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An Instructional Series for the Newcomer to Electronics

In recent articles we have referred to the production of simple signals by electronic means. First the production of a very low frequency square wave was explained, then circuits were described illustrating the production of sine wave signals of high and low frequency, respectively. As a part of our progress, we covered the requirements and actions of the various components used, and we have managed to mention some of the basic laws governing circuit operation—the "rules of the game" as it were.

Now we are ready to ask the question, "To what uses can these various types of signals be put?"

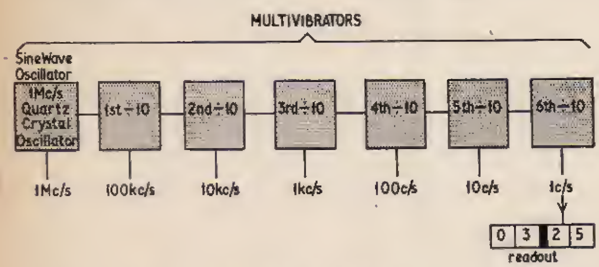

Fig. 22.1. The principle of the quartz crystal clock. Multivibrators are used to divide down the highly accurate frequency generated by the oscillator

CONTINUOUS OSCILLATIONS

It has already been seen that a sine wave purely and simply cannot convey very much in the way of information, but that which it does carry is very important. This information concerns *time;* or strictly, what amounts to the same thing, frequency.

If we have a continuous oscillation of very accurate and stable frequency we have (the analogy of the "pendulum" again!) a very good time keeper. This is the principle of the quartz clock (see Fig. 22.1), which uses the constant signal from a quartz crystal oscillator to time the readout device, in this case a digital hours/minutes/seconds/tenths/hundredths/thousandths, etc. seconds indicator. Also, all the wavemeter or frequency meter test equipment (and some of these devices are very expensive) rely essentially on an oscillator to produce a very stable and accurately known oscillation, for calibration purposes.

RADIO TELEGRAPHY AND TELEPHONY

Perhaps the earliest method of transmitting intelligence by means of electronics, was the chopping up of the continuous sine wave oscillation into the long and short bursts corresponding to the Morse Code as illustrated in Fig. 22.2a. This type of signal became known as "c.w." (continuous wave) and is still used a great deal.

Fig. 22.2a. A continuous wave of oscillations is broken up into long and short bursts by a morse key

It was soon found that the electrical signals produced as a result of sound waves striking the diaphragm of a microphone could be superimposed or "carried" by the high frequency c.w. radiated by a radio transmitter. This is performed by varying the amplitude of the radiated wave in sympathy with the microphone signal, see Fig. 22.2b. The resultant "amplitude modulated" signal is then processed by circuits in the receiver to give back a replica of the original microphone signal, which can then be used to operate an earphone, producing a sound similar to the original. The "carrier" wave, as it is known, is discarded in the receiver.

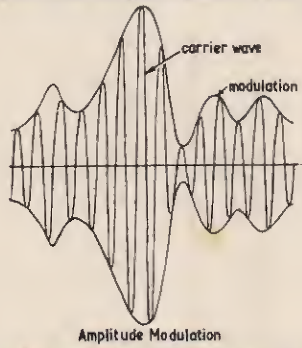

Fig. 22.2b. Here the steady continuous wave is "modulated" by a low frequency signal such as that produced by a microphone. This is known as amplitude modulation

Thus Wireless Telephony became possible . . . . and it was only a matter of time before visual signal information was "carried" in the same way, to give radio photograph transmitting systems, and then television.

Another development took place, in which the *frequency* of the radiated wave is varied in sympathy with the *audio frequency* signals, as microphone and other low frequency (hearable) signals are called. This is illustrated in Fig. 22.2c. Frequency modulation (f.m.) has certain advantages over a.m. systems, in that less interference is caused by noise "signals" from such sources as thunder storms, motor-car ignition systems, and so on.

