BY D. J. HOLFORD

WHISTLERS AND OTHER STRANGE R-F NOISES

THEIR ORIGIN IS OBSCURE, BUT YOU CAN HEAR THEM ON YOUR RECEIVER

IN 1886 Austrian long-distance telephone operators complained of hearing strange whistling noises on the line. Six years later, British operators reported hearing similar noises—especially when the aurora borealis was active. These were the first recorded reports of "whistlers," intriguing phenomena which, although still not completely understood, have become a valuable tool in upper atmosphere research.

Whistlers and similar strange noises occur at the very bottom of the radio spectrum (below 30 kHz) in the vlf range. While most long-range radio signals are propagated by reflection from the ionosphere, strange things can happen at vlf. Some signals get trapped by the earth's magnetic field and make a long-distance trip far above the ionosphere before returning to the surface. When this happens, the signal is not only delayed because of the distance, but signals of different frequencies travel at different speeds. What starts out as a simple pulse returns stretched out, with high frequencies arriving first and progressively lower ones following. The result is a slowly falling tone (hence, the term whistler).

TYPES OF WHISTLERS

One-hop: Originates in opposite hemisphere and has made only one trip into space.

Two-hop: Originates in same hemisphere, probably from a local thunderstorm, and has made a round trip to the opposite hemisphere and back.

Echo train: Series of whistlers all caused by the same event. Each is more drawn out than the previous one since it has made an additional round trip. Up to seven have been heard.

Multiples: Several whistlers, frequently overlapping. May be due to multiple lightning strokes or a single flash but propagated over slightly different paths.

Nose Whistler: Starts at a medium frequency and has both rising and falling characteristics.

Where Do They Come From? Lightning discharges radiate vast amounts of electromagnetic energy over the whole spectrum. When some of this energy is trapped in a magnetic duct, or natural waveguide, whistlers may be generated. However, this does not always happen; and that is one of the great mysteries still surrounding whistlers. Why do some lightning strokes trigger whistlers; and others—seemingly similar—produce no such effects?

While whistlers were first detected almost ninety years ago, it was not until the 1950's that instruments were available to measure and analyze them. By 1953, researchers at Cambridge University (England) had positively identified lightning as the cause of most of these strange noises.

In 1954, an experiment was conducted

OTHER VLF NOISES

Hiss: May vary in amplitude over periods of about one second or may remain stable for several hours. Frequently associated with auroral displays.

Chorus: Series of closely spaced fast-rising tones, usually from 1 to 5 kHz. Frequently heard near dawn (Dawn Chorus).

Discrete: Any short-term signal. May be rising or falling tones or hooks (falling tones which reverse direction and rise again).

Periodic: Any sequence of related or similar signals.

between Stanford University and the USS Atka, which was at sea south of Australia. When monitors at Stanford detected a whistler, the Atka reported lightning in her area. Since the two sites were at opposite ends of the same magnetic line of force—conjugate points—this was the first firm proof that the earth's magnetic field was involved in whistler generation.

Whistlers have since been monitored by several satellites, providing proof that they do indeed penetrate far out into space.

By 1957 and 1958, during the International Geophysical Year, whistlers had become so intriguing that a major international monitoring program was set up. It provided much new information, including the fact that high-power vlf radio transmitters, operated by the U.S. Navy on frequencies between 10 and 30 kHz, could also generate whistlers under certain conditions.

Although many of the IGY monitoring stations no longer exist, several nations still operate an international whistler research program.

Why Listen to These Noises? Mainly because they are an ideal tool for learning more about the structure and composition of the upper atmosphere and the far magnetic field. By careful analysis of whistler signals, it is possible to determine what elements and particles were in their path—information that would be very difficult to obtain in any other way. For example, satellites and balloons can give us detailed information on certain levels, but whistlers reveal an overall picture from the surface, out to several thousand miles.

This has led to the establishment of the world's largest plasma laboratory. (Plasma is the ionized conductive gases which make up the far fringe of the atmosphere.) Stanford University, which has been a leader in whistler research for over twenty-five years, has set up a transmitter at Siple Station, less than a thousand miles from the South Pole. A receiving station at Roberval, Quebec, monitors the signals, which are transmitted from a 13-mile-long antenna. (The two stations are at conjugate points.)

The signals are short pulses transmitted on frequencies between 4.5 and 30 kHz, at powers up to 100 kW. The pulse length is increased until whistlers are generated; then the power is decreased until they stop.

This experiment will reveal much previously unknown information about the composition of the atmosphere and ionosphere and the shape and variations of the magnetic field.

If all of this intrigues you, why not try listening for whistlers yourself? Occasionally, sensitive vlf receivers are available from surplus houses. Also you might try building your own vlf preamplifier to be connected to a sensitive audio amplifier. The antenna could consist of 200 turns of #25 enamelled copper wire on a 4-ft. diameter wooden frame, tuned by a fixed 0.02-μF low-voltage disc capacitor. This could be coupled to a 2-stage transistor amplifier using interstage coupling capacitors in the order of 10 to 35 μF. Be sure to position the antenna for minimum 60-Hz power line hum.

If you don't hear anything other than clicks, pops, and hiss for a couple of days, don't be disappointed. There are frequently periods of several days with very few whistlers. They also vary on both daily and seasonal bases. Peak activity is between midnight and dawn, and the best time of year is winter. At peak periods, up to 10 whistlers per minute may be heard.

You may also come across some of the other strange inhabitants of the vlf band—hisses, chirps, and a peculiar sound called the dawn chorus. This sounds like a flock of birds chirping and though it is frequently heard around dawn, it can occur at any time.

There is still a great deal of mystery surrounding many of these noises; and if enough serious experimenters were to set up monitoring stations, they might be able to contribute some really valuable information, which can't be gathered by the small number of official stations presently in operation. ◈