each end of the car, passing down through the roof, and may be revolved by the motorman by means of a handle through a set of gears. The collectors are of steel tubing and may be easily detached.

The trolley wire insulators were tested under rainy conditions to 20,000 volts and the electrical equipment of the car, including all circuits in apparatus, were tested to 15,000 volts, while the large and small transformers were tested for an hour under a potential of 20,000 volts.

The high tension switches have a double break on the three branches and are of the tube type. The switches are placed in sheet-iron boxes next to the small transformers. To the cover of each box the six insulators are fastened. The switch is closed by the raising of the plate operated by the air-cylinder piston. The compressed air which is used for the operation of the electric switches as well as for the air brakes is obtained from two electrically driven air pumps placed under the car.

The duplex pump operates at 190 revolutions per minute, the two cylinders compressing 400 liters of air to a pressure of 8 atmospheres. Each motor is operated from a small step-down transformer supplying 110-volt current to the motor terminals. Each platform is supplied with the necessary cocks for controlling the air in the rubber tubes and iron pipes beneath the floor of the car, connected with the starting cylinder. Within sight of the motorman are the various air-pressure gages, ammeters and voltmeters.

The large transformers noted in the accompanying diagrams are placed beneath the car, the cores being provided with air pipes for cooling. The windings are heavily insulated with mica, the leads passing through porcelain insulators at the ends, heavy steel plates holding the coils together by several heavy bolts. The leads from the transformers are connected to four high-tension fuses of the mica tube type. The secondary current from the step-down transformers is supplied to the motors after passing three sets of safety fuses and switches. The motor switches have double breaks of 140 millimeters in each phase, six tubes with contacts being placed in a circle, the switch being operated by means of compressed air by an air cylinder in the center of the circle.

Two transformer switches are required, one connecting the secondary for delta and the other for the star winding. In starting the car each of the four motors supplies 750 horse power, or about three times the full speed current (250 horse power), about 20 horse power being cut out at each step. There are 29 steps, 25 of which are used for gradually increasing the speed and 4 for cutting in the motor. The controller cuts in the four motors one at a time by means of two air cylinders, working in opposite directions. The air cylinders are of different diameters and so arranged that the controller may be stopped at any particular contact.

There are three large and three small resistance boxes—one for each phase. The larger boxes each have 25 coils and the small ones 4 coils. The air is supplied from the outside of the car through the numerous openings, keeping the resistances at a proper temperature.

The motor has six poles and is directly connected to the car axle, which has a speed of 900 revolutions per minute, the diameter of the car wheels being a trifle over 4 feet. The rotor of the motor is mounted directly on the axle, and is about 2 feet 6 inches in diameter. The rotor carries the primary pressure of from 1,150 to 1,850 volts, the current being conducted through three collector rings, upon each of which eight carbon brushes press, giving the necessary contact. The slots of the rotor are well insulated with mica, and wooden wedges are used to hold the bar winding in place together with the usual wire bands.

The stator winding is of the ordinary alternating kind, 72 slots being used in the secondary and 96 slots being used in the primary, the motor having a 6-pole winding. The total weight of the car fully equipped is 88 tons, being very close to that previously calculated.

The Current Supplement.

The current SUPPLEMENT, No. 1,362, is begun by an article on Mexico, accompanied by a number of illustrations. "The Bursting of Small Cast-Iron Flywheels" describes some very ingenious experiments which were tried. "The Venom of Serpents and Anti-Venomous Serum" is accompanied by a number of illustrations. "Recent Science" is by Prince Kropotkin.

On January 1 the new Japanese patent law went into effect. Under this an inventor who has applied for a patent in a foreign country will obtain priority as from the same date in the United Kingdom, if, within twelve months, he files an application there. He, however, loses the advantage that may be gained by first applying for provisional protection only, as he must at once file his complete specification.

Patent Department

Profit in Patented Inventions.