RADAR TECHNIQUES

With the advent of Radar, electronic techniques really began to develop. Radio Detection and Ranging uses a large signal pulse radiated by a transmitter and a

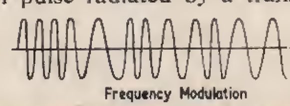

Fig. 22.2c. An alternative method of transmitting audible intelligence is to vary the frequency of the carrier in sympathy with the audio signal. The amplitude remains constant

receiver which detects returning "echo" signals produced by objects in the field of the transmitted pulse. Obviously, a great deal of development had to take place in order to arrange for circuits to switch on the transmitter, switch it off again, turn on the receiver, connect over the aerial to it, start the time measuring device and get the readout device ready—all within *millionths* of a second, and repeat this some thousand times a second anyway.

Radar signals contain a large amount of information. The distance of the "target", the bearing, and the altitude perhaps, are all recoverable from the received pulses, by appropriate processing. The transmitter is switched on, and some one microsecond later switched off again, by using a square pulse. A multivibrator is often used in these devices, just like the one you built to switch the lamps (see No. 13 of this series). This is probably where the term *switching waveform* was first used. The same multivibrator starts the timing circuit, and operates the receiver, also the readout device, usually a cathode ray tube. In fact, the whole circuit works in synchronism controlled by one *master multivibrator* which generates the switching signal. A block diagram of a radar installation is given in Fig. 22.3.

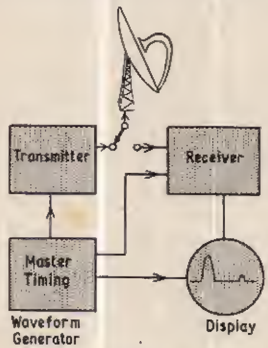

Fig. 22.3. The basic arrangement of a radar installation

It is possible to use pulses of *sound* waves and a microphone to pick up the echoes, and this sound version of a radar set is termed AUDAR, and the writer knows of two successful sets built by amateurs. A similar system for detection of objects under water is known as SONAR. (No example of a radio wave radar set built by an amateur is known to the writer, but it would form a very interesting and challenging project for an enthusiast to attempt.)

TRANSDUCERS

Of course, *all* the methods of producing electronic signals from the variety of sources that exist, both electrical and non-electrical, are important and the student of electronics would be very wise to attempt an early understanding of the methods and techniques commonly used. This part of the subject involves devices called *transducers*, and these are so important (and interesting) that a separate article will be devoted to them. However, once the electrical signal is produced, from whatever source or kind of transducer, it is "handled" by circuits which are all very similar. All said and done, electronic signals are virtually the same from any source—it is the information they carry which differ.

We mentioned before that it is the purpose of the electronic circuits and components behind the front panels to either *amplify* the signals without changing their form, or to process them in some way. The transducers are the "go betweens" between the sources and the electronics, and then from the electronics to the ultimate destination—whether it is a "readout" device to stimulate one of our senses, or the operation of some machine or control device. This is illustrated diagrammatically in Fig. 22.4.

TO SUM UP

To sum up our survey of signals and the handling of them, we should first mention the oscillators we have already described in this series; these are, of course,

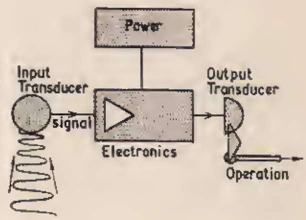

Fig. 22.4. Industrial control systems are built up on the lines depicted in this basic diagram

electronic generators of signals. The main job of much electronic circuitry is to amplify such signals, and we will describe a practical amplifier for home construction next month. You will then have an idea of all the basic operations carried out in simple electronic apparatus; all except transducers, that is, but another article in this series will cover these devices.

You could gain plenty of experience now, by studying all the devices and circuits described in PRACTICAL ELECTRONICS, and analysing them by using your now increasing knowledge. The *Radio Control of Models* articles are a good example. Study how the signal is generated at the transmitter, the nature of this signal and the kind of information it carries; how the receiver "processes" this signal, the operation of the *servo* (electro-mechanical transducer) and the final result obtained.

The mysteries behind the front panels should be unfolding now!