CHAPTER XIX

Contrasting Methods of Aerial Excitation

I WILL introduce this subject by an analogy. There are two types of model or toy locomotives on the market: one type driven by potential energy, the other by kinetic energy. The first is energized by twisting india-rubber, or tightening a coiled steel spring. This is an example of static energy, stored in the shape of material strain. The other type is energized by spinning a fly-wheel, much as a top is spun by a piece of string. The energy thus imparted is kinetic; and by resting the axle of the fly-wheel on a larger wheel, the whole thing progresses slowly like a steam-roller, till the energy is exhausted.

The above is an example of two different types of mechanism. But a smaller difference can exist between the modes of excitation of a single type. Thus take a violin string, for instance. There are two ways of making it sound; one by gently bowing it, or by blowing on it, or in some other way working up the oscillations gradually to a sufficient intensity. That is one way. The other is by plucking it

—that is to say, by pulling it forcibly aside till it has acquired a certain amount of potential energy, and then liberating it, so as to oscillate freely until that energy is exhausted.

A string struck by a hammer, as in a piano, belongs to the kinetic type; for the energy is imparted in the form of motion; but it is imparted very suddenly, and it virtually amounts to shock-excitation.

Thus we have three different methods of exciting a string: a pre-arranged strain, or static method, illustrated by plucking; a gradual working up of the oscillations, as illustrated by some form of friction or bowing; and the shock excitation method, illustrated by striking, as in a pianoforte. A harpist, presumably, is able to utilize at pleasure any one of the three methods. But most wind instruments depend on the gradual working-up method. Whereas drums and triangles, and other such devices—the *batterie de cuisine*, as a musician has jocularly called it—are obvious examples of percussion.

In exciting an aerial for wireless telegraphy all three methods have been employed. In the early days, working on the lines of Hertz, a spark gap was introduced into the aerial, the upper area was charged positively, the lower area negatively, setting up a strain between

them, until the air between the spark knobs gave way, a rush occurred, and oscillations began. That is the steady strain or pre-arranged method—by static electrification. And on this principle many Lodge-Muirhead stations were worked. It is a very powerful method, and very difficult to tune out, since the initial jerk is rather violent. For some purposes this is a defect; for others it is an advantage. It was found to be a defect when arranged on the Great Eastern Railway line of steamers between Harwich and Antwerp; for though very efficient, it was rather too efficient, and the Government forts in the neighbourhood found they could not always tune us out. With better tuning devices and without earth connexion it could be done; but it was admittedly not easy.

The advantage of this mode of excitation is felt when tuning-out is *not* wanted; that is, when you desire every station within range to hear, to whatever wave-length it may be tuned. This is the case with an S O S signal; and accordingly for distress purposes this method of excitation used to be employed on board ship, and possibly is still so employed. It should be.

Then came the percussion method of excitation, utilizing what I used to call a "B

spark"—that is, the rush between the outer coatings of two Leyden jars whenever a spark takes place between their inner coatings. In that case the aerial was not pre-charged at all, but was charged with a rush or a blow, by the impact of the liberated induced charges in the outer coats of the jars or condensers employed. This method of shock-excitation has been used a good deal; and the quenched spark system is a modification of it, since the vibrator is left to oscillate freely after receiving a blow, like a bell.

The third method of excitation, that by gradual working up, is now largely employed in various forms at continuous-wave stations. And so far as I know it was introduced at spark stations by Marconi in his famous 7777 patent, the aerial being excited inductively by an oscillating discharge in a closed circuit, to which it was coupled. Inductive connexion at the receiving end had been patented before, viz. in my patent of 1897, but not at the sending end. For though shock-excitation is in that patent-specification clearly foreshadowed, the continuous working-up method remained for future development, and when introduced was regarded as a decided improvement. For the oscillations do not now begin with any suddenness. They are gradually worked up from zero

to a maximum, just as you may bow a tuning-fork or a bell, instead of striking it; and thus excite a purer tone, more satisfactory to deal with, and easier to tune out when not wanted.

In this inductive method of excitation there is, in one sense, a pre-arranged static charge, at least at a spark station; but it is not a charge in the aerial itself. The potential energy is all in a closed local circuit. It is in the spark gap of this circuit that the strain is suddenly relieved, by fracture; and the oscillations which then begin are employed to stimulate oscillations in the coupled aerial. The spark in the primary may be quenched as soon as it has achieved its function, so that the aerial may be left free to oscillate, without being hampered by anything like tight coupling to a closed circuit; since that, as is well known, is liable to give waves of double periodicity—that is to say, a double kind of wave instead of a single one, a wave with two peaks, both of which it is difficult or impossible to tune out simultaneously.

The valve and arc methods of excitation are representative of the continuous-wave system, like an organ pipe steadily blown from a bellows; the oscillations being varied artificially by the operator, who makes them respond to the movements of his signalling key, the

key being arranged sometimes so as to give variations in pitch instead of in amplitude, as in a flute or other keyed wind-instrument.

The inductive method of excitation, whereby the energy is communicated to the antenna kinetically instead of by static strain, bears some analogy to the fly-wheel kind of model referred to at the beginning of this chapter, as contrasted with the static energy of a wound-up spring. There is initial strain in the latter, or potential-energy, case; there is none in the kinetic mode of excitation. The act of throwing a ball is an example of a kinetic method. The liberation of an arrow from a bow, or a stone from a catapult, is an illustration of stored potential energy suddenly liberated. So is the projection of a bullet by the chemically stored energy of gunpowder. But a magnetic gun, if such a thing were ever made, would be more kinetic in its action. The two necessarily shade into one another, because suddenness is a relative term: but suddenness in a pre-charged antenna, charged electrically until it reaches its bursting point, is a definite fact.