How Many Stations on One Wavelength?

A Discussion of the Problem of Enabling More Than One Station to Operate on the Same Wavelength in a Program Network

By J. H. Barron, Jr.

THE broadcasting of chain programs has now increased to such a great extent that many listeners, particularly in the Middle West, complain of being able to receive no others. This has brought up to many the question, why not have each of the stations broadcasting the chain program operate on the same wavelength or frequency so that other programs could be broadcast by other stations without interference for those listeners who do not care to hear the program being broadcast by a chain of stations?

There are two important technical problems to be solved before this is practicable. First, it will be necessary that each broadcast station be adjusted to and maintained on exactly the same frequency; and second, it will be necessary that each transmitter utilize exactly the same sound quality in its modulation.

The program from the studio where the actual rendition is taking place is transmitted over telephone lines to the various broadcast stations comprising the chain, as described in the previous issue of RADIO NEWS. Because of various electrical effects encountered while passing over the telephone lines, the audio current derived from the original sound, when arriving at various stations, does not necessarily contain exactly the same frequencies or tones. Certain tones are accentuated or reduced, on account of the varying effects encountered. To increase the reduced frequencies and properly reduce the accentuated ones, so that the sound will be restored to its approximate original quality, requires that the telephone lines be connected to a device known as an "equalizer," which, by proper adjustment, accomplishes the desired result. As there are differences in equipment of the same or different makes used, it is not likely that exactly the same frequency as that originating in the studio will be produced; it is very likely to be of a slightly higher or lower pitch. After being equalized, the sound-currents are then amplified and passed on to the modulating system, which is that part of the transmitter where the audio waves are superimposed upon or "modulate" the generated waves of radio frequency. In this process further changes occur, and are usually different at each station. This causes a still greater dissimilarity of tone quality between the program broadcast by the individual station and that originally heard at the studio.

The result is that at each station the transmitted program will have a pitch slightly higher or lower than the original one. This in itself is not of great importance, as the distortion or change is usually not sufficient in amount to be objectionable to the ear.

STATIONS "OUT OF TUNE"

However, if a number of stations, all within range of the receiver, were broadcasting a given program on exactly the same fundamental wavelength, the result would be comparable to the effect produced if each instrument of the same type were tuned slightly different. For example, if there were three violins, each of which was sounding respectively the notes "C," "D," and "E," the result would be a dissonance. If there were three stations within range of the receiver and the note produced at each differed slightly, the effect would be comparable. These three notes, arriving at the same receiver, would clash. It is, of course, not probable that the distortion would be so great as instanced above; but some clashing or discordance would be noticed if any varying distortion of the original sounds existed in the programs broadcast at the several stations.

An example of this effect has probably been encountered by many listeners. When receiving conditions permit, it is possible to listen to one of the stations broadcasting a chain program, and then quickly to change the controls, so that the same program is received from another station. A difference will often be noted; in some cases, certain instruments in an orchestra will be more plainly heard from one station than from the other. This will usually be especially noted in the case of the bass instruments, such as the drum, bass viol, etc.

The phenomenon of *fading* also tends to increase the difficulties incident to the problem. What is known as "selective fading" also introduces great distortion; this is due to the fact that some of the transmitted frequencies fade more or less than the other frequencies which make up the particular combination of tones transmitted at the time. This has been noted by most listeners. It is mostly apparent when receiving

