25.00. C. McDowell, 2455 S.W. Montgomery Dr., Portland. Ore. 97201.

NIKON camera equipment. Trade for two or six meter SSB xcvr. What do you need? R. Warren, 19 Sahle, Fredonia, N.Y. 14063. WA8ZXU.

STEPPING SWITCHES, take-off's, like new $5.00 each postpaid. C. B. Goodman, 5826 S. Western Avenue, Chicago, Illinois 60636.

SELL: LA400C Linear 800 W Pep $90. HW30-$35 plus shipping, WB2V2W, 10 Scott Street, Massapequa Park, New York 11762.

WANTED: Manual and/or Schematic for Lakeshore Phasemaster II transmitter. Fred Thomas, W7NDC, N. 5524 Fleming, Spokane, Wn.

LETS TRADE: Hv almost new (1 mo.) TH3MK3 tribander. Need gud cw rcvr., if good will pay sum cash diff. WA7JUS, Box 184, Cedar City, Ut. 84720.

FOR SALE: KW Linear Amp. pair of 572 B's in GG. Built in power supply. Asking $75.00. K2QMF, 163-27 91st Street, Howard Beach, Queens, N.Y.

SELL: 600v oil caps. 1mfd .12; 2mfd .15; 4mfd .25; 6mfd .50. Rotary Inductors KW size $6.50. Shipping extra. Ken Maas Burlington, Wis. 53105.

POSTAL EMPLOYEES—National net opens Tues. thru Sat. 0330Z kHz with arrival of Standard time. For info contact W8QCU.

See page 110 for New Reader Service

HAM TRANSFORMERS REWOUND, using Hi Temperature wire and insulation. Jess Price, W4CLJ, 411 Gunby Ave., Orlando, Fla. 32801.

NEW AWARD W-10-U for working 10 University Club stations. QSL's and $1.00 for handling to W4DQD club secretary, GA Southern Radio Club, rules for SASE.

WC4GSC special events station again active at Ogeechee Fair, October 11-19, 1969. A new one for WPX, Special QSL's via W4DQD club secretary.

RTTY INFORMATION for the Amateur interested in RTTY. F. DeMotte, P.O. Box 6047, Daytona Beach, Florida. 32022.

FOR SALE: Hammarlund HQ-110C & S-100 spkr., exc. cond. $135.00. Jeff Croner, WA5YBG, 1020 Wesley Dr., Wichita Falls, Texas 76305.

HALLICRAFTERS SX-101, 160M through 10M, $140, Heathkit HG-10B VFO, $25. Sell locally. Call IV 6-2053, ask for Cliff (WA8ZAZ).

PP Modulation Transformer—RCA, New. Will modulate plates and screens of pair 813 with 1 kw input. Weight 40 pounds. $30 plus transportation. E. M. Shook, 227 West Woodin Blvd., Dallas, Texas.

FOR SALE: Collins 75A4 Serial 714 single owner, excellent cond. Mechanical filters 6, 3.1 kHz, and 800 Hz. $325.00. 320 Harwood Ave., Satellite Beach, Fla.

GLOBE CHIEF 90 xmtr, screen modulator, Drake lowpass filter. $30. Joe Olesik, WA1JQA, Concord Terr., Somers, Conn. 06071.

SELL ARRL Handbooks, 1935-36-42-44-49-52-54-63 and RADIO Handbook 1936—$2.50 ea. P.P. W6IL, 12620 Washington Blvd., L.A., Calif. 90066.

QUICK SALE: Ranger I, EICO 720, HA-350, & Q-Mult all with manuals. Make offer WA2FQH, Tel.: (212) 454-1369.

WANTED: Mint 32V-2, 75A-1 cabinet, Handbooks 1, 2, 7. Falk, W8PP/W8UV, 724 Custer Street, Monroe, Mich. 48161.

FOR SALE: Polaroid Model 100 Camera complete w/ Portrait & Close-up lenses—Exc. Cond. $70; Charles Simmons, 5024-A, Idaho Ave., Plattsburgh, N.Y. 12903.

FOR SALE: GONSET Comm. IV-2 mtrs—$150; SWAN 420 VFO $65; Exc. cond. Charles Simmons, 5024-A Idaho Ave., Plattsburgh, N.Y. 12903.

FOR SALE: Drake TR-6 all accessories, 2 mo. old, $750.00 plus shipping. Consider mint SB110-A. J. Gysan, 53 Lothrop Street, Beverly, Mass. 01915.

WANT: A used rig covering novice frequencies WN0YTF, Tim Meyer, RR1, Brule, Nebraska 69127.