A writer in The New York Sun considers a good patent as valuable as a gold mine in its way. Patents and gold mines resemble each other very much in one respect; there are no infallible signs by which one may recognize the bonanzas. No matter what the prospectus may say, the mine must be worked before its value may be known. No matter what the theories of the inventor may be, the world's market, and not himself, must determine the value of his invention.

Some very large fortunes have been made out of apparently trivial inventions. There is much luck in the first place. But skill in handling the patent counts for even more than luck. The little rubber stopper with the wire attached to it, which is used now on every beer bottle, is a good example of fine business management in the handling of an apparently trifling invention.

Often the inventor fails to realize the value of his device. Everyone is familiar with the hook eyelet now commonly used on boots and shoes. The man who invented it could dispose of it only by selling the complete title to his patent to a shoe company. Even the shoe company did not fully appreciate the value of the invention which they had acquired; for the hook and eyelet was regarded as an eccentricity and would require expensive machinery in its manufacture. It is said that the inventor realized $600 for his hook and eyelet; the profits to the manufacturers were some hundreds of thousands per year.

Some inventions, says the writer, drag along for years without getting to a paying stage, and then suddenly make fortunes for their owners when the patent is almost run out. The typewriter is an example of this thing. The men who believed in it had many reasons for giving up all hope of its ultimate success. The man who had the general agency for the whole South in 1877 sold only four machines in a year, three of them in one town, Huntsville, Ala. It was not until the most valuable part of the patents had expired that any one made any money on the typewriter. Bell offered to sell a half interest in his telephone to his next-door neighbor for $1,000, and the neighbor laughed at the absurdity of paying such a price for an interest in a freak scientific toy.

Speaking of Bell's telephone, it is not generally known that he came very near losing all his English patent rights, and would have done so, but for a most remarkable piece of luck. At the time of the telephone's invention Lord Kelvin was in this country, and he took back with him to Scotland one of the crude instruments which Bell had made, intending to exhibit it to his college classes as an American curiosity. At that time the transmitter had a spiral spring on the upper side, and while the model was knocking about among the scientist's baggage in its journey across the ocean this spring somehow got bent upward. When Lord Kelvin came to give the promised exhibition the thing would not work, because the spring was bent up too much. It is almost impossible to believe, but it is nevertheless a fact, that it never occurred to the giant intellect of this great scientist to press that spring down again, and he had to apologize to his audience for the failure of the much advertised experiment. A publication before application for a patent is a bar in England, and when the great trial to settle the validity of the Bell patents came up over there, it was sought to prove this previous publication, and this lecture was a case in point, but it was conclusively proved that there had been no publication in this lecture, because the model would not work. Had Lord Kelvin pressed down that little spring and shown those Scotch laddies how the telephone worked it would have cost the Bell company many millions of dollars and made telephones very cheap in England.

Most successful inventors are men who have been brought up in connection with the business to which their inventions are to be applied, or have at least made themselves familiar with the laws governing the processes which they seek to improve. There are cases in which inventors have discovered new laws or new applications of old ones, especially in chemical processes. The Bessemer converter is a familiar example. The cyanide process of washing gold and the manufacture of acetylene gas are others. Some inventors have had courage enough to dispute the established facts of science, as in the case of some recent experiments in fog signaling, in which the inventor used the principle denied by such eminent authorities as Tyndall and Prof. Henry.

It is well known that there is very little money in surface washing or placer mining for gold, and that all the big profits are made out of long and patient development of deep mines. The same is true of patents. There is very little profit in inventions which can be realized upon almost immediately. They are mere surface washings. All the big things have taken time and patience to bring to perfection, and any inventor who finds himself making quick profits may be sure they will be short-lived, although he may have a good thing while it lasts, like the pigs-in-clover puzzle. Confidence, tenacity of purpose, and capital are the requisites for building up big fortunes on the foundation of a patent; the thing itself must have intrinsic merit to begin with or it must fail before long.

