SCIENCE

FRIDAY, JANUARY 25, 1889.

THE STORAGE OF ELECTRICITY.

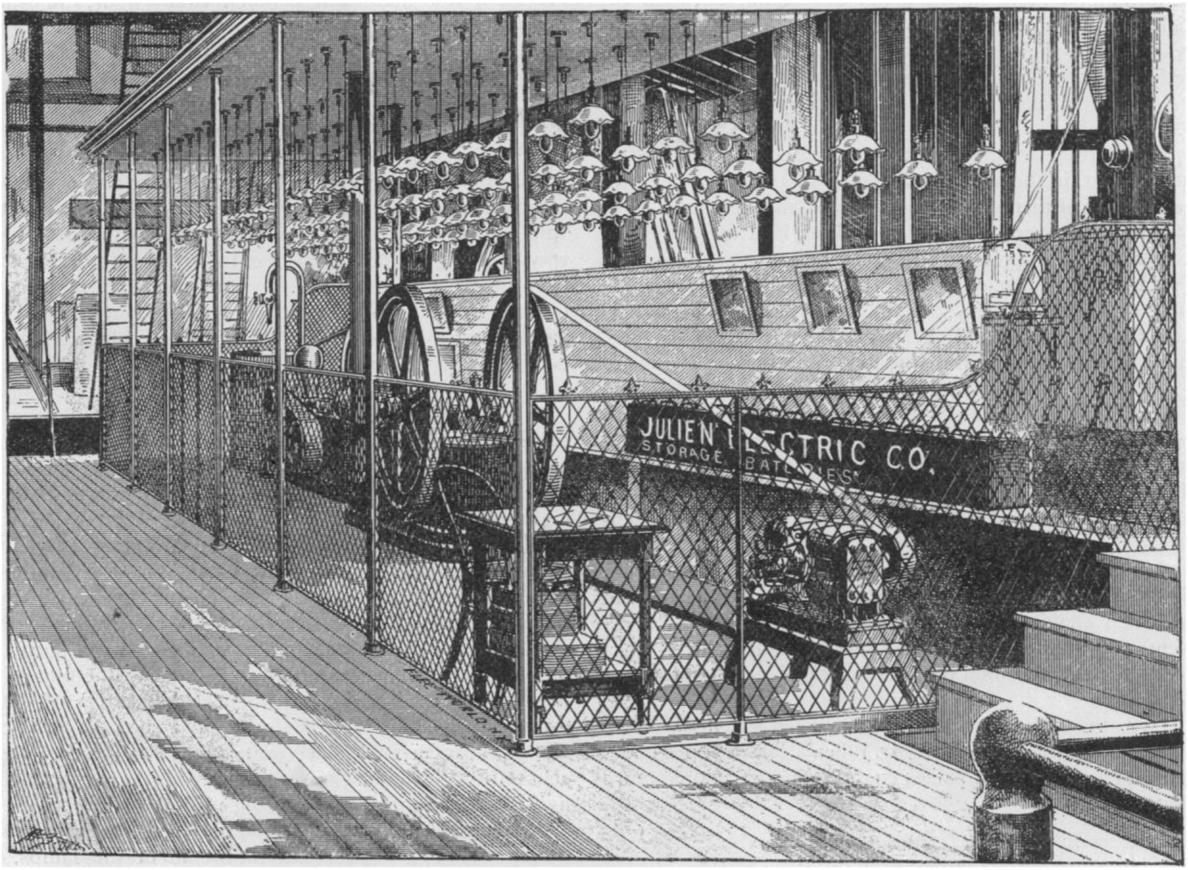
ONE of the greatest drawbacks to the introduction of electricity as a servant of man has heretofore been a method of providing a suitable means of accumulating it, so as to have it at hand when and where wanted. The development of storage-batteries is doing as much to-day to advance the universal adoption of electricity as the dynamo when invented did to introduce it.

To Gaston Planté, more than to any other investigator, are we indebted for our knowledge of storage-batteries. He it was who first took advantage of secondary currents in voltaic batteries. He examined the entire problem of the polarization of electrodes, using all kinds of metals as electrodes or plates, and many different liquids as electrolytes; but he found that the greatest efficiency was produced by electrodes of lead in diluted sulphuric acid.

