New Signals from an Old Timer ... WWV

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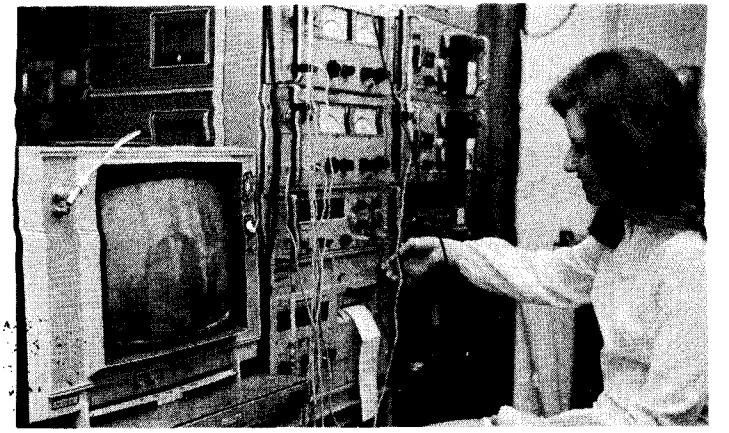

Fig. 1 On occasion, operator makes television time comparisons at NBS Boulder. Sandra Danielson of the Broadcast Services is at the controls.

Although many other changes have occurred in broadcasting over the years, those who tune in to the National Bureau of Standards time broadcast stations WWV and WWVH have come to expect the same familiar time signals year after year. But not much longer. Soon a new broadcast will be heard with more kinds of services than before for a wider variety of time and frequency users.

Starting July 1, 1971 there will be more frequent voice time announcements, a different way of marking hours and minutes, no silent period, and no more Morse code or the fast NASA time code. Instead, a slow time code will be added along with some other changes.

In many respects the services will be the same. The WWV transmitters will remain at Fort Collins, Colorado, broadcasting on the same frequencies of 2.5, 5, 10, 15, 20, and 25 MHz. Power output will not change from the present 10 kW on 5, 10, 15, and 20 MHz and 2.5 kW on the other frequencies. The ticks will continue nearly as before: 5 cycles of 1000 Hz each second. There will be a special tick 0.8 seconds long to mark the beginning of each minute. This tick will also be 1000 Hz except for the first one each hour, which will be 1500 Hz.

Voice announcements will be once each minute instead of once every five minutes. But . . . apparently nothing is safe from Women's Lib . . . time announcements from WWV's sister station, WWVH in Hawaii, will now appropriately in a woman's voice, even ending with a friendly Aloha! There will still be the same audio tones as before, 440 and 600 Hz, but rearranged into new places with some periods where 500 Hz is added for good measure. All use of the Morse Code will be dropped along with the NASA 36-bit "buzz saw" code which will be replaced with a one-bit per second IRIG H time code on a 100 Hz subcarrier. There still will be geoalerts and some other announcements. There no longer will be any completely silent periods.

Now, let's look at the new format from the user's standpoint. The casual clocksetter will never have to wait longer than a minute to get time-of-day information. This feature will also benefit those who wish to time tape recordings of various occurrences; for instance, intermittently occurring conversations between a radio dispatcher and outlying stations. To time the occurrence of short exchanges, the tape recorder need run no more than one minute. For all these uses the tick at the beginning of the first second will be lengthened to 0.8 second to provide easier recognition of the beginning of the minute.

For more precise clock setting, the well-known oscilloscope technique of aligning the beginning of a received 5 ms 1000 Hz tick with the scope trigger from a local clock may still be used. No matter what other modulation is on the station at the time, the 5 ms tick will always be protected from interference from this modulation by being appropriately located in a 40 ms "hole" chopped in the modulation. Knowledge of propagation delay then makes time synchronization to about 1 ms possible, as before.

Standard Audio Tones

For standard audio frequency comparison purposes the 600 Hz tones every other minute (with some exceptions) or the 440 Hz tone once per hour may still be used. In addition, the 45-second slots not used for announcements will be used for a 500 Hz tone. NBS takes the point of view that some kind of modulation should be present nearly all the time to make the signal easy to find when tuning it in.