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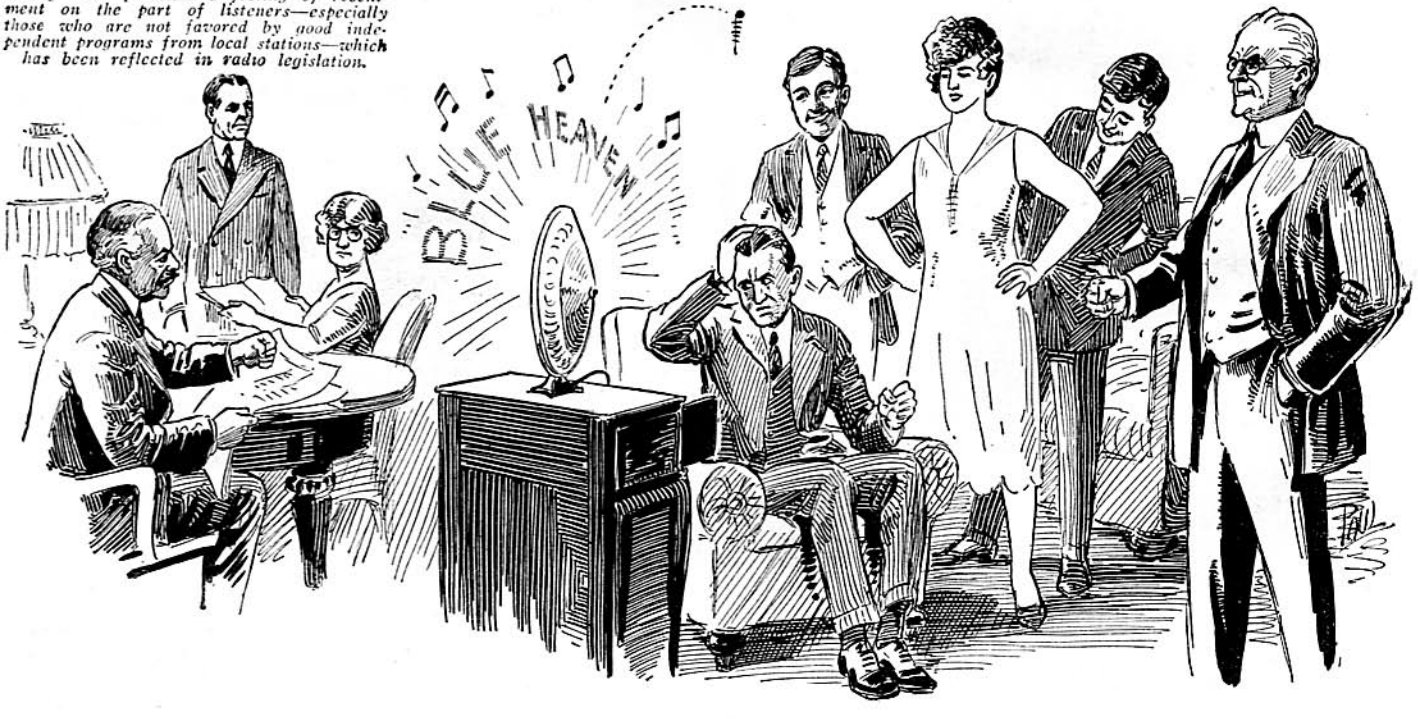
Chain programs may be of the highest quality; but to be greeted too often by the same number from top to bottom of the tuning scale produces a feeling of resentment on the part of listeners—especially those who are not favored by good independent programs from local stations—which has been reflected in radio legislation.



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from long distances at night. This distortion may add to or decrease the total distortion at the time.

CHANGE OF FREQUENCIES

Then, too, quite a large number of stations broadcast chain programs for an hour or two only. When a station came into or left the chain program, this would compel it to revert to its former assigned frequency. From 15 minutes to several hours is required to change the frequency adjustment of most present-day transmitters; this would mean that such time must be wasted. Also, the few hours during which such a station was connected to the chain would not be of great value to another station which desired to use the channel thus vacated.

If a great number of stations were broadcasting the same program, there would undoubtedly be many localities where a given receiving set would receive some energy from quite a large number of stations. This would prohibit the announcing of call letters by the individual stations; as it would be necessary that all transmissions from every station be identical. If, for example, each station did announce its individual call letters, those listeners who were within range of more than one station would hear the announcements from these different stations clashing in at the same time. Though it might be possible to have each station announce its call letters in turn, this would be impractical, as it would require a great deal of time for each station of a large chain to announce its call letters.

Stations, therefore, being unable to establish their individual identities would suffer an advertising loss which would result in a great decrease of their value to the company sponsoring the chain broadcast.

CARRIER-FREQUENCY REGULATION

Considering the second phase of the question, the problem of maintaining more than one station on the identical frequency, is one which is not commercially practical as yet. It is absolutely necessary that the frequency of all transmitters of the chain be maintained exactly the same; if this were not done, the various waves from several stations would interfere and clash with each other; producing whistles of varying intensity and pitch, even if no program were being broadcast.