The first set of Planté cells was exhibited in 1860, before the Paris Academy of Sciences. It was immediately recognized that the storage-battery had a field peculiarly its own, and that its application was only limited by the application of electricity. This was all before the introduction of the dynamo; and at that time little real commercial value was attached to the discovery, as the accumulators had to be charged by means of primary batteries, and it was then well known that electricity, when produced by chemical means, was far too expensive for any purpose outside of the laboratory.

Mr. Planté's discovery consisted of the fact, that, if a current of electricity be passed back and forth through a pile composed as above, the plates of metallic lead become gradually converted into spongy lead on the negative pole, and peroxide of lead on the positive pole, and that such a cell would hold current and deliver it again with but small loss. The chief reason that a storage-battery of this character could not be made of use practically, was the fact that to form the lead plates it was necessary to pass the charging current daily back and forth by a series of reversals for many months before they became converted to their new forms.

On the discovery and perfecting of the mechanical production of electricity by means of the dynamo, the production of a suitable form of storage immediately became one of the leading questions of the day; but how this formation of Planté's plates might be hastened, so as to reduce the cost of manufacture within practical limits, was what was first to be solved. The first step forward was the artificial application of the oxides found on Planté's plates to sheets of lead which were bound on by strips of felt. After a short time, however, under the action of the sulphuric acid, these strips of felt became eaten, and the surface of the plates fell away.



JULIEN STORAGE-BATTERY EXHIBIT AT THE AMERICAN INSTITUTE FAIR.

It remained for Mr. Edmond Julien, a Belgian engineer, to make a battery of such a form as to be electrically and mechanically suited to the requirements. His battery consists of perforated plates or grids, into which are pressed the active materials or oxides, which, after a short charge, become almost one homogeneous mass, being what Planté in a crude way produced by the continuous action of a series of reversals of a current. This, however important, did not turn out to be his most valuable invention. When put to practical use, it was found that after a short time the positive plates showed signs of corrosion, which limited their life to about one year. He therefore entered upon the work of constructing a battery free from its defects, and, after a period of six years of continuous experimenting, he produced the Julien battery in its present form (represented in the accompanying cut), founded upon the principle of an inoxidizable support plate, which is materially opposed to that employed by his predecessors. All support plates made before Mr. Julien's discovery were founded on the principle of the oxidization of the positive plates or their conversion into peroxide, so that they soon fell to pieces.

The difference between a lead plate and one composed of this inoxidizable alloy — lead, antimony, and mercury — is perfectly evident: one is practically useless, while the other can be successfully used for years. The importance of this point is made plain by a recent decision of the commissioner of patents.

The following is an extract from the report of Benton J. Hall, commissioner, Dec. 8, 1888, in the case of an interference between John S. Sellon, assignor to the Electrical Accumulator Company, and Edmond Julien: —

"The addition of mercury as a battery constituent is of great value in the formation of support plates of secondary batteries, on account of its tendency to unite with the other metal or metals of the plate, forming a more active union or contact between the plate which contains an admixture of mercury, and thus diminishing the resistance of the electrode, and therefore the resistance of the whole battery, thereby increasing the current, which is a result of the greatest importance in the use and application of secondary batteries.

"This property (that of diminishing the resistance of the electrodes) is so valuable, that, in the manufacture of plates for contact batteries, the addition of mercury to alloys of lead and antimony gives marked advantages over batteries formed of lead and antimony alone, and renders them preferred for secondary-battery purposes. This is the characteristic value of the Julien battery, or the triple alloy battery of Julien, which is so much preferred in modern use on account of its durability and efficiency.

"The action of mercury in the three-element battery — that of Julien — should at once remove it from comparison with two-metal batteries of any kind as yet known, and which appears to be due to the admixture of mercury in the alloy, which renders it unlike the other batteries with which it is classified wrongly in this interference, and with which it should not have been placed in interference; for the presence of mercury in the plate gives it a distinct and separate place, and forms a different alloy."

These plates, in addition to being inoxidizable, and thus having practically an unlimited life, are of great rigidity and mechanical durability, which enables them to be made very much lighter, and also prevents any tendency of bending, or, as it is called, "buckling," under the severe strain of heavy rates of charge and discharge.

