

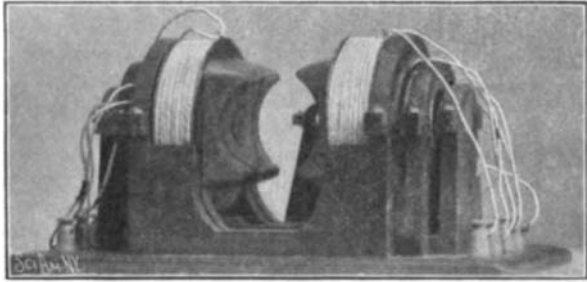
AN IMPROVED ELECTRO-MAGNETIC APPARATUS.

Our illustrations represent an efficient type of electro-magnetic machine, invented by Francisco de Borja Pavon, of Caibarien, Cuba, the field of which machine is so constructed that the lines of magnetic force are concentrated to obtain a current of great strength.

The two opposite fields consist of a number of tubular cores arranged one within the other, the innermost tubular core receiving a cylindrical core. The cores are surrounded by windings, so arranged as to prevent contact of their walls, and are independently supported by uprights and bases forming complete magnetic circuits. The upper portions of the uprights are made in the form of yokes screwed to the lower portion, so that the sections of the polar inductors may be readily removed and repaired.

The winding of the cores can be made continuous, because the current for all the coils is the same. But for the purpose of easily separating the parts, the inventor connects the ends of each winding with binding-posts on the base and thereby attains the same result as if he had used a continuous wire. To facilitate the interior magnetization of the tubular cores, each is longitudinally slotted, parallel to its axis.

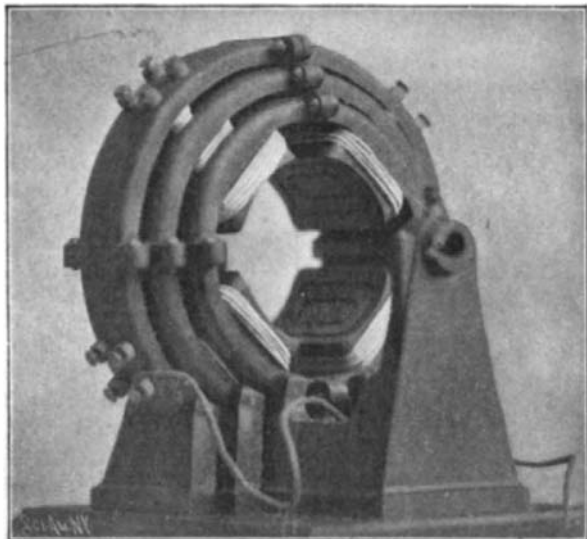
In this machine, the electro-magnets are excited by the same current, but each, with the uprights and



SINGLE CIRCUIT, BIPOLAR ELECTRO-MAGNETIC MACHINE.

bases, constitutes an independent system and magnetic circuit. But since the polar tubular ends are introduced one within the other, the magnetic force is concentrated toward the central core in the space between the opposite polar ends, thus producing an increase of the magnetic field as a result of the common action of the electro-magnets.

The principle can be applied to bipolar machines or



DOUBLE CIRCUIT, MULTIPOLAR ELECTRO-MAGNETIC MACHINE.

to multipolar machines with a double circuit, with tubular cores of circular, elliptical or square sections, and with armatures of any shape.

Influence of X-Rays on Selenium.

M. Perreau has lately made a number of researches as to the effect produced by X-rays upon selenium, and has presented his results to the Academie des Sciences. He finds that selenium, which is sensitive to light, is also affected by this form of radiation. The experiments were carried out with a selenium cell made up in the usual way with brass strips $\frac{1}{4}$ millimeter thick separated by strips of parchment paper of $\frac{1}{8}$ millimeter. The cell contained in a zinc box, and covered by a sheet of aluminium, was placed in circuit with a Daniell element, a resistance box and a galvanometer. The resistance of the selenium was found to be 40,000 ohms in the dark, and when exposed to diffused daylight or to a gas burner at a distance of $1\frac{1}{2}$ meters, this fell rapidly to 33,000 ohms, coming back to its original value in the dark. When exposed to the radiation of a Crookes tube, whose anticathode was about 5 millimeters distant, the resistance of the selenium diminished rapidly to 34,000 ohms; upon suppressing the X-rays, the resistance returned to its original value, but somewhat more slowly than in the former case. The action diminishes as the tube is further removed, but is still appreciable at 17 centimeters.

STASSANO PROCESS.

BY FRANCIS P. MANN.