Practically every listener is familiar with the whistles heard on some of the broadcast frequencies; this is due to slight difference in the carrier waves of the stations, operating on that channel. For instance, suppose two stations sufficiently near are broadcasting on the 1260-kilocycle channel; but one of the stations is slightly off its correct frequency and operating on 1261 kilocycles, and the other station is maintaining its carrier-wave on exactly 1260 kilocycles. The two fundamental frequencies will produce a third, equal to the difference between 1261 kilocycles and 1260 kilocycles, or 1 kilocycle. This one-kilocycle frequency is heard as a fairly high pitched whistle, or 1000-cycle note.

If both stations were operating on exactly the same frequency, however, the difference would be zero and no note would be heard; this condition is called "zero beat." The slightest deviation is not permissible, which requirement eliminates the use of "manual control," wherein one station's carrier is kept at the same frequency or "zero beat" with another, by the operator of one station listening in on a receiver at a remote point and adjusting his own transmitter by hand to "zero beat" with another when a whistle is heard caused by his station operating on a different frequency from the other stations operating on the same channel. Nor will automatic devices do to produce this result, as they require that the station's carrier-frequency change slightly before it may be restored to the proper frequency.

Controlling two or more stations from one crystal requires great multiplicity, and therefore great expense, in wire connections between the various stations. A system, whereby synchronous operation is effected by one station's (when varying from its correct frequency) producing a similar variation at another, has been accomplished; but this is expensive, especially where there is any great distance between the stations so controlled.

Because of the distortion taking place during wire transmission or due to differences in the amplifiers used and in the actual transmitter, it is not considered practical at this time to provide a single channel on which a chain program should be broadcast. The result would probably be that only those listeners within close range of but one station, where no perceptible effect would be produced by the transmission from other stations, would be able to receive the program clearly. Any listener whose receiver was affected by more than one station would probably hear nothing but discordant tones.

However, if it ever becomes practicable to have chain programs broadcast on a single channel, the advantages resulting will be numerous. These will be explained in another article to follow in the near future.

(Another interesting phenomenon which might arise, in case a number of high-power stations were operating on exactly the same fundamental frequency and with identical programs, even after the technical problems above listed have been satisfactorily solved, is that of interference due entirely to the location of receivers in the areas at which two stations come in with approximately equal strength. There might then be expected to occur an effect similar to the fringes of color noted where two light waves alternately strengthen and cancel each other; at points where the signal of one station had to travel one-half a wavelength farther than that of the other, the two should completely cancel each other, except as the directional characteristics of the receiving aerial might overcome this interference. However, it may be remarked that this condition would probably not manifest itself in inability at all times to receive either station; but in a peculiar fading effect, as the paths of the waves were alternately lengthened and shortened slightly by the changes in the condition of the atmosphere. Some experiments have of late been made in operating two stations with the same program on the same frequency, as related above; and we will be very glad to hear from any of our readers who live where the normal field strengths of two such transmitters are nearly equal, as to the constancy of the signals received by them.—EDITOR.)

A Britisher Chats on Radio

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"How I motored by night from Ogdensburg to Ottawa, and the reason why. A Problem Story." Or even, Among the lion-hunters of Fifth Avenue."

But what do we get? Shades of White Corpuscles! "The History of the Frozen-Meat Trade;" "The Romance of Bimetallism from 1843 to 1926;" "Furnishings in Oak;" "Evolution of the Morris Dance;" "History of the Coffin-Makers' Guild from the time of Henry the First;" "The Influence of the Etruscans on Grecian Burial Ceremonies;" "The Evolution of Hot-water-pipe Systems."

THE ETHEREAL EXILES

From the B.B.C.'s chamber music and talks has sprung the great British amateur radio movement; the movement being an escape. Anything British amateurs have done in the DX line has been directly inspired by the desire to evade British broadcasting. Our most prominent amateurs openly declare that they would rather eavesdrop on a lecture by a Thibetan band of nose-flautists playing on instruments made of human thigh-bones, than endure the customary B.B.C. fare; not because the good in it is so insignificant, but because the bad is so venomous.

In order to give you the proper hang of the real amateur movement in this island, I must explain that it is impossible for a man here to get a license permitting him to hook up and operate a transmitter, *unless he can satisfy the post office that his intention is to engage in genuine research, the object of which must be stated and must satisfy the post office.* If a man said, "Look here! I want to work a set purely for the fun of communicating," the postmaster general would do one of two things: (a), Resign; or (b), call in the law lords to see whether they could not frame up a charge against the sinner which would earn for him a couple of months in prison, or, as some American Milton says, in the *"hoosegow."*

(I do not care much for *"hoosegow;"* it is ugly. "Frazzle" has music; "hootch" has the virtue of conveying the right idea without circumlocution; "piker" is sufficiently

How Many Stations on One Wavelength?

