

# The Staggering Band Theorem

## *A Design for Living in Amateur Radio*

BY LARSON E. RAPP, W1OU

• Once again Rapp, the fearless April scientist, walks boldly in "where angels fear to tread" and locks horns with the greatest problem of all amateur radio, the 'phone vs. c.w. controversy. Attacking it with his usual logic and analytical skill, he comes up with a solution to all of the frequency-subdivision situations. Here is enlightening reading for all students of this basic amateur question.

THE "circular-band theorem" described<sup>1</sup> a year ago put many thinking amateurs to work devising ways and means for best utilizing this very logical system for reducing interference in the amateur bands. The work of Shuart<sup>2</sup> and Sexton<sup>3</sup> was particularly outstanding, and it is safe to say that, had conditions remained as they were in 1946, or, better yet, 1936, there would be no need for further attacks on the problem. However, in the year that has elapsed, three factors have contributed to increased interference in the amateur bands to such a magnitude that other solutions must be sought.

The factors responsible for the augmented QRM are the increased number of amateurs, the surplus equipment now available, and 'phone operation. The most reliable figures on the growth of amateur radio indicate that the number of amateurs will be increased by 50 per cent within one or seven years, or possibly sometime in between.<sup>4</sup> Taking the most optimistic attitude, it is still apparent that something must be done. The surplus market, which is just beginning to get under way, now makes it possible to build a complete 1-kilowatt transmitter complete with pilot lights (three colors) for \$47.85, and it is difficult to estimate how many kilowatt rigs there are lurking throughout the world, just waiting for a receiver before they can start working other stations. Some idea can of course be obtained by listening to the number of stations

testing each night, obviously with no thought of ever listening, but these figures will vary with the locality, and nothing definite is available. Conservative estimates of the surplus market, which take into consideration the present amateur practice of stocking up on spare parts, all agree that it will be roughly 37 years and 4 months before an appreciable dent in the stock becomes apparent. It is interesting to note that the custom of storing the large spare tubes in the final amplifier — it is not at all unusual to find a conservative 1-kilowatt amplifier that uses four 450-THs in push-pull-parallel — may have some effect on the number of licensed amateurs in the near future, according to the FCC. Radiotelephone operation, in this and other countries, has increased instead of dying out and, although apparently a more attractive form of communication to many than "talking with their hands,"<sup>6</sup> it is a great devourer of kilocycles.

As a matter of strict fact, amateur 'phone is undoubtedly the greatest contributor to amateur interference today, both in the amateur and in the broadcast bands. Some of the foreign countries, with whom we enjoy the most friendly relationships otherwise, have developed 'phone techniques that require several times the channel space required by the more primitive domestic 'phones, but information on the exact methods used is difficult to come by. At least nothing on the subject has appeared in the domestic press in the past few years, so the secret must be kept fairly well guarded. However, it is not the purpose of this treatise to engage in a discussion of the relative merits of 'phone vs. c.w., but only to propose a solution to their working together in closer harmony with no mutual jealousies or demands for more frequency assignments.

Reasoning along the lines of more band edges for everyone, a major objective of the Circular Band Theorem,<sup>5</sup> careful study of the "Ten-Meter Plan"<sup>7</sup> was made and many observations of students of that band were carefully analyzed. Regardless of the merits of the proposal, the consensus seemed to be that it was too complicated and that the average amateur, already overburdened by weighty problems about his standing waves and an S-meter that will only hit the pin on strong signals, could not be expected to remember where one allocation within a band leaves off and another begins, even though it is to his best interests to acquaint himself with these details. This weight of opinion discouraged a plan

<sup>1</sup> Rapp, "The Circular Band Theorem," *QST*, April, 1946.

<sup>2</sup> Shuart, "Vertical Modulation," *QST*, June, 1946.

<sup>3</sup> Sexton, "Putting Circular Bands to Work," *QST*, June, 1946.

