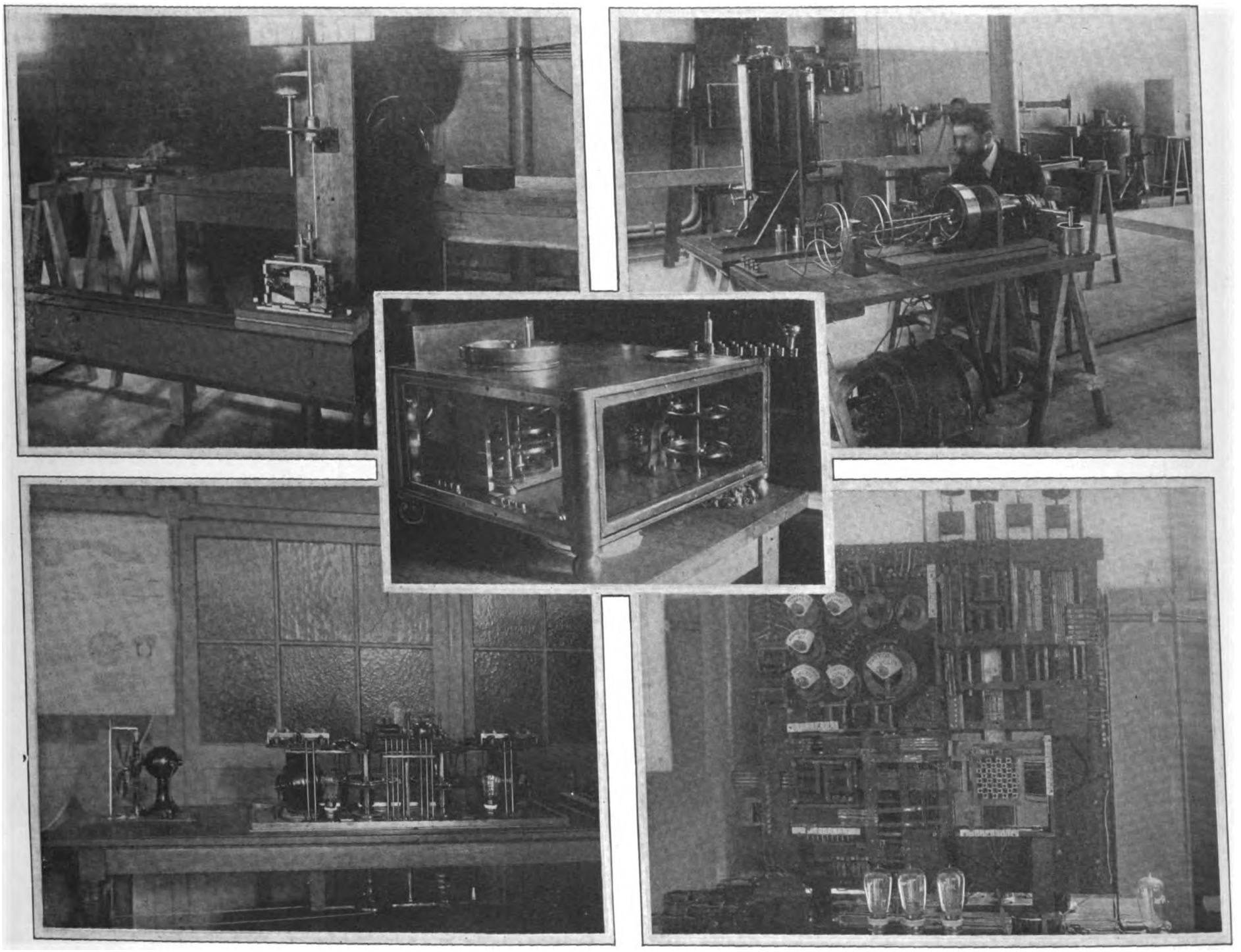

Fig. 1.—Some devices designed by Torres.