An interesting process has been lately devised by an Italian engineer, Stassano, for the production of iron and steel by the electric furnace, using the heat of the arc to reduce the oxides and fuse the resulting metallic mass. A series of tests has been recently carried on at Rome in which the process appears and has given satisfaction. The electric furnace used for this purpose has somewhat the appearance of a blast furnace on a reduced scale, and is formed of two truncated cones placed together at their larger base, as shown in the figure, in which *A* is the chamber where the ore is reduced and melted. The fused metal is collected in the crucible, *C*, below, and runs out by the opening, *E*. The two carbons, *cc*, are each 10 millimeters in diameter and are about one meter long; their distance is regulated by hand, according to the indications of the ammeter and voltmeter of the circuit. The slag is taken out by a hole in the top of the crucible, while the gases given off by the reactions rise through the mass and escape by the openings, *tt*. These openings may be closed by a hydraulic valve, *B*, to prevent the entrance of air when the mouth of the furnace is opened; the cover, *TT*, serves to close this, and is opened to introduce the charge.

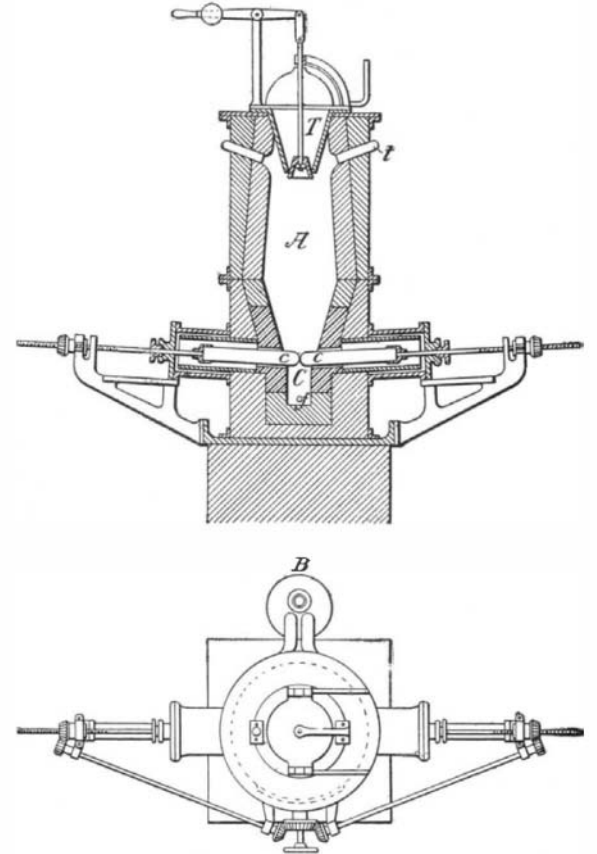
In this process it is necessary to give the ores a previous treatment before introducing them into the furnace. These ores are generally oxides or carbonates; the latter are first roasted. A certain percentage of carbon, lime, or silica is added, analysis determining the proportion of each necessary for the reduction of the ore in question and to obtain a metal of a given composition. The ore and all materials are powdered and well mixed together, with the addition of 5 or 10 per cent of pitch which serves to agglomerate the mass. The resulting paste is formed into bricks by a hydraulic press, each brick containing about 0.04 cubic meter. After drying, these bricks are fed into the furnace. When it is desired to prepare an iron containing manganese, nickel, chromium, etc., the oxides of these metals are added to the powdered mixture. By the heat of the arc the ore is decomposed and forms in the presence of carbon carbonic acid gas, which is then transformed into carbon monoxide, and by the combustion of this latter gas the process is facilitated. The energy necessary for the production of a ton of metal is estimated at 3,000 horse power hours. The following table will show how this calculation is reached:

	Red Hematite, Fe ₂ O ₃ .	Magnetite, Fe ₃ O ₄ , or Roasted Carbonate.
Theoretical quantity of ore to produce one ton of metal.....	1,429 kilos.	1,380 kilos.
Theoretical quantity of combustible to produce one ton of metal.....	357 "	317 "
Heat necessary for the reduction of the metal.....	1,707 calories	1,600 calories
Heat necessary for the fusion of the metal.....	400 "	400 "
Heat developed by the transformation of C in CO.....	773 "	686 "
Heat necessary to be furnished to obtain the reactions.....	1,334 "	1,314 "
Electrical energy in horse power hours.....	2,100 h. p. hours	2,070 h. p. hours
Quantity of CO produced per ton of metal.....	750 kilos.	666 kilos.
Quantity of heat resulting from this..	1,826 calories	1,622 calories