<sup>4</sup> Harkness, "The Pros and Cons," *Ossining Golf Digest*, Oct., 1946. Also, latest report of the Gallop Pole.

<sup>5</sup> Miller, Joe, *The World's Funniest and Oldest Gags*.

<sup>6</sup> Rapp, *ibid.*

<sup>7</sup> "A Plan for the Ten-Meter Band," *QST*, Dec., 1946.

that the author was about to propose for all of amateur radio, namely, to stagger the 'phone and c.w. assignments every 100 kc. throughout the spectrum. However, it was this very discouragement that gave impetus to a new and even better plan, so it appears that the "Ten-Meter Plan" served a very useful but unexpected purpose.

### Research

From intimate discussion with well-informed representatives of both factions, the author has reached the conclusion that if the subdivision of the amateur bands were left up to the 'phone men, all of the amateur frequencies would be made available exclusively to 'phone. Likewise, members of the brass-pounding contingent would be only too happy to see all of the bands made exclusively c.w. That this is basic will be agreed by all and, indeed, it is confirmed by the traditional greeting between 'phone and c.w. men.<sup>8</sup>

Obviously the best solution to the problem would be the development of some new form of 'phone and c.w. that would allow the two to work independently on exactly the same frequency. It would then be possible for the bands to be thrown open in their entirety to both 'phone and c.w., and both factions could go along blissfully unaware of the other on the air, in much the same fashion that they do now off the air. While this attack is still being carried on in the laboratory, it may be some time before the solution is obtained. Another very promising approach is based on a communications method involving the inverting of the normal speech frequencies into corresponding "contrapolar"<sup>9</sup> frequencies — i.e., frequencies less than zero — modulating the carrier with these frequencies and then reinverting them back to normal after reception. Since negative sidebands are obtained, the signal disappears entirely with modulation, and the higher the modulation frequencies the more it disappears. Thus the more high-fidelity 'phones active on the air with contrapolar modulation, the more room there is, and the only problem, aside from the technical ones, is to guarantee that there be enough 'phones talking all of the time to insure the existence of the frequencies. Present experience indicates that this problem is insignificant. Stations in neighboring countries will undoubtedly supply large portions of the bands to us and will thus be helping to make room for many more stations, a very worth-while step in the right direction.

Staggering the 'phone and c.w. assignments, as mentioned before, brought out some interesting possibilities. Obviously 100-kc. segments are too large and, since all of the international assignments are not necessarily even multiples of 100,

there would be some disagreement by the two factions. The next step was to reduce the idea to 50- and then 25-kc. segments, and by the time 8-kc. segments were reached a general equation was developed that permitted one to study the effect regardless of the segment widths. The actual equation is beyond the scope of this paper but, suffice to say, it does show that, for an upper audio limit of 4000 cycles, 'phones always take up more room than c.w. stations. The reciprocal of this equation, incidentally, is the factor by which 'phone men think their assignments should exceed the c.w. assignments. However, in a broader sense, such as 'phone, by using the theory of limits one can visualize reducing the segments until the 'phone and c.w. portions are superimposed. This is the principle of "imposition" which has been hinted at by other workers but never fully explained. Suffice to say, however, it shows the impracticality of staggering assignments in frequency, or "space" on the dial.

### The Staggering Band Theorem

The other approach, the new Rapp plan, is one that requires no great technical progress and can therefore be put into effect almost at once. It too is derived along the general basic space-time-frequency canons, and it is so simple and so logical that it seems unfortunate, and somewhat amazing, that no one has suggested it before this time. Known as the "staggering band theorem," it consists simply of staggering frequency assignments in time rather than in space (frequency)! Stated another way: During alternate 24-hour periods, make the bands exclusively 'phone or exclusively c.w.! For example, on the day the plan goes into effect, the 3.5-, 14- and 50-Mc. bands would be exclusively c.w. throughout the world, and the 7- and 28-Mc. bands would be exclusively 'phone. At the end of the 24-hour period, 80, 20 and 6 would be exclusively 'phone for a day, while the c.w. men held forth on 7 and 28 Mc. At the end of that 24-hour period, conditions would revert back to those of the opening day for another 24-hour period, and so on. The periods would be concurrent throughout the world, the calendar being based on GCT or some other well-known time. WWV is already prepared for the move, since time signals as well as standard frequencies are a part of the regular schedule.