Upper Left.—Universal accellerator. Upper Right.—Testing lubricating oils. Center.—Universal pantagraph. Lower Left.—Wireless boat control. Lower Right.—Automatic chess player.

Torres and His Remarkable Automatic Devices

He Would Substitute Machinery for the Human Mind

THE Spanish inventor L. Torres y Quevedo is already known for a number of remarkable inventions, one of these being a most ingenious apparatus for solving algebraic equations, while more recently he designed an airship which now forms part of the French military equipment under the name of the "Astra-Torres." We wish to refer to the work of this inventor which he is engaged in carrying out at his large and well-equipped mechanical laboratory at Madrid, subsidized very liberally by the government: his idea being to develop the question of automatic mechanism in order to allow mechanical devices to make a wide number of most complex movements, such apparatus having a most practical bearing in the industries.

The Paris University invited M. Torres to make an exhibition of several of his most interesting devices, and accordingly they were mounted in working order in a section of the new laboratory of Mechanical Physics. One of these devices which attracted much attention is a mechanical chess player, it being, however, constructed with another end in view, this being to demonstrate certain of the inventor's ideas relating to automatic mechanism of a very complex character such as he claims can be carried out. In the present apparatus, the chess board, which makes up a comparatively small part of the whole, will be seen toward the right in Fig. 1, it being mounted in an upright position. The game is indeed not a complete one, and is here reduced to a single element, that is, the machine plays with one white king and one rook against one black king which the spectator can move as he desires. Even thus simplified the possible number of combinations that the machine has to provide for is very great, hence, the elaborate apparatus, and besides the machine is required to actually move the pieces, these being in the shape of jack plugs. The square frame surrounding the board provides for a double slide piece which can come over any one of the squares and then pick up the plug by clamping its head, withdrawing it, and then sliding again into a new position, inserting the plug into another square and then traveling off to the repose position clear of the board, leaving the surface of the latter free.

When we make a move by inserting the black "king" on any square, the machine first examines whether the move conforms to the rules. If not, it "protests" by lighting up one of the electric lamps seen on the base; but should the move be correct the machine takes account of the position of the three pieces, decides the move to be made and displaces one of the pieces as we have above seen. The game thus continues until the machine finally checkmates the opponent's king. No more than three false movements can be made by the opponent, each time a lamp being lighted, but after the third lamp, the machine refuses to work, and a special switch needs to be closed in order to commence a new game, the lamps then going out and the machine puts the pieces in the zero position. M. Torres explains his general ideas on the construction of electric automatic machines as follows:

The ancient automatons, among which the most celebrated is Vaucanson's "duck" and others of his devising, imitate the appearance and movements of living beings, but this has not much practical interest, and what is wanted is a class of apparatus which leaves out the mere visible gestures of man and attempts to accomplish the results which a living person obtains, thus replacing a man by a machine. In a submarine, which must keep a certain definite level in the water, the man in charge watches an aneroid and a level-indicator which show him the boat's depth and inclination, then he operates the rudder accordingly, so as to keep at the same depth. A torpedo, on the other hand, uses analogous instruments in order to automatically control the steering, human work not being used. Here, however, the nature of the movements is not a complicated one, and the result is easily obtained. But when it comes to an apparatus in which the number of combinations makes a very complex system, analogous in a small degree to what goes on in the human brain, it is not generally admitted that a practical device is possible. On the contrary, M. Torres claims that he can make an automatic machine which will "decide" from among a great number of possible movements to be made, and he conceives such devices, which if properly carried out, would produce some astonishing results. Interesting even in theory, the subject becomes of great practical utility, especially in the present progress of the industries, it being characterized, in fact, by the continual substitution of machine for man; and he wishes to prove that there is scarcely any limit to which automatic apparatus may not be applied, and that at least in theory, most or all of the operations of a large establishment could be done by machine, even those which are supposed to need the intervention of a considerable intellectual capacity. When the principle which he uses in the present chess player is examined, he is certain that any one will be convinced of the truth of his ideas, and he is now working