For the reduction of Fe₃O₄, for instance, will be necessary $\frac{1,380 \times 48}{232} = 285$ kilos. of carbon, or 317 kilogrammes of a 90 per cent combustible. If it is desired to produce steel, a somewhat larger percentage of carbon is necessary, but that contained in the pitch must be also taken into account. It will require, then, 1,600 calories to reduce the 1,000 kilos. of iron contained in the magnetic oxide, and 400 calories to melt the resulting mass, or a total of 2,000 calories; deducting 686 calories developed by the oxidation of the carbon, 1,314 remain to be furnished by the electric energy; this corresponds, allowing 75 per cent efficiency, to 2,760 horse power hours. The 3,000 previously estimated will thus cover the energy necessary for producing a ton of metal; this may be produced in Italy for about 18 lire, and in spite of the cost of preliminary operations, maintenance of the furnace, etc., the great economy realized on the fusion permits of arriving at a much lower price per ton of bar iron. According to the inventor, this does not exceed 100 lire, as compared with 160 lire by the usual process. A part of this economy is obtained by using the excess of carbon monoxide to heat the furnaces for the ingots.

The principal ores found in Italy are hematites, magnetites, and sphaerosiderites. Red hematite is found in considerable quantities in the island of Elba; magnetite in the valley of Aosto, in the district of Ivrea, and at Cape Calamite. Extensive deposits of sphaerosiderites exist in the valleys of Camonica and Trompio, where numerous hydraulic plants could be economically placed. An experimental furnace of 100 horse power

has been established at Rome for the treatment of the Camonica ores: the energy is furnished by two dynamos of 300 horse power each, and the potential reduced by transformers to 50 or 60 volts. After passing the current for twenty minutes to heat the furnace, the charge was gradually introduced; the treatment lasted for thirty-five minutes. From time to time, the current varied on account of the differences of resistance encountered in the mass by the arc. A quantity of metal



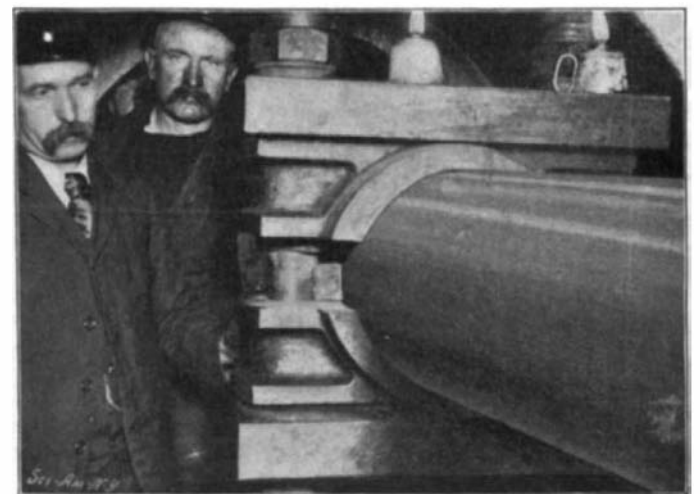
VERTICAL SECTION AND PLAN OF STASSANO ELECTRIC FURNACE.

equal to 8 kilogrammes was thus obtained, with an expenditure of energy of 2.7 horse power hours per kilogramme. The numerous tests carried out under these conditions have resulted in the formation of a company which will take up the process and in the near future will install three furnaces of 500 horse power each in the valley of Camonica, whose total yearly production is estimated at 4,000 tons.

REPAIRING A PROPELLER SHAFT AT SEA.

There recently came limping into the port of New York, with a broken propellershaft, the tramp steamer "Manica." Her torn and battered topsides and deck fittings bore eloquent tribute to the fury of the Atlantic gale in which she all but foundered; while down in the engine room and in the shaft tunnel she bore evidence, in the shape of many an ingenious makeshift repair, to the resourceful skill and indomitable pluck with which the engine-room staff had confronted impending disaster and saved the ship.

The "Manica" is a freight steamer of 2,733 tons gross tonnage, and 11 knots' speed, belonging to the Norton line. Ordinarily she runs from New York to the River Plate. On the present occasion she was on a voyage from Shields, England, to New York, and when about



PROPELLER SHAFT REPAIRED AT SEA WITH TWO SPARE CRANK-PIN BRASSES, AND TWO CAPS AND HOLDING-DOWN BOLTS FROM THE MAIN ENGINE.

1,600 miles from her destination she experienced very heavy weather, in which she broke her propeller shaft cleanly in two. The fracture, which occurred on the second length of intermediate shafting from the thrust block, was what is known as a "scarf" break. It began about 4 inches from the coupling and extended diagonally for $34\frac{1}{2}$ inches through the shaft. The