The simplest inventions are the best money-makers, because to perfect complicated machines costs time and money. A great many have ended with the original conception, the inventor having no ability to handle detail so as to carry out the original idea in a practical way. The Bessemer process of converting steel is extremely simple, blowing hot air through the molten metal. Just sit down and get out the drawings for a machine which will carry out this idea, especially the arrangements for controlling the supply of air that is admitted to the converter, and see how soon you will find that the first idea is a small part of the invention as a whole. The use of compressed air as a motive power was understood and appreciated thirty years ago, but no one could invent a governor which would control it, although hundreds of patents were taken out which professed to do so. The power of the steam from a kettle was evident to Watt long before he could devise a means of utilizing it. The combination of the piston and the slide valve, which looks so simple to us now, was not worked out in a day.

It is a common practice to speak contemptuously of inventors on account of their exaggerated notions of the value of their ideas. When the invention is obviously a delusion this is quite natural, but it must not be forgotten that without this infatuation for the creatures of their brains inventors would be much more easily discouraged than they are, and many of the most valuable inventions might be lost. The tenacity with which some of them cling to their ideas until they finally force their adoption upon the world almost amounts to inspiration. It seems born in some men to fight harder for the children of their brains than for their families, and it seems a pity that their reward is not often greater than it is.

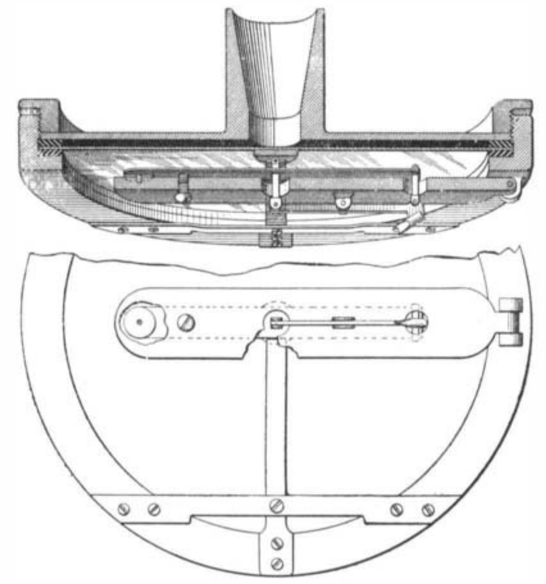
Novel Uses of Electricity.

An electrical steam boiler is the subject of an invention patented by Charles E. Griffing, Hamilton, Ohio. The boiler shell is wound with copper wire which is suitably covered with an insulator. The water-heads are secured at each end of the boiler and are connected by pipes running the full length of the boiler and provided with a series of minute perforations directed to the interior face of the boiler-shell. Additional water-heads at each end of the boiler are secured immediately within the previously mentioned water-heads, and are connected by perforated pipes. These additional water-heads are divided into three separate compartments. A series of alternately arranged heating pipes is introduced between the water-heads to connect the water-pipes or tubes. These heating pipes are provided with electrical conductors, suitably insulated from each other and from the pipe in which they are inserted. The conductors in the several heating pipes are connected in series and arranged to be disconnected separately for purposes of repair. The insulation employed, although a non-conductor of electricity, is an ample conductor of heat. The first-named water-heads are connected with the source of supply, whereby the desired amount of steam can be generated.

Mr. Elihu Thomson, who is well known for his numerous inventions, has devised an apparatus for uniting the edges of metal sheets, which apparatus is applicable to the joining of separate sheets or plates of metal, or to the joining of two opposite edges of a single strip or sheet formed or shaped so that its two edges will approximate. The invention is particularly useful for the protection of pipes by forming or rolling up a strip or skelp into a cylindrical form, and in making a joint between the longitudinal approximated edges. The invention is carried out by approximating the edges to be joined, preferably upturning them so that they are in contact or nearly in contact. A strip of metal or wire, which is adapted to be joined by welding to the pieces to be united, is laid along the line of the joint. An electric current is passed transversely through the wire or strip into the joint and through the edges against which the wire is laid, the volume being sufficient to bring the wire and edges to the welding temperature. Pressure is then applied to cause the edges of the wire or strip to weld or unite in order to form one piece, thus completing the joint. In forming a pipe, a strip or piece of sheet metal is rolled up into the form of a hollow cylinder with the edges meeting to produce a seam. Into this seam or joint is laid a wire or thin strip of the same metal or other allied material, and under the pressure of current-conveying contact-rolls, the wire is flattened and pressed into this joint. The union takes place under pressure and electric heating. It is said that the parts are so homogeneously welded together that the pipe is practically one piece.