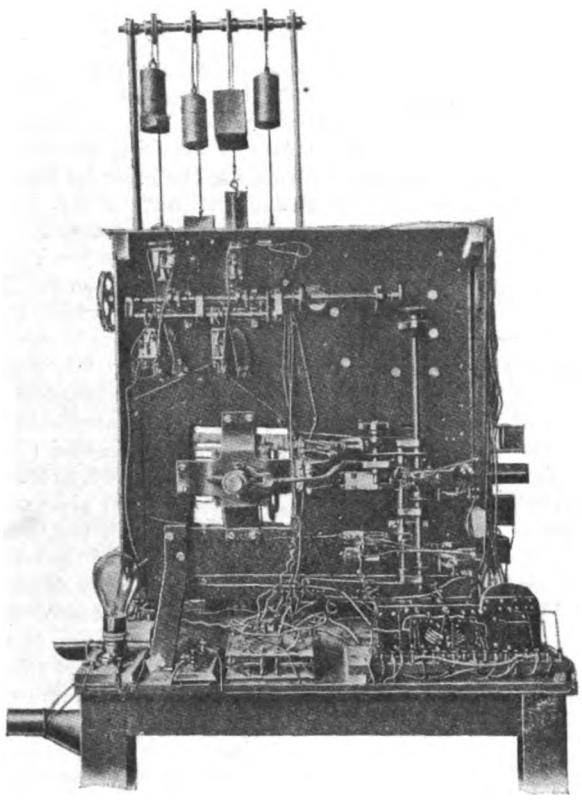

Fig. 2.—Back of automatic chess player showing, gearing and mechanical action.

to develop them on a wider scale.

Among the apparatus shown at Paris is a device which is intended to show that a mechanical movement of a given character can be transmitted to a given device not only when the latter is making a regular movement, but when it moves in a very irregular way. In this case it would be thought impossible to produce the same result, but the idea is very well demonstrated in an apparatus which contains a fixed cardboard disk placed in the right hand circle on the top of the cover (shown in the central illustration in Fig. 1) and a second disk mounted in a metal frame on the left. But this frame is movable and can take various irregular positions. The operator first selects a certain figure, such as a letter of the alphabet, *A*, and works the extensible handle so as to inscribe this letter by means of a pencil upon the fixed disk. With the second disk at rest, a pantagraph movement inscribes the same letter, *A*, on the second disk, this, of course, being very easy. What is remarkable is that in a second case, the operator proceeds to inscribe the letter upon his disk, while another person takes hold of the left hand disk and moves it about in any irregular manner. But this does not prevent the machine from inscribing the given letter upon the second disk as before, for all the irregular motions are exactly compensated for in such way that the machine acts as if the second disk were quite steady, and the result is practically the same as in the first case. It will be seen that if the second disk represents an irregularly moving mechanism, or an object which is being transported by crane or other device and swinging in space, such movements will not present any desired result from being obtained by the action of a controlling mechanism, in spite of the various motions of the object.

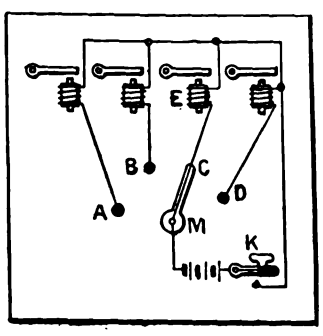

Fig. 4.—Switch giving four selections.

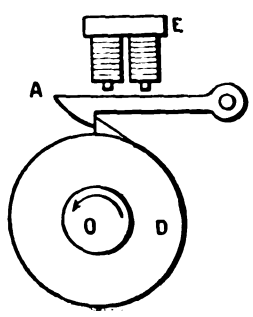

Fig. 5.—Escapement wheel with detent.

