TABLE II.—WEIGHT PER HORSE POWER HOUR CAPACITY OF VARIOUS SECONDARY BATTERIES.

Name of Battery.	Elements Only.		Cell Complete.		Authority.
	Lb.	Kilos.	Lb.	Kilos.	
Plante	....	....	396	180	Reynier.
Faure	....	....	88	40	Faure.
"	....	....	165	75	Sir W. Thomson.
" (old model)	....	....	198	90	Reynier.
" (new model)	....	....	134	61	Reynier.
E.P.S. L plates	....	....	133	60·4	Prospectus.
	....	....	110	50	Reckenzaun.
" S "	66	30	135	61·3	Fitz-Gerald.
Reynier { Zinc posve	50·6	23	117·5	53·4	R. Tamine.
Reynier { Plante form.	105	47·6	....	....	*Idem.*
Lithanode battery (old form)	42	19·1	76	34·5	Fitz-Gerald.
Lithanode battery "Union" cell	42	19	70	31·5	G. Forbes.

ject to correction and amplification, which in some measure illustrate this improvement, although there are other points of equal importance which require to be taken into account. The "lithanodes" mentioned in these tables were the subject of a paper which I read at the British Association meeting at Birmingham, and which will be found in the *Electrician* of September 10 last year. It is peroxide of lead—with more or less sulphate of the metal—in a coherent and highly conductive form, having generally a specific gravity between 7·5 and 7·9.—*By Desmond G. Fitz-Gerald.*

PRACTICAL ELECTRICITY.

Lighting and Extinguishing Button.—Fig. 1 represents a small, practical apparatus constructed by Mr. E. Salomon. It is designed to open and close a circuit successively by one and the same maneuver, and is particularly applicable to the lighting and extinguishing of lamps or to continuous electric bells.

It has the appearance and dimensions of the button of an ordinary electric bell. The mechanism comprises an 8-toothed ratchet wheel carrying four pins. The

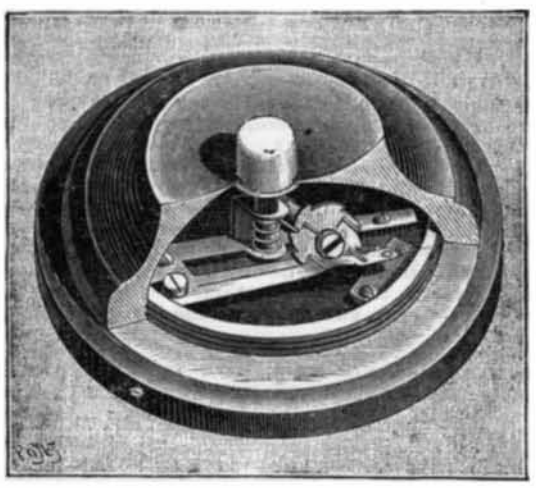

FIG. 1.—LIGHTING AND EXTINGUISHING BUTTON.

button itself carries a pin that extends to the teeth of the ratchet wheel. Every time the button is pressed, the ratchet wheel advances one tooth, from left to right, and makes an eighth of a revolution. Under the button there is a spiral spring that has the effect of pushing it out as soon as the pressure is removed—the ratchet wheel keeping the position that it has obtained.

The four pins, through the revolution of the ratchet wheel, press in succession against a horizontal strip of brass forming a spring that alternately opens and closes the circuit, according as one of the pins is or is not opposite the slightly curved part of the strip. Fig. 1 represents the button in the open circuit position.

To prevent the ratchet wheel from moving backward, a second flat spring engages with each tooth and holds it in place.

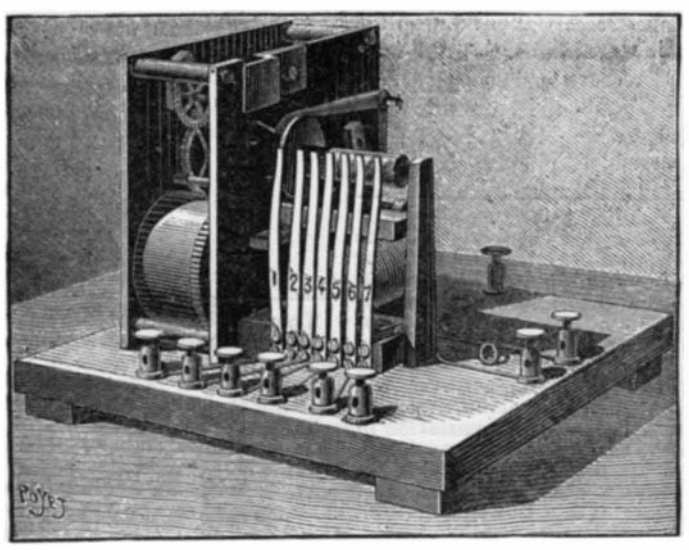

FIG. 2.—AUTOMATIC COMMUTATOR.

Since we are speaking of commutators, let us mention an elegant device got up by one of our subscribers, Mr. Grangier, of Dinard, for the purpose of lighting or extinguishing a lamp at a distance, from any number of points, by the sole aid of a button and two wires. The principle of it is very simple. It consists in actuating the electro-magnet of a relay commutator by pressing upon one of these buttons. The motion of the armature revolves a ratchet wheel one eighth of a revolution at each maneuver. This revolution is utilized for effecting contacts through the aid of two springs that press against friction rollers provided with parts that are successively insulating and conducting, thus effecting an opening and closing of the circuit connected with the two springs.

