6.

aeroplanes and airships is so important, it becomes interesting to inquire how we can control the radiation, so as to direct it upwards at any inclination.

This has been mathematically discussed by Dr. Van der Pol, jun., in a paper "On the Wave-Lengths and Radiation of Loaded Antennæ." He has shown that if large capacity is put at the top of an aerial, so as to form a current node at the centre, the most energetic radiation will be directed in an upward inclined direction; the polar curve of radiation then resembling a pair of butterfly's wings.

A few words must be said in conclusion on the lay-out and design of large radio-stations.

If power can be obtained from a near or distant electric power-station, then it is most convenient to take advantage of this and convert it to mechanical power by electric motors. This is the case at the large Marconi station at Carnarvon.

If, on the other hand, power must be locally generated, then the arrangements are simply those of an electric lighting or power station. Boilers, engines, and condensing plants; coal supply and means for handling fuel and water, as well as the duplication of plant, to secure from interruption, are put in, but the engines drive high frequency alternators instead of low.

If the station is on the spark system, the alternators would have a frequency of 300 to 500, and their voltage would be raised by oil-insulated transformers to 20,000 or 30,000 volts.

These latter would then charge a bank of condensers, across the terminals of which is some form of rotating spark gap, in series with the primary of the oscillation transformer.

If the station is an undamped wave station then entire high frequency alternators would be put in, giving a frequency of not less than 50,000 volts. This may be obtained either by a Goldschmidt frequency raising alternator, or by the use of an induction alternator, giving, say, a frequency of 15,000 or 20,000, associated with frequency raising transformers.

Senatore Marconi has invented a method of producing practically undamped waves by the employment of several rotating disk dischargers, each of which causes successively the discharge of a large condenser in such fashion that the oscillations produced by one disk begin just at the moment those produced by another end. Thus slightly damped trains of oscillations can be induced in the aerial so that the head of one train is in contact with the tail of the preceding one.

The antenna supports form an important element in the design. These may be wooden or steel lattice towers, or else steel masts built up in sections as made by the Marconi Company. The height of these, in large stations, varies from 250 ft. to 600 ft. or more. For very long distance working high antenna masts are necessary.

Before long the world will be covered with high-power radio-stations, and as far as can be judged at present the indications are that the radio-telegraphy of the future will chiefly be conducted by means of undamped or continuous waves produced by various methods.

BEAD-MAKING AT MURANO AND VENICE.

Glass-making in Venice is of remote antiquity. By a law of November 8th, 1291, the authorities of Venice, to avoid the risk of fire, ordered the glass-making industry to be transferred to the adjacent island of Murano, referring in the decree to the "ancient traditions of the populace there dedicated exclusively to glass-making." Ever since, Murano has been the most important centre for handmade glass and glass-bead manufacture in the world.

In recent years the manufacture of certain kinds of handmade beads that must be worked and ornamented individually over the blowpipe, and certain processes in the manufacture of machine-made beads, such as stringing and the polishing and glazing of some types, have been again transferred to Venice. Most of the loose stringing of beads is carried on by cottage labour in Venice, and the processes for the manufacture of bead articles, such as purses, curtains, flowers, and design work, are domiciled again in Venice, leaving in Murano the glass and bead foundries.

The island of Murano lies less than a mile distant over the lagoon north of the city of Venice. Its population is chiefly engaged in the various glass industries, including bead-making.

Until 1896 there were a number of competing companies engaged in bead-making at Murano, but at that time eleven companies consolidated, forming the Società Veneziana Per l'Industria delle Conterie, whose paid-up capital stock is now 4,500,000 lire (£180,000 at par). This company enjoys a complete monopoly of the bead-making industry, has been very prosperous, and does an exporting business on a great scale, shipping to Africa, Oceania, Asia, including India, Europe, and the Americas. It makes the beads that are used as money by certain tribes in the Congo and in West Africa, and ships many thousands of tons of bead ornaments to the savage as well as the civilised nations of the world. The offices of the company are in a magnificent old palace at Murano, the Palazzo Trevisan, which boasts frescoes by Tiepolo. Near by are the foundries and factories, covering many acres of ground. Before the outbreak of the great war this company kept in storage more than 2,000,000 kilos (4,409,245 lb.) of manufactured beads. At the present time the quantity in stock is very much less, and production has greatly decreased, owing to difficulty in securing fuel and raw material, and to the immense rise in the cost of these requisites.