COLLINS 75A1—$85.00 mint condx. 32 V1—$75.00. Both $140. W9D.B.S. Jim Demetral, 16530 Skyline Dr., Tinley Park, Ill. 60477.

REGENCY DR-200 Receiver 30-50, 152-174 MC, in like new condition $110. Postpaid. W. J. Davis, 4434 Josie Avenue, Lakewood, Calif. 90713.

GONSET IV perfect $200.00. Matching VFO $60.00 both $250.00. WA2OHN, 845 Cliffside Avenue, N. Woodmere, N.Y. 11581.

WANT: Heavy duty Crank up and/or Fold over tower. Johnson Kw Matchbox with SWR. WA1AWX, Bob Hill Rd., Ridgefield, Conn. 06877.

JOHNSON Adventurer with 18 Crystals $35. Heath X Former 800, 120 and 6.3V (for SB 200). Unused $15. WA3 JHB, 2286 Rose Garden Road, Pittsburgh, Pa. 15220.

BUILD THAT LINEAR—All kinds high power parts, tubes, sockets, transformers, capacitors, SSTV parts. W7SAB, Bremerton, Wash.

TRANSMATCH MILLEN 2KW like new original carton $115. K7SPH, Box 4099, Tucson, Arizona 85717.

WANTED: Johnson Valiant, 500, SSB adapter, matchbox, also bug. WN2JJF, Gary Whitehead, 6 Reynolds Road, Glen Cove, N.Y. 11542.

WANTED: Heath Signal Generator, Capacitor Checker, VTVM also Swan VOX Accessory, all in good condition. TS Hawley, 322 Interstate Pkwy., Bradford, Pa. 16701.

SALE OR TRADE: TG34A keyer with four tapes, BC 522 two meter rig, make offer on above. Want DX-60 with VFO. W7CRP, 55 E. 8th, Sheridan, Wyo. 82801.

FOR SALE: Collins 75A4 Ser. 3118, $375.00. HT32A, Hallicrafters, $250.00. Both mint condition. Original owner. R. H. Cherrill, 8005 Palmetto Ave., Philadelphia, Pa. 19111.

WANTED: Swan 250C with 117xc in excellent condition. Ed Wagner, 6307 E. Gate Road, Monona, Wis. 53716.

WANTED: Cathode Followers for RRB Rec. #10563. Also Rack Mount #CKJ10350-A. E. Wagner, 6307 East Gate Road, Monona, Wis. 53716.

GERTSCH FM—7 frequency meter with DM-2 Deviation meter, very good condition. $1000.00. P. Olson, Box 342, Hyde Park, 12538.

HORNET TB-1000-4 1 yrs old. $75.00. going Quad Bennett, K4YYT, 1738 Fouraker Rd., Jacksonville, Fla. 32205.

FOR SALE: Johnson Viking II Xmtr, Model 122 VFO, EV Speech Clipper, mike and spare tubes—All $100. W9BET, 4349 South Kedvale, Chicago, Ill. 60622.

DRAKE TR-3—3 transceiver with AC-3 power supply. Excellent condition. $365.00. Harold McGilvray, P.O. Box 77, Llano, Texas 78643.

WANTED: Johnson KW Match Box, Millen 90651 GDO, Impedance Bridge. State condx., age, min. price. All replies ans. C. Harrow, Box 505, Conway, N.H. 03818.

S.C.A.N. So. Calif. Amateur Network 14325 0400 GMT Monday through Friday, Join us.

WANTED: 75A-4 filters (not 3.1), good condition. Send price. K0HIL/5, 15-B, Albrook, Big Spring Tx. 79720.

4D32 Tubes 2/$15.00 p.p. 304TL 2/$35.00 p.p. Write for other. K4PNY, 4103 NW 15 Street, Gainesville, Fla. 32601.

WANTED: Mint 80-10 Linear, HW32, Heath 3" scope, Ameco Pt Preamp, Sell: 90 Ft. Hvy. duty tower. Give full particulars K3WIU, Waymart, Pa. 18472.

WANT: Globe VOX-10. Lorenson Hillsdale, N.Y. 12529.

FOR SALE: Ranger II w/Ptt & F.S.K. HQ-110, RTTY w/tape gear & truckload of goodies! $400.00. Nowm Fowlkes, K8ANZ, 1212 Crown Drive, So. Charleston, W. Va.