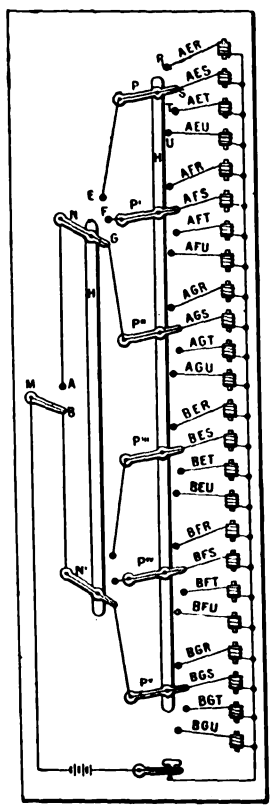

Fig. 6.—Switches controlling 24 operations.

One of our views in Fig. 4 shows a method for wireless steering of boats which was very successfully applied upon a good-sized boat containing a number of persons. On this occasion the boat was run in the harbor of Bilbao, and could be steered in all directions, started, stopped and run at various speeds.

By examining the picture (Fig. 1. lower right hand), which presents the face of the chess player, the board will be seen as a very small portion of the machine, being mounted in the vertical toward the right. The game is not a complete one, being here reduced to a simple element, the machine playing one white king and one rook against one black king which the spectator may move as he desires. Even simplified to this degree the possible combinations will be very great, in addition to which there is the mechanism required to actually move the pieces, which are pins or plugs fitting into holes in the squares. At the top and left of the board will be noted two arms which can combine to cover any square, seize the piece therein by its neck, lift it clear, transfer it to any other desired space and place it in its position there. The arms then retire to their neutral positions.

When the spectator moves his king, the machine first tests out whether it is according to rule, and if not, it protests by lighting one of the lamps at the base. If the move be a correct one, the machine takes account of the position of the three pieces, decides the move to be made by it, and makes the move. The game thus continues till the machine finally checkmates the king of the man. No more than three false moves are permitted, a lamp being lighted each time. and following the third one the machine refuses to continue and a new game must be begun. This is effected by closing a special switch, whereupon the machine extinguishes its lamps and sets the pieces in the zero position again.

The novelty in the matter is that the machine looks over the field and selects one possible action in preference to another. There is, of course, no claim that it will think or accomplish things where thought is necessary, but its inventor claims that the limits within which thought is really necessary need to be better defined, and that the automaton can do many things that are popularly classed with thought. It will do certain things which depend upon certain conditions, and these according to arbitrary rules selected in advance.

While it is out of the question in the space available to describe the chess player in detail, it is still possible to set forth some of the principles which it utilizes. One of these is that the pieces are plugs and in each of their

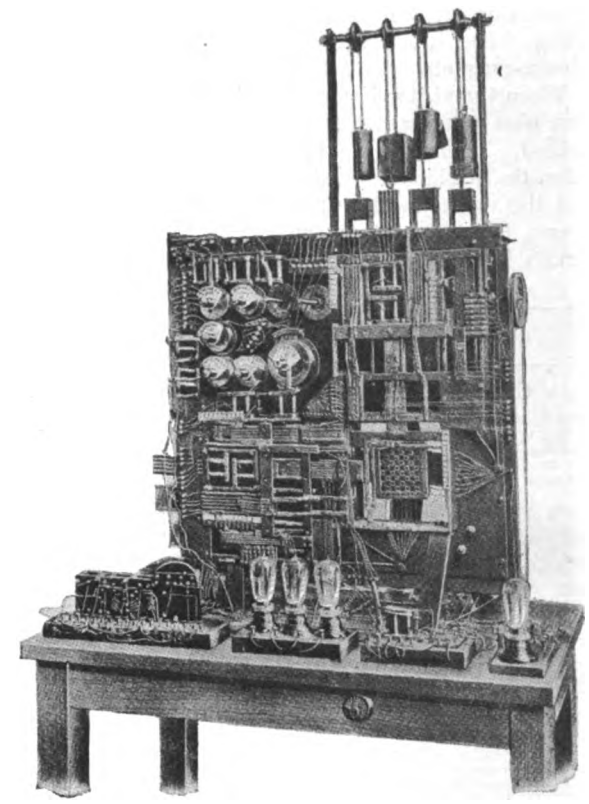

Fig. 3.—Face of automatic chess player.