According to an exhaustive report on the bead-making industry at Murano and Venice, furnished to his Government by the United States Consul at Venice, the first process in the manufacture of beads is making glass compounded of soda, sand, and various minerals according to the colour desired. The yellows and oranges have a large admixture of lead. It is introduced in the form of an oxide known as "minio." This minio is, it is believed, oxide of lead, and comes in several grades according to the vividness of the colour, ranging from deep orange to red.

The fondant for ordinary types of beads had formerly a base of Egyptian natron (native sodium carbonate). Nitrate of soda from Chile and crude nitre (saltpetre), refined carbonates of soda, sulphate of soda, refined nitre, potash, cryolite (a fluoride of sodium and aluminium produced in Greenland, used for obtaining soda and alumina), and especially the highly refined Solvay soda used as a solvent for sand (formerly imported from France, now made also in Italy), figure in the fondants required for the higher types of beads.

The colouring materials are all mineral, including in recent years various oxides unknown to the glassmakers of antiquity, especially oxides of cobalt, chromium, and uranium. The more important colouring materials are minio, compounds of manganese, copper (from which a great variety of colours are obtained), iron, zinc, arsenic, antimony, silver, gold, and zaffara (a sort of mixture of which cobalt is the base, used for tinting glass blue).

Cobalt in its various combinations gives deep shades of blue and was a colouring agent known to the Egyptians, as was also copper. Silver was used by the ancients to give a yellow-gold colour, but the master glassmakers now know how to obtain the same shades without the use of silver. The first to obtain a formula was a certain Giovanni Giacomuzzi. This maker also tried to produce the deep ruby or pigeon-blood colour for which gold is the only successful colouring agent, and marketable shades have been produced, but none that compare with the ruby glass of the old makers which was coloured with gold. This glass is known as rubino. Most of the secrets of the trade lie in the colour formulas, which naturally are not divulged. New colours and shades and combinations are constantly being formed, so that Venetian beads run through the entire prismatic scale.

The processes of bead-making are often said to be three, to wit, making the glass, making the canes, making the beads out of the canes; but so simple a classification is not instructive. A better division is obtained by following the processes of the industry itself as seen at Murano:—

(1) Compounding the materials; (2) fusing the materials into the fondant or molten glass; (3) cupping the fondant to prepare the orifice that will run through every cane and every bead; (4) pulling the fondant into long hollow tubes; (5) cutting the tubes into canes of about one yard in length; (6) sorting the canes according to diameter; (7) clipping the assorted canes into bead lengths and fanning out the powdered glass; (8) filling the orifices of the sharp-edged beads with a composition of charcoal and lime, mixing the beads thus filled with a quantity of sea sand, re-fusing in revolving crucibles to eliminate the sharp edges and round the beads, and cooling; (9) fanning out the sea sand and mechanically sorting the beads for size; (10) mechanical sorting for perfect perforation; (11) in some cases polishing or elucidation; (12) and (13) stringing or mechanical threading on fine metal wires; (14) sorting strung beads for colour; (15) packing for shipment.

This list of processes will cover the manufacture of all the smaller beads produced in bulk, and, in fact, of all one-colour beads not handmade. Taking up these processes in their order, it may be noted that all except the first are subject to inspection.

(1) Compounding the materials. This is done according to formulas more or less secret out of the materials already enumerated, and others such as carbonate of lime, cream of tartar, and various minerals. At present the basement of the immense plant of the Società Veneziana is used as a storage room where soda, potash, sand from Fontainebleau, minio, and other minerals for composing the fondant are kept.

(2) The glass is fused into the molten mass or fondant in immense crucibles, lined with fireproof tiling and clay, some of which hold five and six tons of molten glass. The degree of heat obtained varies from 1000° to 1600° C., as the materials must be exposed to a heat of 1000° before they fuse properly. The immense pots or crucibles are covered over, lined with fire clay, and have orifices or port-holes through which can be seen the glow of the melted glass.

(3) About the crucible are workmen with great tubes of iron like a section of gas-pipe 12 or 15 feet in length, called ferri da canne. This they dip through the port-holes into the molten fondant and take out a doughlike mass, which is then pounded on metal tables or anvils until it begins to change in colour from white to red. Roughly rounded by this process, the doughlike mass on the end of the rod is then opened by another workman with an instrument called a borsetta, that appears to be a giant pair of spring pincers, and the fondant is scooped and pressed out as if it were a dumpling being prepared for an apple.

This scooping out creates the orifice or hole, which ordinarily remains through all other processes until the beads are finished and complete. This cupped mass is again thrust into the oven and heated to white heat and almost the consistency of glue without being allowed to collapse or lose its cupped form. It is again taken out of the crucible, and another workman, provided with an iron rod having a broad, blunt end, presses that end against the top of the fondant cup, to which the heat causes it to adhere.

