Form of Aerial.

We will now consider the best form of aerial under different circumstances.

There are two main principles to be remembered in the design of an aerial wire. Firstly, the higher the antenna the more rapidly will the energy be radiated, and, secondly, the larger the capacity of the antenna the larger will be the total amount of energy at our disposal for radiation for a given voltage in the aerial (for Q = SE).

This means that the higher the aerial the more efficient is the open oscillator as a radiator of electro-magnetic waves, and the larger the capacity the lower will be the voltage necessary for the charging of the aerial with a given amount of energy. Conversely, the larger the capacity the larger will be the charge necessary to raise the pressure in the aerial to the maximum working limit—that is, the voltage when brushing just begins to take place.

The most strongly radiative antenna is the straight vertical wire, commonly called the "Marconi aerial," since it was with this type of antenna that Marconi first demonstrated the practicability of telegraphy without connecting wires. The capacity of such an aerial is, however, very small, so that it is now customary to connect to the top of the vertical wire or wires a system of wires more or less parallel to the surface of the earth.

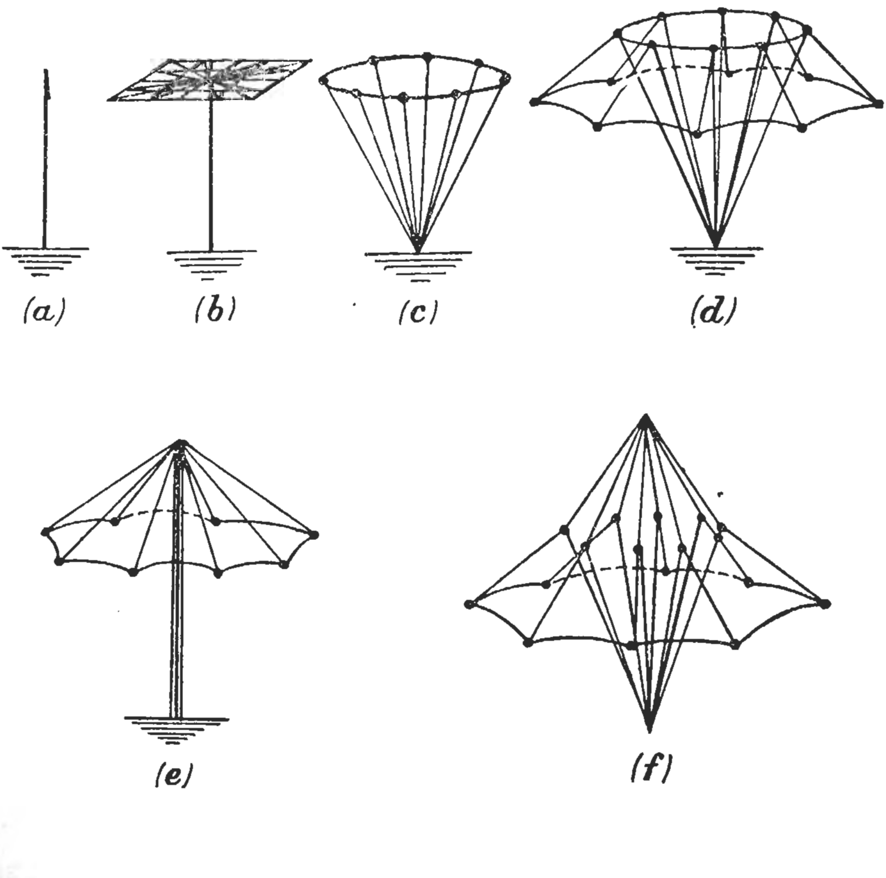
The ideal aerial, therefore, consists of a large overhead area, carpet, or "roof" stretched out parallel to the earth at as great an elevation as possible, and connected to earth by several vertical wires. The large overhead carpet makes for a large capacity, the great height is necessary for efficient radiation, yet tends towards a small capacity, so that the two desiderata, the great height and the large capacity, are antagonistic. We, therefore, have to adopt a compromise in practice by getting masts as high as possible, and then making the overhead area as large as possible.