To illustrate the difference in weight between a battery whose plates are made of pure lead and of Mr. Julien's compound, I quote from pamphlets issued by companies engaged in the manufacture of these batteries: —

	Weight of Cell in Pounds.	Capacity in Ampère Hours.	Capacity per Pound.
Gibson (lead)	120	200	1.6
Faure (lead)	121	300	2.5
Julien (alloy)	32	150	4.7

The value of Mr. Julien's inventions was immediately recognized by capitalists in America, which resulted in the organization of the Julien Electric Company, to exploit his systems of traction and lighting by means of these batteries. To that company is due the great progress which has been made within the last two years in the storage-battery industry. American ingenuity and proclivity for labor-saving machinery has grappled with and overcome almost all the difficulties in the manufacture of these batteries, which, up to a short time ago, had been considered insurmountable.

The plates were at first cast, pasted, and pressed entirely by hand, and, in fact, these crude methods are still in use in Europe and by all other makers in this country; but the Julien Company have a machine capable of producing in one day one thousand completely finished plates. It is almost automatic in its action, and requires but one attendant. All the plates are uniform, and the action of the battery is therefore free from the irregularities inseparable from hand-made batteries.

A word as to the application of storage-batteries. They have been extensively and successfully used for the following purposes: electric lighting of buildings of every description; lighting of railway-trains, street-cars, and omnibuses; the traction of all vehicles, more especially street-cars; the propulsion of yachts, launches, and pleasure-boats; the lighting of steam-vessels, etc.; running motors of all kinds; telegraphy, signalling, etc.; medical uses; electroplating; general laboratory-work, etc.

Electric lighting, however, is one of its most interesting and useful applications. It is here that its functions as a reservoir of energy become utilized to the greatest advantage.

Where lights are supplied direct from a dynamo, the machinery must have a power-capacity equal to the maximum number of lamps in a given installation; and, since the lights are usually only needed a few hours out of each twenty-four, the plant will remain idle the rest of the time. Moreover, to secure first-class results, the engine and dynamo must be of the best construction and design, steady and quick regulating, to prevent flickering. But with storage-batteries the generator is not limited as to the time or manner of working, but can prepare its supply slowly, ahead of time, during the day, in the many hours at its disposal; and, in addition to its requiring a dynamo of very much smaller size, the machinery may be of much simpler and cheaper construction, as with the battery irregularities in movement can exist without in any way affecting the quality of the light, since the current given off from the accumulators is always uniform and regular, even while the charging current is subject to marked fluctuations. The storage-battery is, in fact, an equalizer and regulator to the dynamo, besides acting as a reservoir in case of accident, which is liable to happen with the best machinery.

In all cases a direct lighting-plant can be made complete and perfectly reliable by the addition of storage-batteries, as the surplus energy, which can be stored while the dynamo is running under light load, can be utilized during the remaining hours of the day or night.

With water we cannot expect a reliable supply without providing suitable facilities for accumulating and storing certain quantities of it; and in every case we have such means of storage, whether it be a reservoir, tank, cistern, or well. With gas the supply must be yet more uncertain and unreliable without the gasometer, in which the product of the retorts can be stored ahead of the time of consumption. In the profitable and practical application of electricity we must also have a means of storing to insure an absolutely steady and uniform current, so necessary with incandescent lighting, and also to provide against any possibility of the extinguishing of the lights by failure of the generating-plant.

Another great advantage to be obtained from the use of storage-batteries is the great increase in the life of the lamps, due to the fact that the current flows with absolute steadiness at all times, thus adding from twenty-five to fifty per cent to their life, and effecting a great saving, for the renewal of lamps is one of the chief items of expense in the maintenance of an installation.

They can, for example, be charged without trouble and danger from an arc as well as incandescent circuit. Thus the electric light may be introduced in many places where a special generating-plant for charging batteries could not be employed, or where its expense would be objectionable. This permits of the introduction of incandescent lighting without too great initial cost of installation, or in the subsequent running expense.

In places where an arc circuit is already installed, the introduction of the incandescent light becomes a comparatively simple and inexpensive matter. The arc dynamo can be used in the day-time to charge the batteries, and at night to supply the arc lamps, while the stored electrical energy is used to supply incandescent lamps.

What one generation looks upon as a luxury the next regards as a necessity. Of the numerous applications of the inventions utilized during the present century for the promotion and extension of the comforts and luxuries of life, there has been, perhaps, nothing more wonderful than the improvements in the methods of obtaining and utilizing light.