Part II, of a Discussion of the Problem of Enabling More Than One Station to Operate on the Same Wavelength and Same Program

By J. H. Barron, Jr.

IN the June issue of Radio News, *Mr. Barron discussed the practicability of "one program, one wave," which so many of our readers hail as the remedy for broadcast congestion. Below he discusses other important advantages which may well be expected from this method. The problem of synchronization, as well as program transmission is, however, one to tax the best of the engineering brains which are being applied to its solution. The amount of technical skill and calculation involved is beyond the imagination of most broadcast listeners. However, we may look with confidence for remarkable improvements in chain-broadcast technique in the next few years, just as we have seen them in the past.—EDITOR.*

ASSUMING that it were practical to broadcast a chain program on one wavelength from a large number of stations in various localities, the benefits derived by the listeners would be manifold; for those located near the broadcast stations as well as those living at remote points.

The effect of "fading," the bugbear of distant reception, would be greatly reduced. At practically any location in the United States, the waves from at least two stations broadcasting the same program may be received. It is not likely that fading would take place equally from each station at the same time. When the transmission from one was decreased in intensity, that from the other would probably be normal or stronger than usual. This would cause a stronger signal to be received at all times; the more stations within range of the receiver, the more consistent would be the reception.

Another annoyance, often caused by one station going off the air at the most interesting point of the program, would be alleviated. If the local station to which one usually listens should cease transmitting, the listener would immediately hear the transmission from other distant stations without interruption. It might be necessary for him to increase the volume slightly, by proper adjustment of the volume control, but the tuning controls would not have to be touched.

It would then be practical to mark the dials or note the adjustment of the controls for the point where each chain program is received. The point where the "Pink" chain, for instance, is tuned in could be marked or noted. The same could be done for other chains. On referring to the programs for any evening, the listener would decide which chain he wished to listen to at a certain time and set his receiver controls accordingly. It would not be necessary for him to "fish" around to see which station is coming in the best. He would leave the controls alone, after they were once adjusted, knowing that he was getting the best reception possible at all times.

RELIEVING BROADCAST CONGESTION

Placing all the stations of a certain chain on one frequency would preclude placing other stations on the same frequency at that time. Thus, the "heterodyning" and clashing of sidebands, now noted on certain frequencies and which are caused by the operation of stations on slightly-differing frequencies or with too short a geographical distance between them, would be eliminated.

Those who wanted to try for distant reception while the chain program was on, could do so, happy in their knowledge that they would tune in a station not on the chain, and not waste precious moments tuning in a station just audible, waiting breathlessly for many minutes—only to discover that this station is putting out the same program carried by the local station!

The need for super-power broadcast stations would be diminished. It would not be necessary for one station to broadcast with 50 kilowatts to reach a listener already served by the clear reception of a number of lower-powered stations. The super-power station could be changed to a 500-watt station and spare the nearby listeners from the blanketing effect of which so many complain.

If the stations on a certain chain had previously occupied fifty different channels when they broadcast on differing frequencies, and were now operated simultaneously on a single frequency, this would leave forty-nine channels for other broadcast interests to use. This would provide the listener with a great increase in the variety of programs obtainable, certainly a desirable situation.

As there are (practically) only five chains at present, widely-differing frequencies might be assigned to each and practically every listener would be able to hear each one satisfactorily. As the case is now, a local station may be broadcasting a certain chain, while the best reception of another chain is to be had from a station operating on the next adjacent channel, ten kilocycles removed from the local. Few receivers will bring in such a distant station very satisfactorily.