HURRICANE CAMILLE is now history. We Gulfport residents are indebted to K4CRU, K4RHL, WB4BHW, WB4LQO, and thousands who helped on the net. Jerry K8YUW/5

WANTED TO BUY: HW12A and RME two 6, and 10 converter. Gerald Duff, 512 Illinois Ave., Nutter Fort, W. Va. 26301.

WANTED: 1296 converter. Perfer solid state. E. Erickson, W2CVW, 13 Robert Circle, S. Amboy, N.J. 08879.

WANTED: Heavy duty crank up and/or fold over tower. WA1AWX, Bob Hill Rd., Ridgefield, Conn. 06827.

FOR SALE: Collins R390-A — $750.00. RME 6900 — $125.00. HW12 — $75.00. HW32 — $75.00. HW32 — $75.00. Power supply for some $25.00. All in excellent condition. A. D. Baldwin, WA0CKO, 1425 Lincoln Ave., Baxter Springs, Kans. 66713.

MISSING: Drake T-4XB S/N 14198R. Anyone knowing whereabouts please contact Wash. D.C. Police Dept. or C. Carr, W3FPP, 1622 19 Street, N.W., Wash., D.C. 20009.

READER SERVICE

To obtain literature from advertisers simply check the box to the name of each advertiser listed below whose product or service is of interest to you. We'll pass your name on and you'll get literature from the advertiser in short order.

November, 1969

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- ☐ AMECO, Division of Aerotron, Inc.
- ☐ Arnold's Engraving
- ☐ Arrow Electronics, Inc.
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- ☐ Eimac, Division of Varian
- ☐ Electro-Voice, Inc.
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CQ Reader Service
14 Vanderventer Ave.
Port Washington, N.Y. 11050

Sirs:

Please send me information on the products and services which I have checked above.

Name ______________ Call ________

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City ____________ State ______ Zip______

Advertiser's Index

See page 110 for New Reader Service

Concerning *Mosley*

Ever since our beginning, we have felt the need for strong demonstration facilities, not the least important of which would be suitable antennas. Four towers supporting forty-four antennas show how serious we are, for an antenna cut to frequency provides an average of 20 db gain over a random length and this is mighty important when you are trying to prove how effective a piece of equipment can be.

Faced with such a substantial antenna investment we had to decide for ourselves whose product represented the maximum value. Almost every existing design is made by two or more manufacturers in roughly the same price class. What then was the determining element which enabled us to choose our particular radiator.

The service life of the antenna was regarded as the most important parameter. In this connection, it is interesting to note that Carl Mosley's products won this test hands down. We have had antennas of his manufacture up in the air for fifteen years with no, I repeat, no service. We have had a TA-36 up for five years behaving as well today as when it was put up. His trap dipoles, such as the TD-2 give a tremendous account of themselves day in and day out and it should be remembered that here in the North East we have some pretty good ice storms and some pretty stiff gales.

A distributor has to sell products for which there is a persistent and continuing demand and Mosley, of course, is only one of several competitive brands. Mosley leans over backward in trying to express specifications concerning their products. The gain references, for example, are compared to a standard dipole, not the theoretical isotropic dipole which another prominent manufacturer uses as a comparison.

This means that when you compare gain figures you have to subtract approximately 2-½ db from this other manufacturer's specs comparing it with Mosley.

This whole subject of antenna measurements is so touchy and causes so much confusion and controversy, that ARRL will not accept advertising in which antenna gain measurements are listed.

I think the conclusion you can draw is that Mosley is conservative and, in addition to being built well and designed well, Carl will not knowingly have any of his products misrepresented. He creates a conservative image of his product and you can believe in what he says.

Because we have been pushing on towers lately, we feel it necessary to point out to our many hundreds of friends that we have the entire Mosley line. We have it in large quantities and we would like nothing better than the opportunity to quote on an antenna package, with or without the tower, and with or without a rotator. So, whether you are interested in a single vertical for these space saving situations, or have a yen for tri-band operation, or want to stack up for points in a contest, Mosley is the brand and we are the place to buy from.

Write in for a Mosley catalog today, or if you have a problem involving your particular situation, address your letter to me personally so I can try to resolve it.