As lately as fifty years ago the candle was the chief illuminant in use. This was replaced by the oil-lamp, which was undoubtedly a great step in the way of progress. A little later this luxury made way for gaslight. But progress could not stop here. Having been educated to a proper appreciation of good light, the public, not satisfied with this improvement, demands that gas, in turn, shall make room for some other agent. The electric light has proved itself the only agency for the accomplishment of the difficulty of still further improvement.

Among its manifold advantages are, —

The great superiority and steadiness of the light.

It does not over-heat the atmosphere, nor charge it with poisonous gases, while depriving the air of its life-sustaining element, oxygen.

It also removes all danger to life and health caused by the escape of gas.

Ventilation, a matter of such vital importance to health and life, thus becomes a comparatively simple matter, the difficulties in this direction no longer increasing in inverse ratio to the amount of light used, as with gas.

The safety it offers over every other form of light, removing the ever-present danger of fire, by doing away entirely with the use of the match. By simply touching a button or turning a switch, any designated light or all the lights in a house can be lit from any part of the building. They also admit of a much more advantageous distribution of light.

The cost of insurance where electric light is used is in all cases reduced.

Its freedom from smoke and deleterious gases, which work such incalculable destruction to ceilings, walls, decorations, books, paintings, etc., makes its adoption the greatest possible saving. But, great as has been its success, its introduction into general use has been limited, as it has not been placed within the reach of all. It has been shut out from the very place where good light is most needed and appreciated, "at home," owing entirely to the method of producing it, — that of lighting direct from a dynamo.

The electric lighting of houses distant from a central lighting-station has heretofore, to a certain extent, been an impossibility, owing chiefly to the fact that a steam-plant has been necessary, and that in the production of electric light direct from a dynamo it has been impossible to obtain light except when the dynamo is running.

The operation of a steam-engine necessitates the presence of an experienced engineer, which immediately makes its production so expensive as to be beyond the reach of any but the more wealthy.

The time when light is most required in a private house is between the hours of six and ten or twelve o'clock at night, when it is almost impossible to obtain the services of a competent engineer.

The noises and vibrations attending the operation of a steam-engine have been another drawback to its introduction, for few are willing to have machinery in operation in a private house until after the hour of midnight or during the time when light is required.

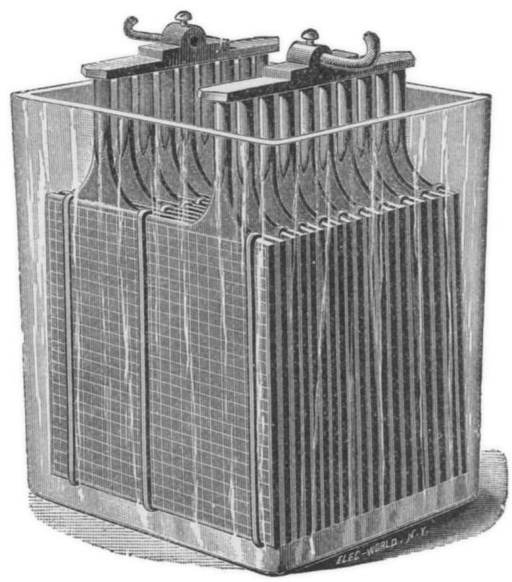
There has been no means of producing electric light with the direct lighting method so that light may be available at all times except by the running of a dynamo continuously, and, unless light can be available at all times, it fails to compete with gas.

The storage-battery, however, seems to overcome all these difficulties, and to solve the problem of incandescent lighting in isolated cases.

In the course of some remarks recently made before an electric-light association by a prominent New York electrical engineer, the importance of storage-batteries in electric lighting was very clearly shown in the following: "I would call the attention of the members, for instance, to the lighting of private residences which are detached, country residences, summer residences, and large mansions. I believe that here the storage-battery has a sphere which it will hold as its own, for the reason that the direct system of lighting of to-day does not afford all the requisites of a perfect application of electricity for lighting. It has not supplanted gas, and you will find that wherever isolated plants are in use to-day they still have gas. Now, I do not consider that we can look upon isolated lighting as a success until we see it drive gas out altogether. To do that, we must have electricity 'on tap' for twenty-four hours a day, the same as gas, and I can conceive of no system by which this can be done successfully except one involving the use of storage-batteries as an accessory, if nothing more."