individual positions on the board they make connections through related relays. Then there is the commutator principle that is everywhere in use. Fig. 4 illustrates this, *M* being the commutator governing any of the contacts *A*, *B*, *C*, or *D* at will. Under the conditions here shown it is the electromagnet *E* that is in circuit and whatever further movement is made it is one that must initially be related to *E*. Fig. 6 presents a more complicated arrangement, the commutators being in three groups, *M*, *N*, and *P*. Commutator *M* may take either one of two positions with corresponding circuits, *N* and *N'*, have the choice of three each, and the group *P* to *Pv* have four contacts each. Such a combination permits of twenty-four different operations. Theoretically, it will be necessary merely to multiply such an arrangement to accomplish almost anything desired in the way of direction of future action, but practice interposes its

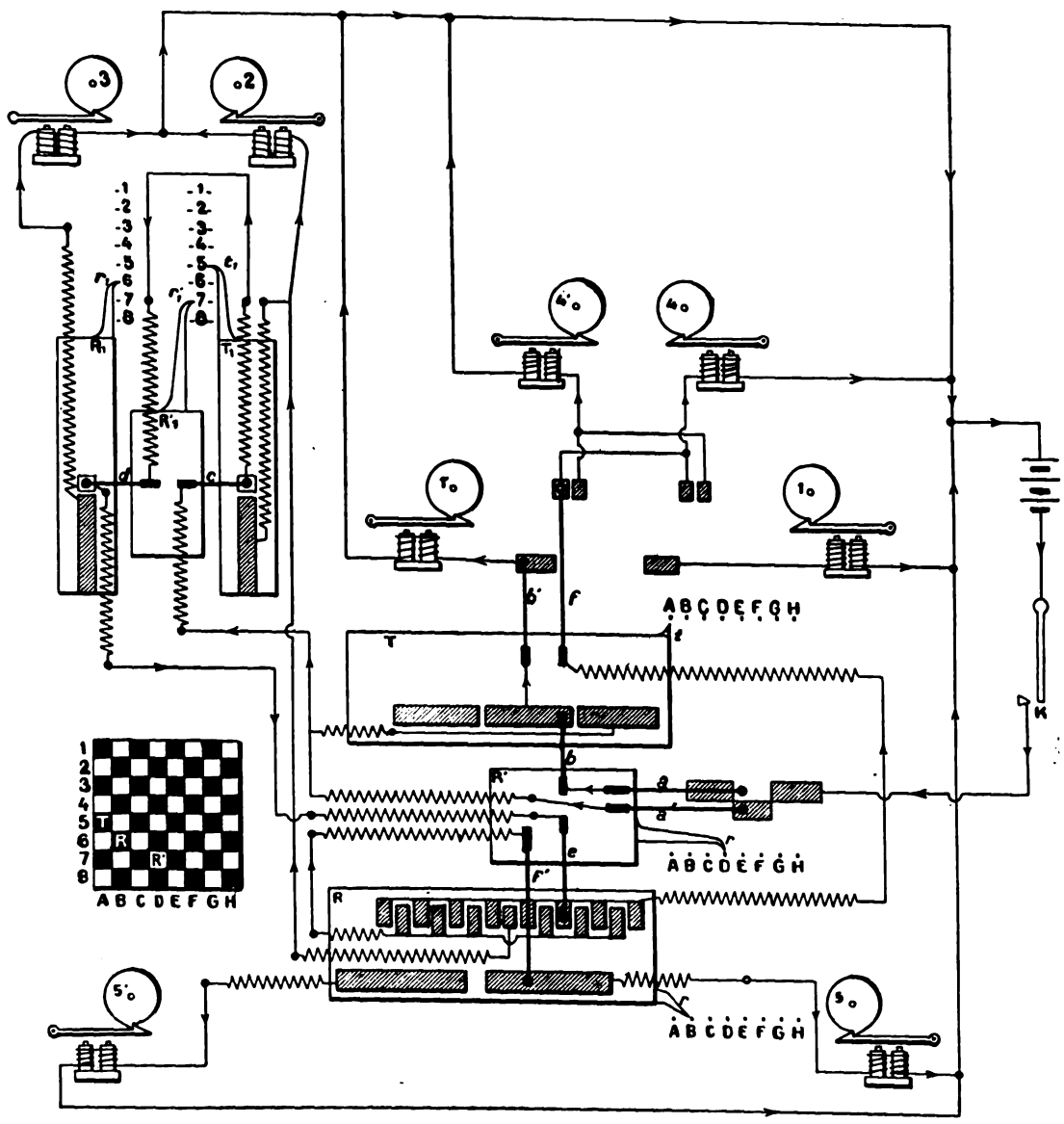

Fig. 7.—Scheme of electrical connections of automatic chess player.

The board is plainly shown, with its vertical columns, and the horizontal rows numbered. *R* and *R'* are the white and black kings, respectively, and *T* is the white castle. Rectangles *R*, *R'* and *T* are movable tablets, whose contact points mark the columns of the corresponding piece; rectangles *R*-1, R'-1 and *T*-1, similar tablets marking the horizontal rows of the corresponding pieces 1, 1', 2, 3, 4, 4', 5 and 5' are wheels held by pawls which are armatures of electro-magnets. Currents in the latter release the corresponding wheel, or wheels for one revolution. Each wheel initiates some definite action.

limitations. Action is secured, as shown in Fig. 5, by escape wheels the detents of which are the armatures of electro-magnets.

When the visitor has moved his piece, the automaton first tests whether it is a correct move, if not, a lamp is lighted. Assuming the move to be according to the rules, the machine determines upon one of six operations and the way of getting at which one is this—it being, of course, understood that the machine is already set in certain ways by the positions of the pieces:

Assuming that the black king					
is in the same zone* with the castle.†	is not in the same zone with the castle and the vertical distance between the black king and the castle is				