HERBERT W. GORDON COMPANY

Woodchuck Hill, Harvard, Mass., 01451

Telephone 617-456-3548

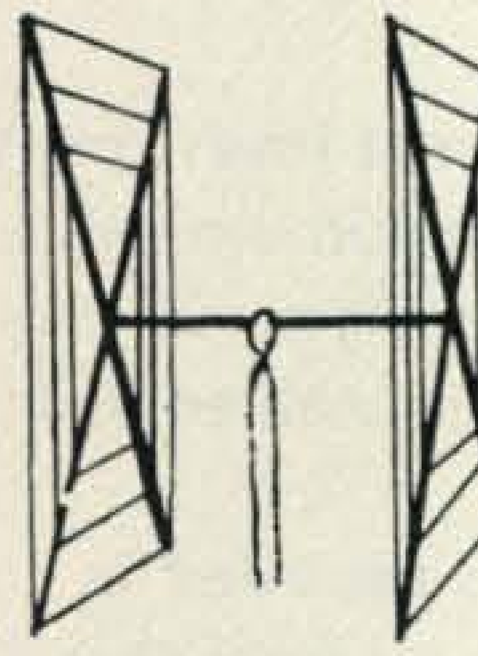
AHA! YOU THOUGHT GOTHAM

had a 47 story factory with 16 beautiful receptionists and 87 research technicians. No! No! No! Gotham is just two brothers making thousands of antennas in a 15' x 35' store, at prices that reflect the low, low, low overhead.

QUADS

Worked 42 countries in two weeks with my Gotham Quad and only 75 watts... W3

CUBICAL QUAD ANTENNAS — these two element beams have a full wavelength driven element and a reflector; the gain is equal to that of a three element beam and the directivity appears to us to be exceptional! ALL METAL (except the insulators) — absolutely no bamboo. Complete with boom, aluminum alloy spreaders; sturdy, universal-type beam mount: uses single 52 ohm coaxial feed; no stubs or matching devices needed; full instruction for the simple one-man assembly and installation are included; this is a fool-proof beam that always works with exceptional results. The cubical quad is the antenna used by the DX champs, and it will do a wonderful job for you!



10/15/20 CUBICAL QUAD SPECIFICATIONS

Antenna Designation: 10/15/20 Quad
Number of Elements: Two. A full wavelength driven element and reflector for each band.
Freq. Covered: 14-14.4 Mc. 21-21.45 Mc. 28-29.7 Mc.
Shipping Weight: 28 lbs. Net Weight: 25 lbs.
Dimensions: About 16' square.
Power Rating: 5 KW.
Operation Mode: All
SWR: 1.05:1 at resonance
Gain: 8.1 db. over isotropic
F/B Ratio: A minimum of 17 db. F/B
Boom: 10' long x 1¼" O.D.; 18 gauge steel; double plated; gold color
Beam Mount: Square aluminum alloy plate incorporating four steel U-bolt assemblies. Will easily support 100 lbs. Universal polarization.

Radiating Elements: Steel wire, tempered and plated, .064" diameter.

X Frameworks: Each framework consists of two 12' sections of 1" OD aluminum 'hi-strength' (Revere) tubing, with telescoping ⅞" tubing and short section of dowel. Plated hose clamps tighten down on telescoping sections.

Radiator Terminals: Cinch-Jones two-terminal fittings

Feedline (not furnished); 52 ohm coaxial cable

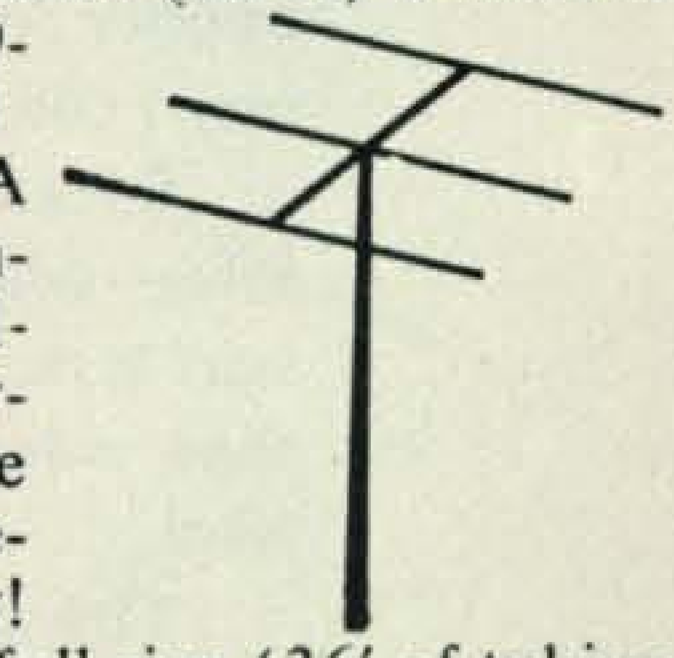
Now check these startling prices—note that they are *much lower* than even the bamboo-type:

10-15-20 CUBICAL QUAD	$35.00
10-15 CUBICAL QUAD	30.00
15-20 CUBICAL QUAD	32.00
TWENTY METER CUBICAL QUAD	25.00
FIFTEEN METER CUBICAL QUAD	24.00
TEN METER CUBICAL QUAD	23.00

(all use single coax feedline)

BEAMS

The first morning I put up my 3 element Gotham beam (20 ft) I worked YO4CT, ON5LW, SP9-ADQ, and 4U1ITU THAT ANTENNA WORKS! WN4DYN Compare the performance, value, and price of the following beams and you will see that this offer is unprecedented in radio history!