The advantages of the plan are obvious. No 'phone man could ask for more frequencies, because they would *all* be available to him. The c.w. man would similarly be content, with no 'phone interference to interrupt his activities. Progressive old-timers, who have camped on one frequency for so long that they have worn a hole there, would have an opportunity every other day either to go on another mode of communication or go to a movie. In either event, they would find out what is going on in the world, an im-

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<sup>8</sup> "Drop dead!"

<sup>9</sup> Wildenhein, "Contrapolar Frequency Spectrum," *QST*, March, 1944.

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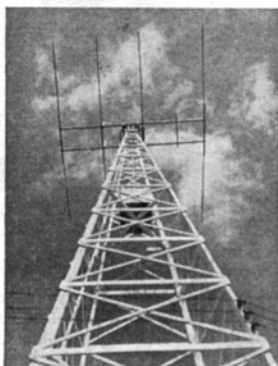
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San Francisco. Other QTHs are: PK6EE, Box 76, Macassar, Celebes, N.E.I.; H18MAF, Max Fiallo, P.A.A., Trujillo City, Dominican Republic; CP1AP, Box 346, La Paz, Bolivia; VP8AM, W. H. Hannaford, No. 1 Arch Green, Stanley, Falkland Islands. . . . . All QSLs for Y12AM should go via ARRL. . . . . Add to QTH list: CT2WX, 53rd Recon. Sqdrn., APO 406, c/o PM, N.Y.C.; PZ1RM, O. W. Morroy, Box 118, Paramaribo, Surinam, D.G.; VP9Q, B. S. Atkinson, Kenrose, 3rd Ave., Cavendish Heights, Bermuda; TI2BF, Paco Bermudez Term., E. San Martin Ave., San Jose, Costa Rica; PA10Y, Box 679, Paramaribo, Surinam, D.G.; ZB1AD, Signals Officer, RAF Station, Luqa, Malta; W7IMW/C7, Det. 44, c/o 1st Marine Division Hdqtrs., FPO, San Francisco, California.

### Tidbits:

Suggest that everyone read the "Operating News" item in this issue entitled "Ending Signals." Several DX stations have complained to us that upon using QLM, QHM, etc., the East Coast ignores the procedure and the QSOs are, in most cases, with W6s and W7s, who seem to know the meaning of these signs. Come on, East Coast, let's show 'em! . . . . . A certain W2 complains about the key clicks from a certain W4. To the W2: How about getting rid of that resonant filter or using and sharpening up ur own signal? Know who? . . . . . About ten of the gang in the N.Y.-N.J. area bought a BC-342 receiver for PAØVD. Upon conversion it was shipped to him, after endless red tape. . . . . W5IWY has received a QSL from FF8WN which he did not earn, he says. The QSO supposedly took place on Jan. 1, 1947, 0455-0500 GCT. Anyone interested drop him a line. . . . . From a reliable source we find that EP3D is a bootlegger, so don't look for any cards from Persia for this one. . . . . 73.

### Staggering

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possible condition at the present time. 'Phone men, who like to listen to other 'phones, could have the benefit of the wide-band transmissions of our neighbors, while the c.w. men would be relieved of this annoyance and would have a better opportunity to observe the eccentricities of some of the weaker DX signals.

The success of the plan hinges, of course, on the ease with which we can get all of the countries of the world to agree to it. From observation of past quick mutual agreements between these countries, the U. N. or any other international group should knock it off like anything! Write your director and congressman immediately, telling of your support of the "staggering band theorem" and all it implies. A convenient blank will be found on page 173 of this issue. Sign it and send it air mail — at once.