A storage-battery can be charged with the use of almost any form of power during the hours of the day, and in many instances energy now running to waste may be utilized in laying up a supply for night use.

One of the interesting developments in this connection is the prominence of the gas-engine as a producer of electric light. This power seems to be particularly fitted for work in connection with storage-batteries. The operation of these engines is so simple that they can be cared for and run by the employees of almost any house. The power is always available. The gas in the engine is ignited by a spark from the battery, and, in fact, can be started by simply turning a battery switch, using the dynamo for a moment



THE JULIEN STORAGE-BATTERY.

as a motor to bring the engine up to speed. Thus by the simple operating of a switch the entire plant is set in motion. The battery is charged during the day, and at night, when the engine is shut down, enough energy will have been stored to supply the house with light for the entire night.

The accompanying illustration represents one of the most interesting displays at the American Institute Fair this season, the installation of the Julien Electric Company, showing the application of storage-batteries to the lighting of private residences in connection with a Baldwin gas-engine and a United States dynamo. The plant consisted of a 4-horse-power gas-engine coupled to a 30-light dynamo and 36 cells of Julien battery. There were in the exhibit some 95 16-candle-power lamps, in addition to two $\frac{1}{8}$-horse-power electric motors used for operating a fan and sewing-machine, — another application to family needs. The current from the battery can also be used for pumping water, the running of electric bells, burglar alarms, and other light work. The dynamo charges the battery during the day; and at night, when the full number of lights is turned on, the dynamo takes care of 30 lights, and the remaining 65 are taken from the accumulators. It will thus be seen, that, in addition to serving as a reservoir to be called on when the plant is not in operation, by the running of the dynamo, and at the same time discharging from the battery, a largely increased number of lamps is available, thus reducing very considerably the amount of power necessary to be introduced. It is generally acknowledged that light derived from storage-batteries is of greater steadiness than that produced direct, thus increasing considerably the life of the lamps.

The cell employed was the type 19 C of the Julien Company, weighing complete about 44 pounds, which is rated by that company as having a capacity of 200 ampère-hours, and the rate of discharge given is 30 ampères. It will be seen, however, that, as these lamps take about $\frac{9}{10}$ of an ampère each, the batteries were being discharged at about twice their normal rate, and, where occasion required, the engine was stopped and the batteries supplied current for the entire plant, thus discharging at almost three times their nominal rate.

This is a particularly creditable showing for these batteries. The principal difficulty heretofore in the use of accumulators has been that they have not been permitted to be discharged at a greater rate than from about one-tenth to one-eighth of their capacity, whereas in this exhibit they were regularly required to deliver their full capacity in about four hours.

The cells were in use from the commencement of the exhibition, the 1st of October, until Dec. 15, and did not in that time require the least attention on the part of the company, the plant being run entirely by a man in charge of the gas-engines, who, until the opening of the fair, had never been in charge of an accumulator plant.

The lights were burned four hours each night, which, discharging at the rate of about 60 ampères, and occasionally at 80 to 85, made a total of 250 ampère hours taken out, while the rated capacity (discharging at the nominal rate) is but 200 ampère hours. This is an indication of the large amount of reserve energy there is always on hand in case of an accident or stoppage of the generating-plant, or in case of an emergency.

A BLIZZARD MEETS AN ELECTRIC ROAD.

RECENTLY one of the severest tests to which an electric railroad can be subjected was experienced by the Davenport Electric Line, installed by the Sprague Electric Railway and Motor Company of New York, at Davenport, Io., and one which proves most conclusively that an electric railway can be operated even under the most adverse conditions of weather. The blizzard, which had been howling about the Dakota prairies during the first part of the week, and getting up its strength by snowing in the territory farmers, decided to come south, and on Jan. 9 struck the city of Davenport.

The snow, which was of the heavy damp variety, fell all day, and covered the streets to the depth of from four or five inches to one foot on a level, and in several places caused deep drifts over the line of the electric railway. In spite of this, the cars on the electric line kept running uninterruptedly, carrying a large number of passengers, and proving conclusively that no amount of snow could prevent the cars from running on schedule time. The president of the road, Mr. W. L. Allen, was greatly pleased with the signal triumph of the Sprague people, who had told him in the autumn that snow could not interfere with the operation of the road, and is enthusiastic over electric railways.