Each beam is brand new; full size (36' of tubing for *each* 20 meter element, for instance); absolutely complete including a boom and all hardware; uses a single 52 or 72 ohm coaxial feedline; the SWR is 1:1; easily handles 5 KW; ⅞" and 1" alumnium alloy tubing is employed for maximum strength and low wind loading; all beams are adjustable to any frequency in the band.

2 EL 20	$19	4 EL 10	$18
3 EL 20	25	7 EL 10	32*
4 EL 20	32*	4 EL 6	18
2 EL 15	15	8 EL 6	28*
3 EL 15	19	12 EL 2	25*
4 EL 15	25*	*20' boom	
5 EL 15	28*		

ALL-BAND VERTICALS

"All band vertical!" asked one skeptic. "Twenty meters is murder these days. Let's see you make a contact on twenty meter phone with low power!" So K4KXR switched to twenty, using a V80 antenna and 35 watts AM. Here is a small portion of the stations he worked: VE3FAZ, TI2FGS, W5KYJ, W1WOZ, W2-ODH, WA3DJT, WB2FCB, W2YHH, VE3-FOB, WA8CZE, K1SYB, K2RDJ, K1MVV, K8HGY, K3UTL, W8QJC, WA2LVE, YS1-MAM, WA8ATS, K2PGS, W2QJP, W4JWJ, K2PSK, WA8CGA, WB2KWY, W2IWJ, VE3-KT. Moral: It's the antenna that counts! *FLASH!* Switched to 15 c.w. and worked KZ5-IKN, KZ5OWN, HC1LC, PY5ASN, FG7XT, XE2I, KP4AQL, SM5BGK, G2AOB, YV5-CLK. OZ4H. and over a thousand other stations!

V40 vertical for 40, 20, 15, 10, 6 meters	$14.95
V80 vertical for 80, 75, 40, 20, 15, 10, 6 meters	$16.95
V160 vertical for 160, 80, 75, 40, 20, 15, 10, 6 meters	$18.95

HOW TO ORDER: Send money order. We ship immediately by REA Express charges collect. Gotham ham and CB antennas are available for pick-up in: Rockford, Ill.; Orange, Calif.; Cleveland, Ohio; Daytona Beach, Fla.; Calgary, Canada; Hannibal, Mo.; Indianapolis, Ind.; South Bend, Ind.; Oklahoma City, Okla.; Leavenworth, Kansas; Dallas, Texas; Brockton, Mass.; Ellwood City, Penna.; and in the Benelux Countries and Australia. Write for name and address of franchised distributor. Other cities open.

GOTHAM
1805 Purdy, Dept. CQ,
Miami Beach, Fla. 33139

See page 110 for New Reader Service

AF Voltage Amplifier
AF Power Amplifier
Automatic Gain Control
Cathode Coupled, Direct-Drive (RF)
Cathode Drive (RF) (Grounded Grid)
Cathode Follower
Clipper
Converter
DC Amplifier
Delay Circuit
Demodulator
Detector, Audio
Driver
Frequency Converter
Frequency Divider
Frequency Multiplier
Gated Amplifier
Indicator, Tuning
IF Amplifier
Inverter
Limiter
Mixer
Modulator
Multivibrator
Oscillator, RF
Phase Inverter
Pulse Amplifier
Pulse Modulator
RF Power Amplifier
RF Voltage Amplifier
Rectifier
Sweep-Circuit Oscillator
Video Amplifier
Volume-Expander-Compress

34 places to use receiving-type tubes

and RCA has tubes for all of them!

Anywhere you look in your shack, you'll find places for RCA receiving-type tubes. In your equipment, socket by socket, they give you the top performance and long-lasting reliability you've come to expect from RCA.

That's because RCA tubes are the result of RCA's many, many years of technical experience and practical knowledge as a broad line, high-volume manufacturer of tubes for every application.

See your RCA Tube Distributor for all your tube needs. While you're at it, ask about the RCA Receiving Tube Manual, RC-26.

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CA Electronic Components, Harrison, N. J.

RCA