(4) As soon as the second rod adheres the two men walk away from each other, pulling out the melted glass between them. Cross-ties are laid at intervals over the floor, and on these the rope of glass is supported. So ductile is the fondant that a mass the size of a loaf of bread can be stretched for a distance of about 300 yards. Even when the fondant is pulled out to the thinness of a cambric needle it remains a pipe or tube, the bowl of the cup growing ever smaller but always remaining hollow. This fact renders bead-making in bulk possible.

(5) As it cools, this tube or pipe (which often resembles an unbroken filament of vermicelli) changes from white to red and from red to the permanent colour given it by its mineral colouring matter. The size of this tube will depend on three things:—

(*a*) The fineness and character of the materials of which it is composed, which will affect its ductility, especially the quality and quantity of soda used.

(*b*) The size of the cupped mass drawn out. A smaller mass makes a finer and thinner tube.

(*c*) The speed at which the two men walk away from each other in stringing out the molten mass. If they walk rapidly the tube will be smaller and thinner.

As large beads are made in precisely the same way as small ones the diameter of the beads will depend entirely on these three things, and especially on the last two, for out of the same fondant tubes of all sizes can be made. These tubes are, when cold, cut or broken into lengths of about one yard. These lengths are called "canne" (canes or reeds) and resemble straws or bamboo rods without joints; and these canne are the material out of which the beads are made. In similar fashion rods that are not hollow canes can be made by merely omitting to make the cup in the fondant.

(6) The canes are sorted into sheaves of the same size. This work is done by women and often by quite young girls, who work by the sense of touch, rapidly dividing canes that are apparently all of the same diameter into different groups between the fingers.

(7) The sheaves are then taken to the clipping machines, which resemble little guillotines. On a flat trough the canes, placed side by side, pass automatically (but guided by hand) under the little guillotine blade that, by the revolution of an electrically-driven wheel, clips the canes into bits by biting off the ends. The length of these bits is about equal to the diameter of the cane. These clipped cross sections have sharp edges. The powdered glass produced by the clipping is sifted and fanned out, and the raw-edged beads are ready for rounding and finishing.

(8) The holes in the raw beads are filled with a composition of charcoal and ordinary lime, after which the beads are intermixed in four or five times their weight of ordinary beach sand from the Adriatic, and the sand and stuffed beads are put into an egg-shaped, covered crucible that revolves on an axis, tilted at about the same angle of inclination as the globe. This crucible revolves in the heart of a gas-fed furnace at about 400° of heat. The charcoal is consumed, the lime vanishes after having served to "fix" the aperture, the edges of the beads become smooth and rounded, the sand grinds and polishes them, and at the same time keeps them from coalescing with each other, and, finally, sand and beads together are dumped out into large shallow pans to cool.

(9) When cold the sand is sifted and fanned away in a series of large, covered, wooden ventilators, and the beads, clean and polished, pass through a funnel or hopper into a series of rocking cradles placed one above the other in a series of eight. The floors of these cradles are sieves with graduated orifices or mesh bottoms, and from these cradles the beads, neatly assorted as to size, pass through little hoppers into baskets set to receive them. Beads of the same colour but of many different sizes are thus automatically assorted as to size. (Assortment as to colour is first made by hand while the beads are still in the cane.)

(10) For the smaller varieties of beads still another sorting is necessary to determine if the holes have been perfectly preserved. For this purpose a cylinder about 15 inches in diameter, covered with thin wire filaments (like a wire brush), revolves over a tray of beads, and the filaments catch the beads that have holes in them, lifting them over, on the principle of a waterwheel scooping up water, and dropping them on the other side through a hopper into a box. The bead is now complete, sorted as to colour, tested as to size and perforation, associated with its fellows and equals, and ready for stringing or for shipping unstrung. This finishes the necessary processes for making one-colour beads.

The necessity of a machine to sort the beads for perforation to detect and discard the imperfectly perforated beads was very great. In 1894 it was possible to make the ordinary small beads for about 70 centesimi per kilo (100 centesimi = 1 lira; kilo = 2·2046 lb.). The threading was done by women, as at present, using a handful of needles (24 to 30) at a time and threading very rapidly. For the very small beads the string was about 10 inches long and for the larger beads about 18 inches long. A bundle consisted then of 480 strings, and a good worker could string 10 bundles per day at 12 centesimi per bundle.