INTERESTING NEW INVENTIONS.

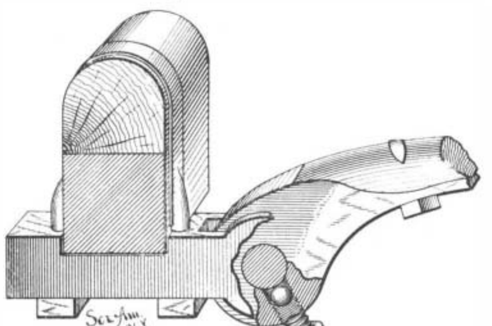
EDISON'S NEW PHONOGRAPH.—Phonograph diaphragms are usually placed under strain by the compensating weight employed to cause the stylus to press upon the wax and at the same time to accommodate any eccentricities in the blank. These strains destroy much of the sensitiveness of the diaphragm. Mr. Edison therefore employs a counteracting spring co-operating with



EDISON PHONOGRAPH-RECORDER.

the diaphragm. This spring counteracts the normal strains to which the diaphragm may be subjected, and which may be due either to the employment of the usual compensating weight or to the direct engagement of the recording device with the record. Our illustrations represent a partial sectional view through a phonograph recorder employing a compensating weight, and a bottom view of the improved recorder. The spring is connected at one end with the weight and at the other end by a link with the working end of the lever-carrying stylus.

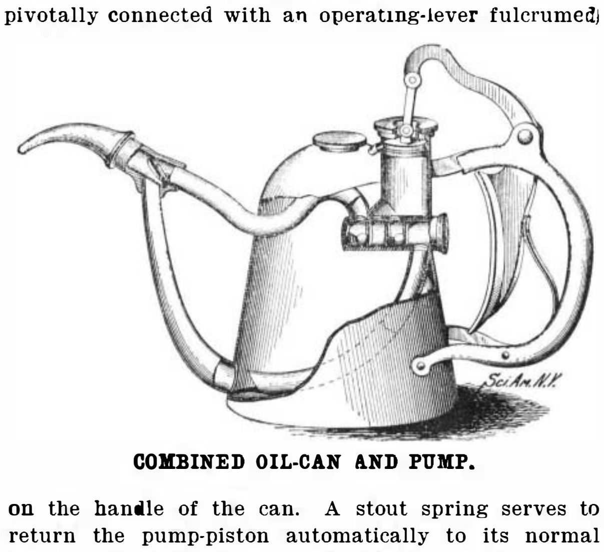
THILL-COUPLING.—A ball-bearing thill-coupling of an improved form has been patented by Seth Bartholomew, of Sturgis, Mich. The thill-iron has a threaded aperture in which a steel ball fits. A screw-threaded



BALL-BEARING THILL-IRON.

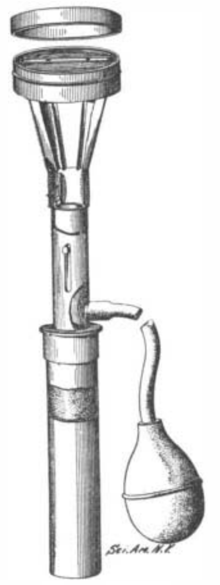
bolt has its inner end concave to fit the ball. By screwing up the bolt from time to time, the ball is pressed in, thus preventing rattling and providing a smooth, movable pressure conducive to the uniform wear of the parts in contact.