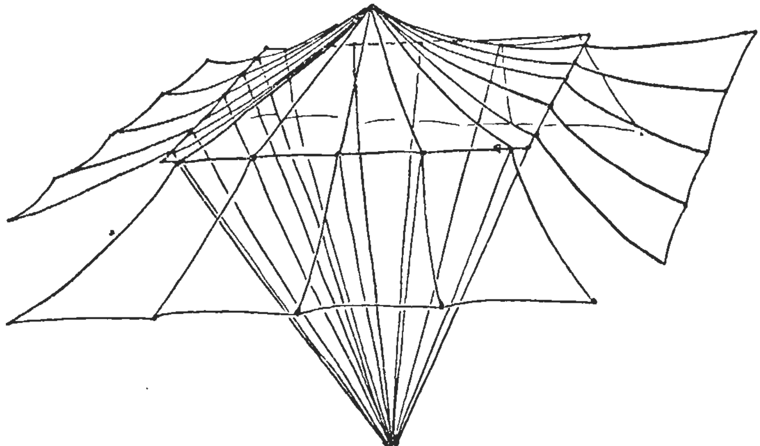
Aerials ashore.

The conditions under which ships' aerials have to be designed considerably restrict our choice, owing to circumstances over which we have no control, such as the number and position of the masts, &c., conditions which will be more fully discussed later; but when a shore W.T. station has to be designed, we can choose, more or less, the number, height, and position of the masts and arrange things accordingly.

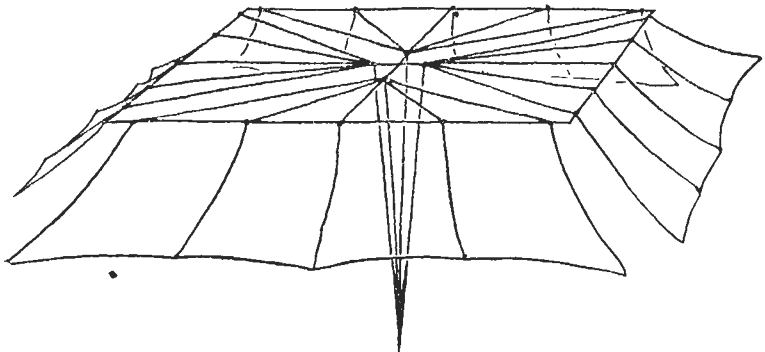
Fig. 110 will explain fully what it is required to show. (*a*) gives the Marconi aerial; (*b*) its development into the more efficient form of a "roof" or "carpet" type; (*c*) is the inverted cone type, one which is fairly effective, but it requires many masts.

We shall call the overhead part the "roof," and the vertical part the "feeder."

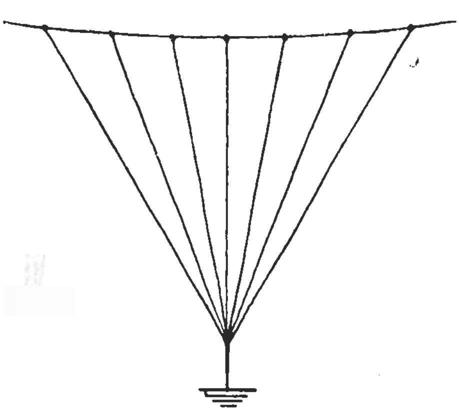




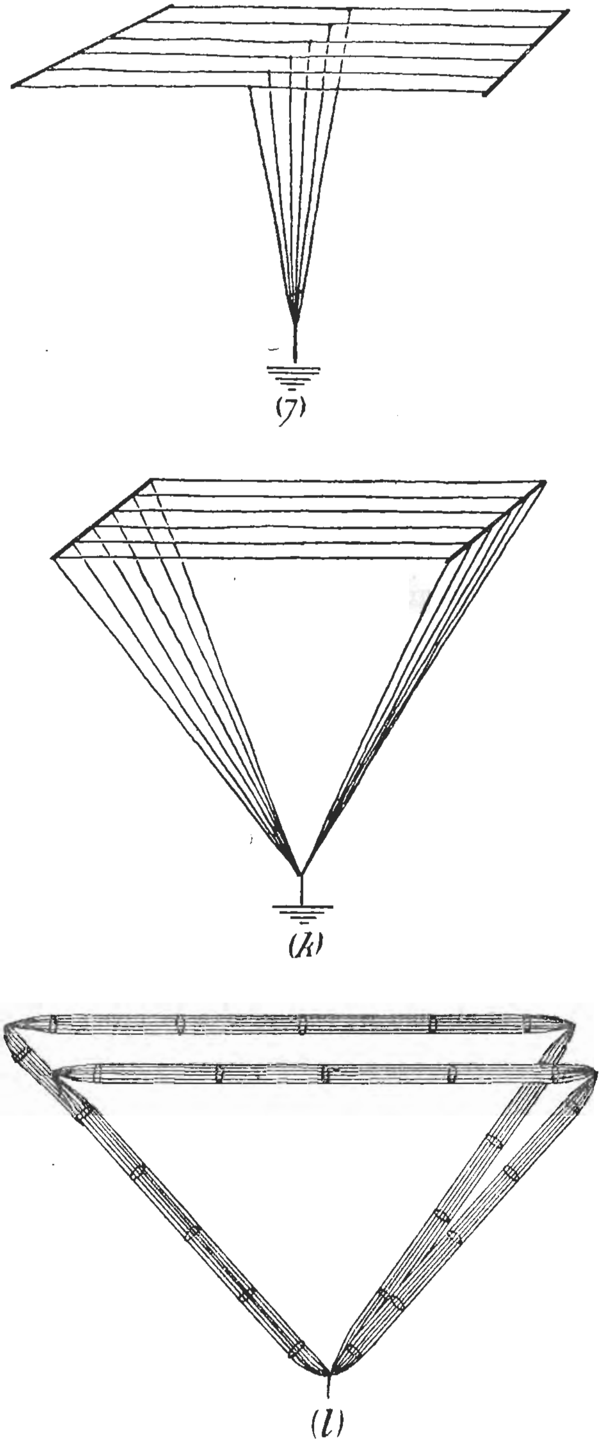
(g)