	more than one square	equal to one square, the vertical distance between the two kings being			
		greater than two squares	equal to two squares and the number of squares that measures the horizontal distance is		
			odd	even	not any
		The result will be			
castle moves horizontally.	castle descends one move.	king descends one square.	castle moves one square horizontally.	White king moves one square toward black king.	castle descends one square.
1	2	3	4	5	6

* "Zone" is used by Torres to indicate one of the three groups of vertical columns, *A, B, C*; *F, G, H*; or *D, E*.

† To avoid possible confusion the term "castle" is used here instead of "rook." The diagrams being from the French, *R* represents the king (roi) and *T* the castle (tour).

The study of the application of these decisions is suggested in Fig. 7. The various rectangles are tablets movable in the direction of their greater length which carry points making circuits through contacts 1–8 or *A–H* which correspond with the horizontal rows of squares or vertical columns as may be seen by referring to the board itself. The three lower central tablets are for the rows or horizontal ranges of squares, *R*, *R'* and *T*, being related respectively to the white king, black king and castle, while the upper tablets, above the board, R_1, R'_1 and T_1 indicate the vertical positions of the same pieces. These tablets change in position with the moving of the pieces. Circuits are established through the points of these tablets which actuate one or another of the single-leg escape wheels, permitting them to do their especial functions by attracting the pawls and giving them one revolution. What they do may be arranged, for example, in some such way as this:

1 carries castle to column *A*,
1′ carries the castle to column *H*,
2 carries the castle downward one square,
3 carries the king downward one square,
4 carries the king one square to the right,
4′ carries the king one square to the left,
5 carries the castle one square to the right,
5′ carries the castle one square to the left.

On the initiative of these wheel movements other mechanism accomplishes the desired results, and in the process of moving the tablets change to accord with the new position, affording means of checking up the propriety of the move and furnishing the basis for the new scrutiny that will determine the next move.