There was a constant controversy between the women and the companies because out of every 100 kilos the former used to bring back 20 kilos, or one-fifth, claiming that they could not be strung—meaning that they could not be strung rapidly as the orifices were small or faulty, and as the woman worked by the piece they interfered with her speed and diminished her pay. Only about 5 per cent., or 5 kilos out of 100, were totally lacking in perforation. So the makers had a grievance as well as the women, as such beads had to be remelted and remade, and for this purpose had a value of only 5 centesimi per kilo, and the makers were losing about 9 lire per 100 kilos on 15 kilos of beads that could have been strung but not rapidly.

Cavaliere Salvatore Arbib, one of the manufacturers, conceived the idea of the sorting drum with the wire teeth, and the machine, called a "tamburo," was made by a British firm. The teeth or threads of the sorting machines may be of various diameters, so that the beads rejected by a coarse-toothed machine may be picked up by a finer toothed tamburo. This machine was perfected in 1894. The first threading machine to thread the beads on fine wire was made by the same firm in the same year for the same man. The total cost of the experiments and the making of the two machines was about £5,000 sterling.

To return to the processes.

(11) Certain one-colour beads for America have the surfaces slightly ground by contact with emery paste or other grinding material, or even sawdust. This process takes place outside the Murano factory and usually in Venice. It is called lucidation (lucidazione).

(12) Certain beads are then strung by special machinery on thin wire filaments. The wires are suspended in brass tubes and the projecting curved end of the wire picks up beads from a revolving basin which forces them against the end of the wire. These wire-strung beads are mostly exported to France for use in making the coarser grades of artificial flowers for funeral wreaths.

(13) All small beads are ordinarily strung by hand. This is done in Venice by cottage labour of women and girls. It is not an unusal sight in the Castello section of Venice to see a group of women and girls sitting in the streets, each with a pan of beads in her lap, threading and gossiping at the same time. The needles are about the length of knitting needles, but much smaller in diameter, with an eye for the thread at the lower end like an ordinary hand-sewing needle. The worker takes a number of these needles and spreads them out like a fan or the tail of a peacock, holding them thus grouped in one hand and thrusting the ends into the pan of loose beads until they are covered for almost their full length, when the beads are slipped down on the threads and the needles are again arranged to pick up more beads. A good worker can operate 24 needles at a time, and some of the women boast that they can operate 48 needles at once.

(14) The strands of beads are sometimes bunched by the women who thread them and sometimes by girls at the Murano factory. Some classes of beads are bunched for weight and others for number. Many of the small beads are sold by number. Such beads are sometimes referred to as "count beads," while those sold by weight are known to the English trade as "pound beads." The bunched beads are sorted for size and colour and in some cases according to country of destination and are stacked in shelf bins in the warehouse according to a chromatic scale. To look at the side of the warehouse is like looking at a rainbow where the shades insensibly melt into each other.

(15) The bunches of loosely strung beads are usually packed for shipment in small packages (1 lb. or 1 kilo) wrapped in manila paper. The label shows catalogue or list-card classification of the merchandise, and also bears the name of the purchaser (printed) when the purchaser is a regular client and buys in large quantities.

Even the smallest beads may be made in more than one colour and can, in fact, be made in a great variety of colours and patterns. The process is identically the same as for making one-colour beads except that a distinct fondant must be made for each shade of colour. Out of the base fondant is made the cup as described in (3) above. The fondants of the other colours are superimposed on this to make the pattern, reheating the cup as often as necessary but never allowing it to lose its cup form. When all the colours are superimposed it is reheated almost to the point of liquefaction and then pulled into the tube as already described. The ductility of the medium causes the pattern (as is the case with the orifice) to be preserved, even though the tube be pulled out to the diameter of a needle. The different shades of fondant may be applied in complete coatings, like insulations on a wire, or in stripes applied to the base fondant.

If the fondant is not cupped, but is pulled out in a solid rod instead of into a tube or cane, a cross section of that rod (not its surface) will reproduce any pattern desired. Indeed the pattern may be made with rods of cold glass so staked that their ends form a mosaic. They are then fused to the point of ductility, but not of liquefaction, and even if drawn out to the thickness of a needle a cross section will show the complete pattern. Glass for mosaics (used also for African and mosaic beads), showing patterns of stars, flowers, and geometric designs, is made in that way, and each clipped segment of the rod shows the pattern on its face.

In the first half of the last century Jacopo Franchini, perhaps the most remarkable glass-worker Murano has produced, by binding tiny straws of coloured glass together formed at the end of the rod a miniature portrait or other design. This combination rod was then fused at a blowpipe and drawn out until a rod no longer than a knitting needle might be cut into cross sections, each one of which would show a perfect portrait or perfect design. In the Murano Museum there is a section of glass rod less than 1 centimetre (centimetre=0·3937 inch) in diameter that shows three perfect portraits side by side, or, rather, in clover-leaf arrangement. Owing to his intense application to so painstaking a work Franchini died in a madhouse, and nobody has since been found who can duplicate his work in glass, although several attempts have been made.