This road has been in operation about four months, and has been giving very great satisfaction to the management and citizens of Davenport, who have had a much better service since its installation than they ever had while the road was being operated by horses. The cars move faster, are under quicker and more perfect control, and are much more easily managed than the cars drawn by animal power. The regular Sprague overhead system, with small No. 6 silicon-bronze wire as a working conductor, is in use upon this road. All the latest devices and improvements adopted by the Sprague Company for facilitating the operation and increasing the convenience of their electric roads are in use here.

Among the principal points of excellence of the Sprague system of electric railway, may be mentioned the system of conducting current to the cars by means of a working conductor, separate from the main conductor, but connected to it at intervals by automatic cut-outs, by which an accident on any portion of the line does not interfere with the remainder of the road; the use of flexible suspension for the motors, preventing accident from sudden strain; and the method of controlling the motors from either platform without the use of idle resistance.

TESTING A PNEUMATIC DYNAMITE GUN.

ON Saturday last a test was made of the capabilities of a pneumatic gun of fifteen inches bore, forty feet in length, intended to throw a shell containing 700 pounds of dynamite and nitro-gelatine. Two shots were fired, when, owing to the leakage of an air-valve, the experiments were postponed to some future time. As far as the trial went, the results were satisfactory. A mile from the gun, which was located at Fort Lafayette, in the Narrows, New York Bay, a rectangular space 50 by 100 feet was marked off in the waters of Gravesend Bay by four buoys. The first projectile from the gun passed about 250 yards beyond the target, though it was an excellent line shot. Its course was easily followed by the unaided eye from the moment it left the gun until it entered the water. It passed through the air as though shot from a rifled gun, without an oscillation or a "wabble." It exploded a moment after striking the surface, throwing up the water, like an immense fountain, from 100 to 200 feet into the air. This first projectile contained 170 pounds of dynamite.

The second projectile, containing 200 pounds of dynamite and 300 pounds of nitro-gelatine, a larger charge than had ever been used before, fell short of the mark, but the effects of its explosion were tremendous. A reversed Niagara, of water, mud, and stones, shot perhaps 200 feet into the air. It seemed as though a water-volcano had broken forth in Gravesend Bay.

The reason for this shell not reaching the target appeared to be that there was some defect in the tail-piece, which is depended upon to keep it from oscillating or wabbling in its flight. Some part of this tail-piece was evidently injured in leaving the gun, and the consequence was that the longitudinal axis of the projectile (which was six or seven feet in length) deviated from the line of flight. It swung through an angle of about forty degrees, back and forth, while describing the arc of flight, the oscillation decreasing as the projectile approached the water.

Further tests of the gun are promised in the near future, and they will be watched with interest, as the dynamite gun is destined to take an important place in the warfare of the future.

THE RISLEY AND LAKE COMPOSING-MACHINE.

THERE is now on exhibition at No. 22 Spruce Street, this city, a machine intended to dispense with the use of type in certain kinds of printing. It is the invention of Messrs. Risley and Lake; and though only an experimental machine, and therefore somewhat imperfect in many of its details, it does its work speedily and well. The printing done by it is not as perfect or as pleasing to the eye as ordinary letterpress work, but is good enough to satisfy the requirements of that important branch of the printer's art known as law printing, in which small editions of lawyers' briefs, legal arguments, evidence, etc., are desired in a few hours' time.

This machine, in its present crude but very promising stage of development, is shown in the accompanying illustration. As a satisfactory description of it cannot be given unless the machine be seen in operation, only a few of its features will be touched upon here. Though not so complicated as the engraving makes it appear, still many of the mechanical movements involved are so novel that they must be seen before they can be readily understood.

It will be perceived that there is a key-board like that of an ordinary type-writer, the use of which is obvious. There is a key for each character used. These characters are all cast or cut on one cylindrical shell or sleeve, in which feature the machine resembles the well-known Crandall type-writer. This type-shell may be seen, in the illustration, at the centre of the machine, immediately to the rear of the key-board, and in front of the sheet of paper upon which the printing is to be done. One peculiar feature of this machine is, that the printing does not begin until the keys for about fifty characters have been struck, so that the operator is always at least a line ahead of the impressions as they appear on the paper. The keys, instead of acting directly upon the printing apparatus, act upon a set of pins, which are carried in a revolving disk; each key, when depressed, setting its appropriate pin in position for actuating the printing mechanism when the disk shall have carried it around to the proper point. In this way there are always stored