The foregoing description is necessarily sketchy and imperfect, but it will serve to give an idea of the kind of machine that is occupying the attention of Torres. The problem to begin with is a definite one in which there is the mathematical certainty that the white pieces can mate the black king. For chess it is a relatively simple matter but at the same time it affords great range in the way of doing it. Torres has become acquainted with the mathematics, has arrived at rules which will lead to the desired results and has been ingenious enough to invent devices which will follow these rules. Fig. 1 gives some idea of the complexity of the electrical layout, while Fig. 2, the back of the machine, shows some of the mechanism whereby the mechanical movements are effected.

In the automatons of Torres there is the extraordinary interest that while without meretricious imitation of the human form they attempt the accomplishment of things that have hitherto been reserved entirely for the human mind. In a submarine the man who directs it keeps his eye on clinometers, manometers, aneroids and compasses which indicate heel, inclination, submergence and course of the vessel, and maintains his proposed direction by the indications that these furnish him. In the automatic torpedo analogous instruments themselves direct the course without human intervention. Such methods of control bear the suggestion of the further use of machines in the industries. It would seem as if factories had already reduced their processes to automatic ones to the last degree, and are utilizing labor for care rather than for direction. Torres believes that the limit has by no means been reached of what automatic machinery will do, and in substantiation of his opinions presents his automatic chess-playing machine.

The Steel Industry and a Year of War*

A Review of Conditions in Four Leading Countries

A REVIEW of the steel industry in the first year of the war is given by Dr. E. Schrödter of Düsseldorf in the last issue of *Stahl und Eisen* to reach this country—that of August 5th. Considerable extracts are given below:

THE GERM N STEEL INDUSTRY.

Hard work under difficult circumstances characterizes the activity of the German iron industry in the first year of the war. In the last year of peace, 1913, Germany mined about 35,941,000 metric tons of domestic iron ore and produced out of this, outside of a sale for export of 2,613,000 tons and an importation of 14,019,000 tons of ore, a total of 19,300,000 tons of pig iron; that is, about 40 per cent of the metal content of our pig iron came from foreign sources. The necessary fuel, with a few minor exceptions, was domestic. But we were dependent on foreign sources, not only as regards our imports of iron ore, but in much greater measure was this the case as to the sale of our products in finished and semi-finished steel, for in the same year, 1913, our exports of iron and steel, including machinery, figured back to pig iron, were not less than 46.6 per cent of the year's production. That an industry which, in so great measure, depended on its foreign relations, both as to imports and sales, should be thrown into the most intense suffering by the unexpected outbreak of war is easily understood.

At the regular meeting of the Association of German Steel Makers on January 31st, 1915, I gave a detailed account of this, and I was also able there to call attention to the gratifying resuscitation which had set in a few weeks after the first stagnation and to the effective transformation which had already made itself manifest. Since then the rate of production has not only been maintained, but it has increased in a satisfying degree. A large number of blast furnaces are again in blast and others are constantly being lighted. Though the average production of each furnace has decreased as a result of poorer ores, yet the daily output of 18,925 tons in August, 1914, has grown to 31,400 tons as the average of the last few months.

The steel production has developed in a similar manner. From the low figure of 18,310 tons per day in August, 1914, it has advanced to an average daily output of 33,000 tons in 1915. It is self-evident that the activity of the rolling and other mills was correspondingly greater.

LACK OF MANGANESE.

A special writer in the London *Times* last spring figured that the German steel industry would have to stop by June, 1915, because of a lack of manganese. The hail of the steel of our guns has demonstrated that this estimate also belongs to the enemy's many false computations of this war. The production of our iron industry, dependent on domestic raw materials as it now is, is so great that it fulfills not only all the demands of our army and fleet, but also the necessary current needs of steel for domestic purposes and even to a certain extent the wants of our neighboring neutral nations. This gratifying achievement is public knowledge. How we protect ourselves in our raw materials is our own metallurgical secret which we have no occasion to reveal to our united enemies. So much, however, may they know—the idea of a dearth of steel for our war needs because of a collapse of our steel industry is a miscalculation, the same as the plan to starve out our population during the war has proved itself ridiculous.