(h)



(i)



(j) (k) (l)

Fig. 110.

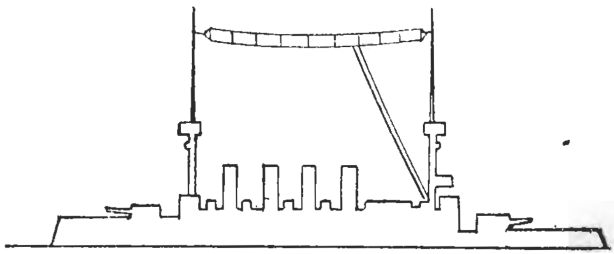
(*d*) is a double cone aerial and is better than (*c*) on account of the larger roof, but limitations on the number of masts available will cause it to take the form of (*e*) or (*f*) if but one mast be available, or the form (*g*) or (*h*) if more masts are fitted. These last four types are called the "umbrella" roof, while (*e*) and (*h*) have vertical multiple feeders and (*f*) and (*g*) have inverted cone feeders. (*g*) represents possibly the best form of aerial for a shore station, but it takes at least one large, four medium, and four small masts.

Where two masts only are to be used the aerial must take some such shape as shown in (*i*), the "fan," (*j*), (*k*), or (*l*). The last three are all good provided the feeder wires are all nearly the same length, and provided the feeder in (*j*) is attached to the centre of the roof wires. The outer wires in (*i*) must necessarily be longer than the inner wires. This is bad, because the wires will not have the same inductance, and will carry unequal shares of the current. Any lack of symmetry in an aerial is bound to cause unequal distribution of energy therein, the result being a great resistance damping in those wires which carry more than their fair share of current.

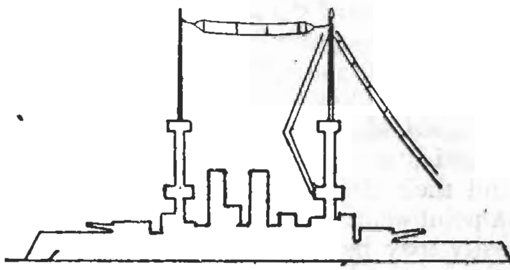
For this reason, wherever more than two wires are used for the feeders, it is better to form them into a cage or tube than to arrange them all in one plane by tying them at intervals to a broom handle, or some such object, as a spreader.

Aerials afloat.

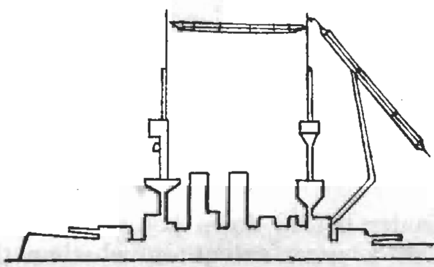
Coming now to ships, we find ourselves very limited in our choice of design. To begin with, we have but two and sometimes only one mast, we have funnels, iron masts, stays, and many other paraphernalia to avoid, and the position of the office may hamper us considerably, all these factors possibly preventing the realisation of all that we should like to have.