Mosaic beads intended for African and other wild tribes are properly classed with handmade beads, but as a small section of the "canna" is always or nearly always used as the base a description of their manufacture is included here. These beads are not spherical, as pieces from one-half to 2 inches in length are clipped off the canna. These are then fused by blowpipes at Bunsen burners, and mosaic beads are pressed into the surface to give the desired pattern and fused to the point where they coalesce but without losing shape. These long beads with snakelike mottlings and markings are then ground to a smooth surface, strung, bunched, and packed for shipment. Such beads are really individually handmade, although they can be made to set patterns very quickly. Nothing but the canes for these beads are made at Murano; all the other work is done at the Venice plant of the Società. The foregoing covers all the varieties of beads made at Murano. There are certain types of beads, each individually handmade, ornamented, and enamelled at the blowpipe, showing surface patterns of roses and other flowers and designs, that are made exclusively at Venice by expert workmen.

In the making of beads in bulk the fondant is mixed, melted, and moulded by men, and men do all the furnace work and the making of the canes. Men also sharpen the axes of the clipping machines, but the greater part of the detail work of bead-making is done by women. Women operate the clipping machines, sort the beads, sort the canes, operate the machines that string the beads on wires, do the work of stringing on thread and of bunching the beads, do most of the work of preparing the beads for shipment, work at the blowpipe in making and also grind the African beads, and do nearly all the work of manufacture of bead articles. They are paid by the piece and can increase their wages by expertness. At the Murano factory the Società normally employs about 1,000 families on bead-making. A woman's wages vary between 1 and 6 lire per day according to her skill and speed.

IMPREGNATION OF TIMBER.

Large quantities of Norwegian timber were formerly exported for impregnation and re-imported into Norway, but lately a factory has been built in Larvik, where large areas are available for weathering the timber before impregnation. The works are designed to treat 2,300,000 cubic ft. of timber annually, corresponding to about 130,000 telegraph poles. Impregnation takes place in horizontal steel cylinders 6 ft. 6 in. diameter, 85 ft. long, in which trucks fully loaded with timber are placed, the covers firmly screwed down, and the cylinder filled with creosote oil, a pressure of 10 atmospheres being maintained, as it has been found that high pressures are the most effective and produce practically complete saturation. A line of telegraph poles creosoted in this way by the Telegraph Department has kept in good repair during the last twenty-four years, while similar posts of untreated timber rarely have a life of more than eight years.

It is estimated that 1,800,000 cubic ft. of timber may be saved annually in Norway by proper impregnation of all timber used for telegraph-telephone-electric transmission lines and railway sleepers. Thus not only the cost of the timber will be saved, but also the cost of labour for the repairs and the cost of traffic interruption.

Good results have also been obtained with timber structures immersed in sea water. Several instances are given in the *Teknisk Ukeblad* of wooden piers that have been in use for twenty-seven years, while similar piers of untreated timber were destroyed in three to seven years. Impregnated timber is also recommended for paving blocks, fences, and building purposes.

COAL-MINING IN SPITSBERGEN.

Coal was first discovered in Spitsbergen in 1900, when a Norwegian ship exported the first cargo. The Gulf Stream affects the climate on the west coast of the island, where the principal settlements are found, most of the claims being taken up by Norwegian, English, Swedish, and Russian companies.

The Norwegian Spitsbergen Company, which is the principal concern, has acquired one English, one American and one Norwegian company, and in two years exported 85,000 tons of coal. Six other Norwegian companies have started work during the last few years.

The coal, according to the *Teknisk Ukeblad*, is of superior quality, containing very little ash, is comparatively free from sulphur and has a high calorific value, varying from 13,000 to 14,500 B.Th.U. per 1 lb. It is excellent steam coal, but does not contain sufficient volatile matter for a gas coal. It does not clinker.

Mining is easy, as the ground is frozen to a great depth and perfectly dry. There is very little dust and no fire-damp. The temperature of the headings seldom rises above 25° F., but the absence of humidity makes the low temperature quite tolerable. The coal is found below a bed of smooth sandstone, which forms an excellent safe roof.

The upper tertiary beds, which contain the best coal, consist of three seams with a combined thickness of 6 ft. They are separated by beds of shale 1 to 2 ft. thick, and nearly horizontal; the dip being only 2°–3° sporadically, the dip increases to 10°–12°.

The coal in the lowest seam, which is 3 ft. 3 in. thick, is free from shale or other impurities.