PUMP OIL-CAN.—A can from which oil can be either poured in the usual manner or driven out has been devised for the use of engineers. Time is saved and spilling and wasting of the oil is prevented. The can is provided with a pump, the piston-rod of which is pivotally connected with an operating-lever fulcrumed



COMBINED OIL-CAN AND PUMP.

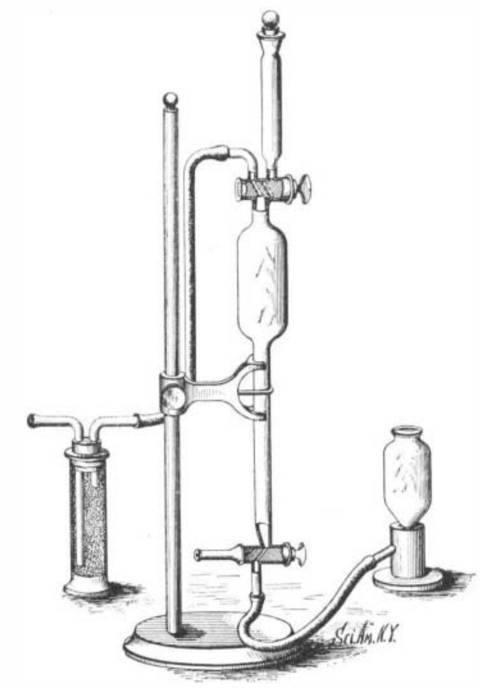
on the handle of the can. A stout spring serves to return the pump-piston automatically to its normal position after operation. The pump-cylinder is connected with a valve-casing comprising valve-chambers arranged to be closed by spring-pressed valves. A pipe leads into the oil from the one valve-chamber, and a second pipe leads to the spout. By actuating the operating-lever the pump-piston on the up-stroke will draw oil into the chamber, press back the first valve, and permit the oil to flow into the pump-cylinder. The next down-stroke of the piston will force the oil past the second valve and down through the spout. A spout-pipe of the usual pattern is also provided to permit the oil to be poured out of the can.



A NEW FLASH-LAMP.

FLASH LAMP.—In a flash-light of recent invention, the flash powder is held in a reservoir from which charges are successively drawn and blown into the lamp frame. The lamp is, furthermore, provided with separate burners that can be interchangeably connected with the reservoir to vary the width of the flame produced. The first of these ends is attained by means of a receiver into which the powder is introduced from the main reservoir by inverting the lamp. To prevent the powder from running out at the opposite end of the receiver a hinged cover is provided which can be operated by means of an arm. By employing an extension of flattened tubular form to be fitted over the outlet tube a longer flow of powder and corresponding increase in duration of the flame are obtained.

GAS-ANALYZING APPARATUS.—An exceedingly rapid, as well as a direct method of quantitatively analyzing gas is the invention of C. C. Tutweiler, of Philadelphia, Pa. His titration apparatus comprises a graduated burette



STREET GAS ANALYZER

provided with three-way valves located at the top and at the bottom. By means of the top valve the burette can be placed in communication with a tar arrester; by means of the bottom valve the burette can be placed in communication with a mercury-leveling bulb. A stoppered graduated vessel is arranged to drop iodine or other liquid into the burette. By properly manipulating the valves and the mercury bulb, it is possible to obtain in the burette a definite volume of gas measured at atmospheric pressure and under a negative pressure. Small quantities of a standard iodine solution are dropped into the burette in measured quantities. The quantities so introduced are proportional to the sulphureted hydrogen in the burette, or in other words, in a measured volume of gas which it contains.

How the Welsbach Light Was Discovered.