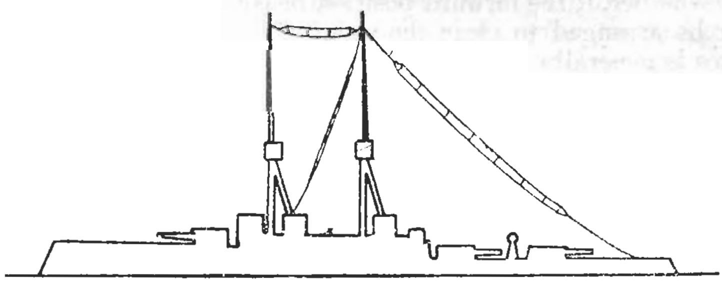
(*a*)



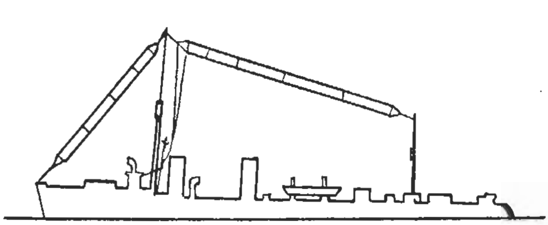
(*b*)



(*c*)



(*d*)



(*e*)

Fig. 111.

The best ships for W.T. purposes will be those with a very large spread between the masts, so that we can get all our roof at the maximum possible height. Such a ship as shown in Fig. 111 (*a*) will have but a very short Q.D. and forecastle, so that any after or forward "legs" attached to the roof would be very far from the horizontal, being nearly vertical. This would seriously lower the mean height of the roof. It is better, therefore, to use nothing but the span between the masts.

The feeder, again, should be attached to the centre of the roof, but the position of the office and the necessity of clearing the funnels (and their attendant smoke) may force us to attach the feeder to a point abaft the centre of the roof as in (*a*).

This necessity may be so instant as to force us to employ after legs to the roof, so as to be able still to attach the feeder to the centre of the roof.

The battleships shown in (*b*) and (*c*) having a small span between the masts and a fairly long Q.D. causes us to use after legs in addition to the roof between the masts. Since the office in this case is near the after bridge, the feeders will be attached at or near the "centre fitting" at the main top-gallant yard. It should be noted that the bottom of the after legs should not come down nearer than about 50 feet from the upper deck.

Whether the feeder be led down before or abaft the main-mast will depend to a great extent on whether the after or the fore bridge is used for flag signalling, whether the gaff is shipped or not, whether the mast is fitted with yards or not, and whether, if the forward position be contemplated, the feeders can be arranged to clear the wake of the main derrick. This latter is generally the most insuperable difficulty against having the before-all feeder, but it is the better arrangement, all other things being equal, because the top end of the feeder more nearly bisects the angle between the horizontal roof and the after legs, and also because the loose halyards do not blow against the feeder. If the feeder be led up abaft the mast it should be as vertical as possible without getting too close to the mast or its stays, because otherwise the top of the feeder and the top end of the after legs will act non-inductively on each other, and that portion of the aerial will hardly radiate any energy.

The correct place for the feeder to be attached should be in the "electrical centre" of the roof, considering the roof and after legs as one roof. By this is meant that the LS value of the roof forward of the feeder attachment should be equal to that of the roof abaft the attachment. It will be seen that this point should be abaft the actual centre of the whole wire, since the after legs have a greater capacity per foot run than have the roof proper, on account of their being nearer to earth.

This is an additional reason for attaching the feeder a little way down the after legs as shown in (*c*).

Several ships have employed a small "forward leg" with advantage in these and in modern large ships.

In all cases both the roofs and the feeder should be led as far away as possible from any earthed objects such as stays, and the feeder especially should not be allowed to run parallel to any wire stay for any considerable distance, even if the space between the two be considerable.

If the two cross at a considerably wide angle the stay will not be in such a favourable position to be cut by the lines of magnetic force from the feeder, and so less energy will be absorbed by the stay.

(*d*) shows the lead of feeder in one of the modern battleships whose offices are forward. It will be seen that the feeder bisects the roof angle very well, and yet can be led fairly clear of the smoke and derrick. It will possibly interfere a little with the flag signalling.

The reason why smoke has such a deleterious effect both on the transmitting and also upon the receiving efficiency of a ship is that it forms a semi-conducting earth leak, which consequently lowers the insulation resistance of the aerial condenser dielectric.

In small ships with short masts, and especially in destroyers and scouts with one mast only, this smoke effect is very important. We must in these ships employ rather shorter after legs than would otherwise be the case and also a small main mast in some cases, as shown in Fig. (*c*), which gives a typical destroyer's aerial.

Again, in these ships the whole fore part of the ship is often smothered in spray, which again, since the water is salt, forms a leak to earth. Consequently the fore-legs must not be carried down too far.