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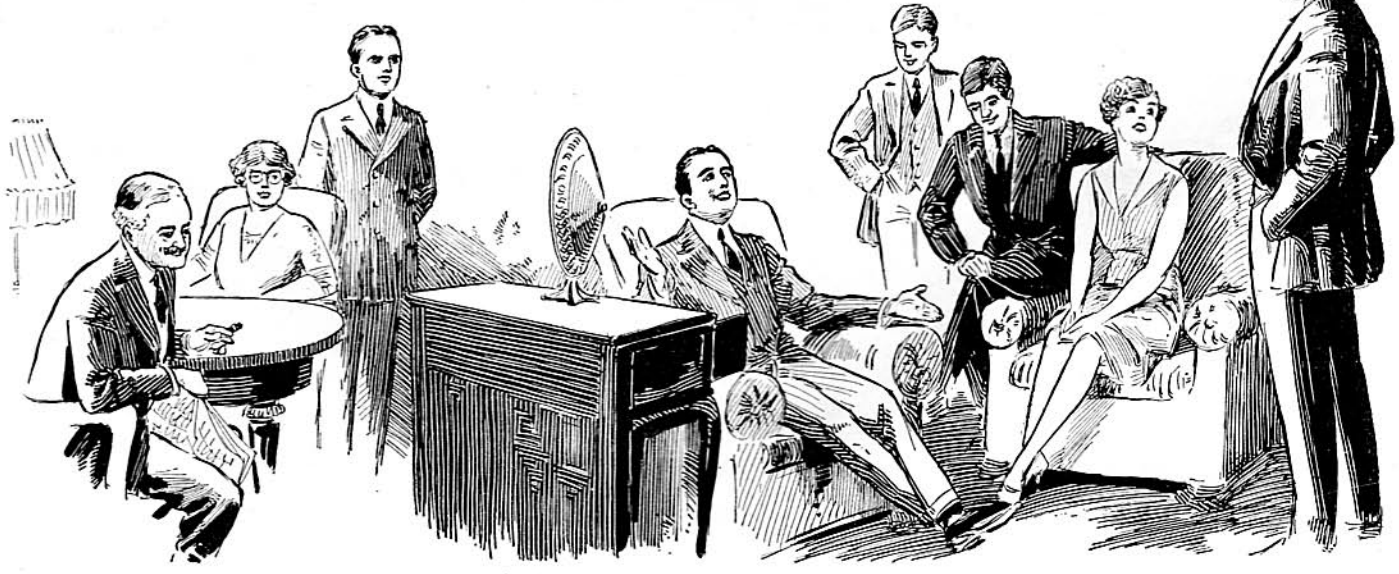
It would not be necessary to limit the number of stations on a given chain; the more the better. Perfect reception of that program could be obtained by everyone at all times.



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INCREASED RECEPTION STRENGTH

A great increase in volume would, it is very likely, be noted, due to the added signal received from a number of stations. The sensitivity of the receiver could therefore be decreased, resulting in clearer reception and more freedom from static disturbances.

There would be no necessity for having more than one local station broadcast a certain program, as sometimes done now.

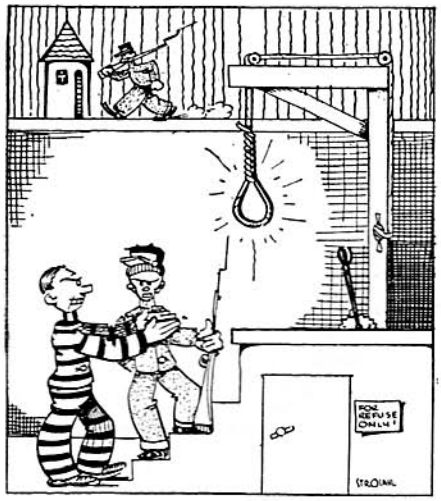
It would not be necessary to limit the number of stations on a given chain; the more the better. If the closely-populated portion of the country could be provided with a 500-watt station every fifty miles for each chain program, perfect reception of that program could be obtained by everyone at all times, regardless of reception conditions.

Better reception conditions would increase the audience served, enhance the value of programs broadcast, and benefit the broadcaster and the advertiser as well as the listener.

A "distant-reception night" could be held as a novelty: at a certain time after appropriate announcements, all stations but one would cease broadcasting, and listeners at great distance from the one still transmitting would attempt to hear it. As it would not be necessary to change the tuning controls, it should be an easy matter to accomplish distant reception. One by one, each station on the chain would in turn take up the broadcasting, giving everyone a chance to easily find out the distance-getting qualities of his receiving set. Many adaptations of this scheme will immediately suggest themselves, such as providing prizes for the one who could verify reception of the largest number of stations, etc.

The fact that two neighboring stations have already accomplished the feat of broadcasting the same program on one frequency indicates that the day may soon come when all chain programs will be broadcast on the same frequency. Many look forward to this with great eagerness.

RADIO TERM ILLUSTRATED



"A Choke Coil"