The new format is designed to serve a new class of users. These users make slow-speed strip chart recordings and desired timing marks. At speeds of 1″ per hour, marks once per hour should serve. These can be obtained from either of two sources. In a high signal-to-noise area the 0.8 second 1500 Hz tick can operate a frequency sensitive circuit such as a resonant reed relay to provide a marker signal.

The same use could be made of the 440 Hz hour marker, but since it lasts 45 seconds much better noise discrimination can be obtained. Absence of this signal at 2400 hours can be used to mark the beginning of the Greenwich mean time 24-hour day. For faster strip chart recordings the same technique can be used to mark each minute with the 0.8 second 1000 Hz tone, or every other minute with the 600 Hz tone.

If complete identification of the time of occurrence of a recorded event is required, this also may be obtained using the IRIG H code. This code has a bit rate of once per second and gives the day number of the year and the hour and minute. This information is presented in binary coded decimal form and is repeated each minute. On the new WWV and WWVH format, the code will be amplitude modulated on a 100 Hz subcarrier, which may not be audible using an

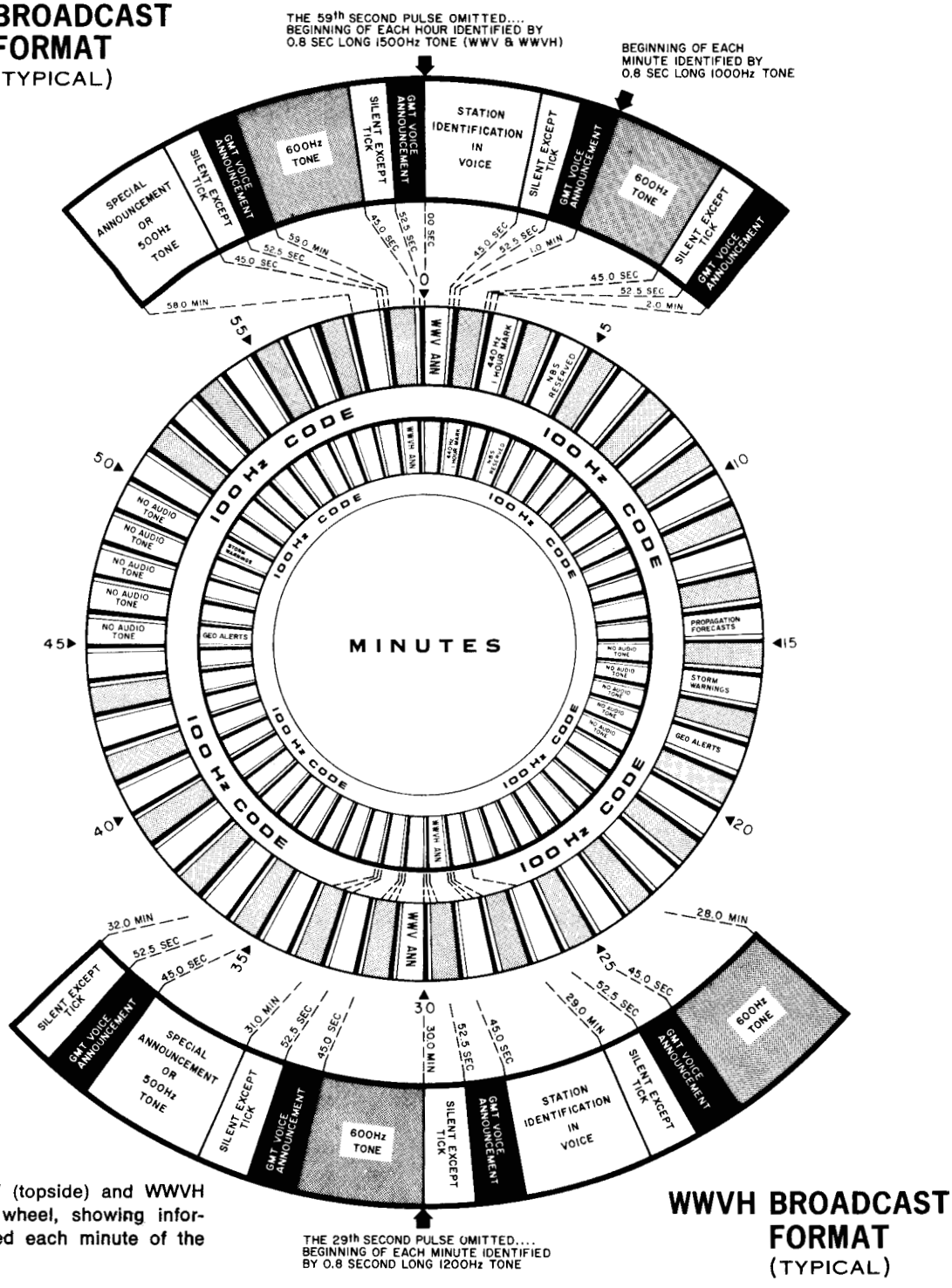

Fig. 2 The WWV (topside) and WWVH (bottom) format wheel, showing information transmitted each minute of the hour.

ordinary receiver. With filtering and clipping, however, it will be suitable for recording on a strip chart recorder and can be easily read by eye with a little practice.

Another new feature of the broadcast is provision for 45-second announcements every other minute (again with some exceptions) from her government agencies for their /n purposes. The geoalerts and propagation forecasts presently broadcast by WWV would fall into this category. There is room for 24

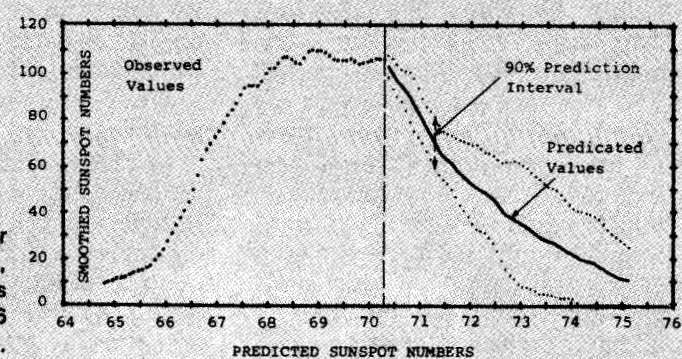

Fig. 3 The 11 year sunspot cycle, showing the years 1964 through 1976 across the bottom.