While engaged in the spectroscopic examination of the light emitted by incandescent erbia and other rare earths Auer von Welsbach found that a small fragment of the earths held on platinum wire did not give sufficiently bright spectra. In order to increase the available illuminating surface he adopted the plan of impregnating pieces of cotton fabric with the salts of the earth. When the cotton was subsequently burnt out the residual oxides were found to be sufficiently coherent for his purpose. Lanthanum oxide treated in this way glowed so brilliantly as to suggest the possibility of applying it to practical illuminating purposes. Thus the idea of the "incandescent mantle" originated. But a mantle of lanthanum oxide was found to disintegrate when exposed, owing to the absorption of moisture and carbon dioxide. This fact led to the use of other oxides, notably zirconia and thoria, in admixture with the lanthana for the purpose of imparting stability to the mantle. Auer thought that such oxides must be so intimately mixed as to form a "molecular mixture." Haitinger, who assisted Auer, then discovered the value of small proportions of ceria in improving the illuminating power of the mantles.

So far the development of the invention had been commercially unsuccessful; the fortunes of the companies concerned were at a very low ebb. Auer again turned his attention to the use of thoria, then a very rare and costly substance. After fifty or sixty hours the light, although originally improved, fell off until it was no better than that of mantles made without it. Then began investigation into the nature of thoria. Crystallization methods were devised whereby it could be prepared in a pure state quickly and in considerable quantities. Then the astonishing discovery was made that the purer these thoria were the lower was the illuminating power of the mantles, until finally a point was reached at which the mantles had very little illuminating power at all. A keen hunt for the light-exciting substance finally led to the discovery that ceria, which persistently clings to thoria and can be removed therefrom only with the greatest difficulty, was the true light agent. Cerium solution was now added gradually to a purified thorium solution, and at last the well-known thoria-ceria mixture, giving the brilliant results of the present day, was invented.

New Magnetic Ore-Separators.

The idea of separating iron ore from the crushed rock in which it is contained was first prominently brought to the public attention by Thomas A. Edison. Since his very elaborate experiments, other inventors have entered the field. A Philadelphia inventor, Marcus Ruthenburg, comes to the fore with a new magnetic separator for ore. In the machines hitherto constructed, much of the magnetic force is expended in bodily uplifting the particles of magnetizable material from the gangue and sustaining the weight of the particles during their progress through the machine without other support than the stress of the magnetic field. Mr. Ruthenburg has devised a magnetic separator wherein the magnetizable portion of the material treated is supported during the process of its extraction from the gangue by means independent of the magnetic field. As a result of this contrivance, an economy of magnetic force by no means inconsiderable is said to result.

Another Philadelphia inventor, Robert McKnight, has devised an improvement in magnetic separators in which the ore flows down an incline of considerable extent over a belt passing in front of a number of stationary magnets. It has been found that in such machines the particles of ore that cling to the belt and are carried upward by it, move through varying fields of force. If the belt be composed of a sheet of magnetic material, or if it contains large sections of the magnetic material, changes of polarity in this material will disturb the attraction of the magnetic particles to the belt and tend to dislodge them from it. Moreover, if the belt be metallic, the difficulty of moving it in front of the magnet is considerable. By causing the belt or apron on which the ore flows and on which the magnetic particles are collected to move together, Mr. Knight believes that he obviates these objections.

Phonographic Improvements.

Among the patents recently granted in the United States are two which relate to novel methods of producing and reproducing sound records, the inventors of which, Emile Berliner and Gianni Bettini, are both well known for their many experiments in the reproduction of sound.

Berliner's invention is concerned with a new method of producing gramophonic records. The invention consists in the method of forming a preliminary groove in a gramophone disk and then superposing the sound record upon this groove. It is claimed that any person can make a sound record by means of this grooved tablet without the use of other machinery than that which he is already supposed to possess. The ordinary gramophone is only a reproducing machine; but by means of this invention it can be converted into a recording machine.

Bettini's invention is concerned with a very ingenious method and apparatus for duplicating or multiplying master records. An ordinary microphone-transmitter provided with a stylus is designed to follow the sound-record line of the master-cylinder. This transmitter is in circuit with a source of electricity. The fluctuations of the current caused by the vibrations of the diaphragm of the transmitter are utilized to effect corresponding movements in the parts carrying the reproducing styli in contact with the cylinders upon which the record of a master-cylinder is to be duplicated. In other words, Bettini reproduces his master-record telephonically.