Automatic Commutator.—The object of this apparatus, which also is constructed by Mr. Salomon, is to permit of effecting, in a certain measure, a nearly constant lighting by Leclanche piles, through a method of automatic substitution of several series operating one after the other, and depolarizing themselves during the periods of rest. The apparatus, when once wound up, gives 2,700 commutations before it has to be wound up again, but it is unnecessary to say that such a limit is not absolute, and that it depends solely upon the proportions of the apparatus and the weight of its spring.

The apparatus (Fig. 2) consists of a clock-work movement, which, every thirty seconds, every minute, or more, according as need be, is thrown into gear, and causes the revolution of an axle a quarter, a sixth or an eighth turn, according as four, six, or eight series are used. This rotary motion changes the communications of the external circuit, puts a new series in circuit, and removes that which has just operated. This result is very easily obtained by means of metallic fingers fixed spirally upon the revolving cylinder, and which come successively into contact with springs, 2, 3, 4, 5, 6, 7, that communicate with the positive poles of the different batteries, the negative poles being connected with a common return circuit.

In order that the commutator may not work while the piles are not operating, an electro-magnet is placed beneath the revolving cylinder. As long as the lamps are out, the clock-work movement is locked, but as soon as the lamps are lighted, the electro attracts its armature, which throws the clock-work movement into gear, and the purely mechanical function of the commutator can then be produced.

According to Mr. Salomon, it would require six batteries of a special model to secure a continuous lighting of indefinite duration, at the rate of 1 ampere, 1·5 volt per element, in making commutations every thirty seconds, thus leaving a hundred and fifty seconds of rest between two successive periods of work.

We do not doubt the efficiency of this method, but it seems to us that the use of six batteries to supply a single 1 ampere lamp leads to a somewhat costly *materiel* and a somewhat complex installation.

Mr. Salomon's commutator, however, by means of slight modifications, may be utilized with advantage for an analogous service—that of the charging of a series of accumulators through a small number of elements (bichromate or sulphate of copper). The commutator should, say every quarter of an hour, make the charging pile pass automatically from one series to the other, and thus perform, systematically and methodically, a maneuver that we have hitherto effected by hand, but quite irregularly.

In his last arrangements of the chlorine pile, Mr. Upward uses an apparatus whose function is exactly the same as that of the one just described, but the high price of it leads us to believe that the Salomon arrangement, slightly modified, would solve the problem in a simpler and more economical manner.

THE ELECTRIC WORKING OF METALS.

THE applications of the heat produced by electric energy are not limited to lighting by the arc and incandescence, and we have several times already mentioned other applications in which heat intervenes. Thus, for example, we have described the electric furnace of the lamented William Siemens, the manufacture of aluminum bronze by the Cowles process, and

ELECTRIC WELDING OF METALS.

the electric welding of metals by means of transformers, through the remarkable processes of Mr. E. Thomson. It is likewise the heat disengaged by electric currents that Mr. De Benardos utilizes in his process of working metals.

The origin of these researches dates back to 1881. The first applications were made by Mr. De Benardos in the laboratory of the *Electricien* in the autogenous soldering of the leaden plates of accumulators. These first results, developed and extended to other metals, have given rise to a new industry, and have been the cause of the formation of a company for the electric working of metals.

The principle applied in this process of welding consists in the creation of a voltaic arc, a sort of electric blowpipe, between the points to be united, and in the use of a piece of carbon that is moved along the two surfaces (see engraving).

The current is furnished by a series of accumulators in tension kept constantly charged by a continuous current machine. The negative pole of this series of accumulators is connected with a cast iron table insulated from the floor and forming, as it were, a sort of electric anvil, upon which the pieces to be welded are placed, and the positive pole is connected with a carbon crayon which is maneuvered by hand.

The welding does not succeed so well, and even not at all, if the table is connected with the positive and the carbon with the negative pole.

Upon lightly touching the piece with the carbon and then quickly removing it to a certain distance, an arc is formed that very rapidly melts the opposite pieces and furnishes a very strong and absolutely tight junction. When there is a long line to be welded, as, for example, when it is a question of uniting two plates of iron, for the manufacture of casks, it suffices to move the crayon along the pieces to effect a junction at once.

The intensity of the current depends upon the size of the pieces to be welded, and is regulated by varying the number of accumulators used. In the recent experiments made under the direction of Mr. J. Sarcia during the annual session of the French Society of Physics, the current was furnished by a Gramme machine of superior type charging Montaud accumulators capable of producing from 300 to 400 amperes.

As a general thing, it requires twenty-eight lead-lead accumulators in tension for obtaining a suitable arc. The intensity of the latter is regulated according to the size of the pieces to be welded by interposing a variable resistance in the circuit. The same process permits of making holes in iron plate; and if a metallic rod be afterward introduced into the aperture thus formed, and its two ends be melted, an electric riveting is obtained.

The brilliancy of the arc would be trying and even dangerous to the workman, through the frequent flashes of light, and for this reason he protects his eyes while at work by means of a frame provided with colored glass and with a handle that he holds in the left hand, while his right hand directs the carbon crayon.

In addition to the soldering of accumulators, which has been practiced for several years, a very important application has been made by Mr. P. Legrand in the construction of absolutely tight metallic reservoirs designed for the carriage of light petroleum oils and sul-