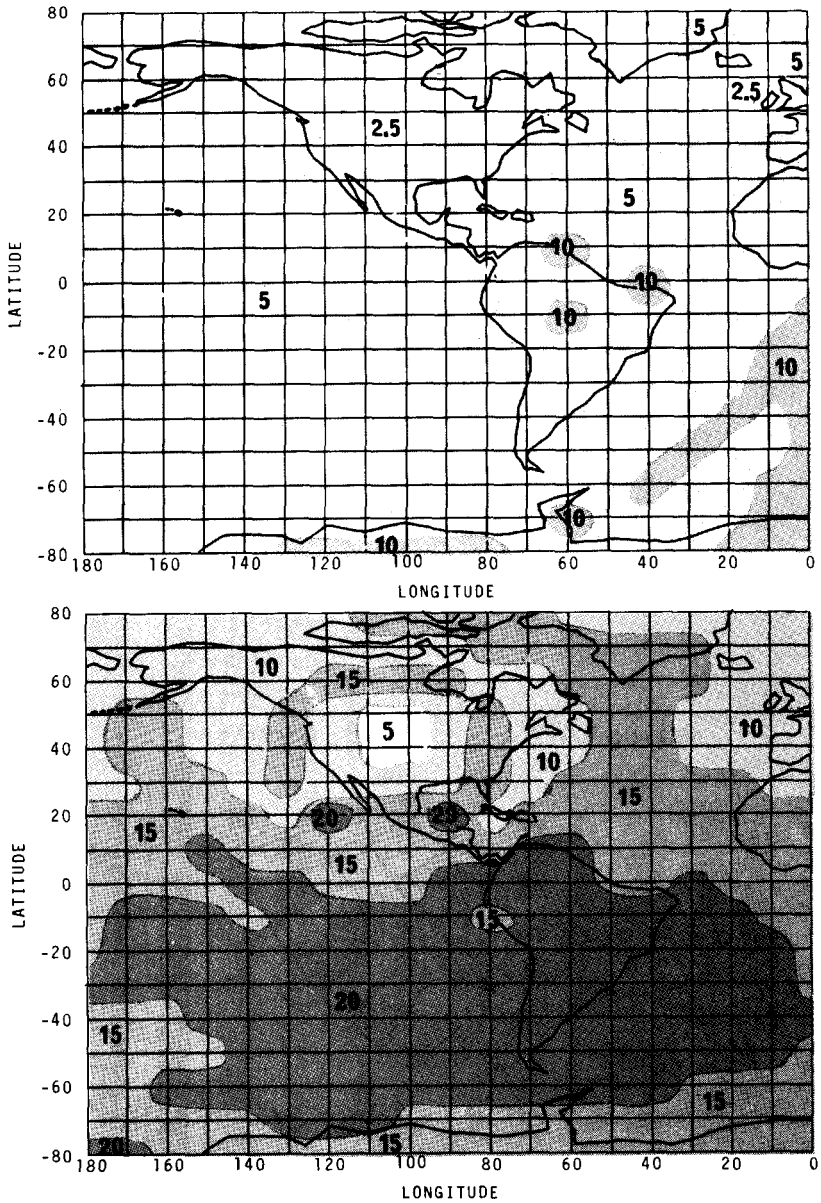

Fig. 4 Map A shows the frequencies (in MHz) around the Western Hemisphere that are predicted to be the best for WWV time announcements for December nighttime. Map B is for December daytime.

such announcements each hour on WWV and 23 on WWVH.

Commercial Use

Even with all these changes, one might never think of hearing WWV time signals coming from anywhere but the WWV transmitters at Fort Collins, Colorado. But, that also may change. The new time announcements are arranged so that WWV on-the-hour time signals can be rebroadcast as a public service by any commercial broadcast station capable of tuning them in on a receiver. The National Bureau of Standards only requires that the rebroadcast be direct and not delayed, and that NBS is identified as the origin of the announced time.

To allow this, the new on-the-hour broadcast will say: "At the tone (pause) 23 hours Greenwich Mean Time." (tone) (pause) "National Bureau of Standards Time." (pause) "This is radio station WWV, . . ." The part to be rebroadcast would be only the tone marking the beginning of the hour and the words "National Bureau of Standards Time." The local announcer would identify the hour of the tone according to his own time zone.

In order to make sure the time announcement can be rebroadcast reliably, the WWV signals must be continuously receivable at the commercial transmitter locations. Due to propagation variations, this is not generally the case on a given WWV transmission frequency at an arbitrary transmitter location. In the continental U.S., however, at least one of WWV's frequencies should always be receivable. A frequency diversity receiver should thus provide the reliability needed for rebroadcast purposes. Such receivers are available commercially from at least one company specializing in WWV receivers.

For general listening use, almost any short wave receiver will suffice. However, there are a number of special purpose timing receivers available capable of being fix-tuned to any of WWV's frequencies. For those who are interested in WWV's geographical coverage on its various frequencies in the Western Hemisphere, some maps giving best usable frequencies are provided. These plots are the result of computerized calculations of coverage predictions made by NBS before relocating WWV from Greenbelt, Maryland to Fort Collins, Colorado in 1966. They take into account seasonal and day-to-night variations and also variations due to the 11-year sunspot cycle. The peak of the sunspot cycle occurred in 1969.

So far, nothing has been s about the source of WWV's time. This is, of course, the world-famous NBS atomic clock located in the NBS research laboratories at Boulder, Colorado. Fort Collins is located 50 miles away and has its own clock system, so intercomparisons must be made with the Boulder clock to insure that the Fort Collins clock is kept in agreement. These are made every day using the signals from a Denver television station to relate the times of the two clocks. The time of reception of a specific "sync pulse" is noted at both Boulder and Fort Collins. Knowing the television signal propagation delay between the two locations then permits a time comparison accurate to a few billionths of a second.

While this is a much better accuracy than can actually be received on WWV, it insures that the almost incredible accuracy of the atomic clock—about a part in 10^{12}—is available to prevent ar long-term drifts or fluctuations fro occurring in the WWV clocks. That will also make sure that old timer WWV keeps right on ticking away.