German science, German technique, German organization, and the adaptation of the German industries, regarded as makeshift by the British, triumph in irresistible victory over all difficulties which the German people are made to meet. This great success of ours is the more noteworthy in that, since the beginning of the war, our iron industry has been hindered in increasing degree by the constantly increasing legal restrictions and the limitations to its mobility caused thereby.

The fact cannot be gainsaid that the foundations for the maintenance of our steel industry on its present scale will continue unimpaired, even should the war last an innumerable term of years.

THE FRENCH STEEL INDUSTRY.

As to the French iron industry, it is conceded that of the normal output not less than 85 per cent is in German-held territory. On the other hand, that country can draw on the iron-ore deposits of Normandy and the Pyrenees as well as bring ore in on the Mediterranean, especially from Algiers and Spain. By this means without doubt France can operate her remaining blast furnaces and steel works, especially those with open-hearth furnaces, and produce, even under the circumstances, sufficient material for war needs, so that the plants in central France near Paris and those on the sea coast can operate.

Commenting on the exceptions taken to his estimates of the amount of France's coal in German hands (65 per cent), published in *The Iron Age* of March 18th, 1915, Dr. Schrödter says:

Official estimates place this year's coal output of France at the most at 18,000,000 metric tons, against 40,000,000 tons in normal times. Besides this the usual imports from German and Belgian sources of 10,000,000 tons are lacking. The supply thus falls short of the normal annual need of 60,000,000 tons by not less than 32,000,000 tons, which England should supply, though normally it exports only 10,000,000 tons to France. While the price of coal from northern France is artificially held at 28 francs per ton, more than 52 francs must be paid for the imported coal at all ports. It is evident that the question of coal is a "burning" one, that it is France's weightiest industrial problem, and hence the cry for state help is heard.

A strong movement is on in France to bolster up the export trade by politically and industrially organized measures, but in the meantime France's exports have fallen off considerably. The official figures, recently made public, show the decrease in iron and steel manufactures in 1914 to be 50 per cent from the total of 1913. The exports for 1914 are about equal to those of the first seven months of 1913. Exports of scrap, however, have doubled, evidently because of Italian demand.

THE BRITISH SITUATION.

In England the disorders in industrial operations resulting from the war have constantly increased in the year. Though the official data of the output of mines and iron and steel plants are not yet made public, nevertheless we know with certainty that the coal output is nearly 3,000,000 tons per month less than that of normal times. The recent strike of the Welsh miners has caused a decrease of at least 1,000,000 tons.

The production of pig iron has had to battle with constantly increasing difficulties. A picture of these can easily be drawn because the freight from Bilbao for iron ore has risen three and four times the normal rate. The exports of iron and steel manufactures, which were to absorb the German field, have not realized this expectation, but have shown an almost uninterrupted decline, which in the war months from August, 1914, to June, 1915, was 41.1 per cent from those of the same period of the previous year.

THE AMERICAN STEEL INDUSTRY.

In the United States the railroad reports, the number of bank failures as well as the complaints as to unemployment indicate that the entire industrial life has not improved, as was assumed by the Chauvinists who hoped for great advantages as a result of the elimination of German world competition. The production of pig iron, which in August, 1914, was 65,393 tons per day, in December had decreased to 49,678 tons, but in May, 1915, it had advanced to 74,180 tons per day, and in June to 80,160 tons.

It is astonishing, however, that the effect of the flow of orders for war material, which our enemies have showered on American plants and which have given rise to many new expansions, has not been more marked on the general current of that country's iron industry. While on the one hand the war industries have made great gains, on the other hand American industrial life has suffered enormously. It can be said to-day with certainty that the hemming in to which Germany is subjected by England's blockade will lead to a lasting falling off from our former large imports from North America, among which oil and copper may be mentioned. A later reckoning will show whether the present gain in war materials may not be at the cost of lasting damage to American exports to Germany.

* From The Iron Age.