

SIXTY-SEVENTH YEAR

# SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CIV.]  
NUMBER 2

NEW YORK, JANUARY 14, 1911

[10 CENTS A COPY  
\$3.00 A YEAR



Copyright 1911 by Munn & Co., Inc.

THOMAS A. EDISON AND HIS IMPROVED STORAGE BATTERY

See page 30

# Thomas A. Edison's Latest Invention

## A Storage Battery Designed and Constructed from the Automobile User's Point of View

By Joseph B. Baker, E.E.

For over a decade, Thomas A. Edison has been working to produce a type of storage battery better than the old lead type. At last he has succeeded. His new cells are now in actual commercial use. In the following article the reader will find a description of the new battery, written after a painstaking study of its manufacture.



LD; indeed, is the idea of the commercial storage battery. Lead plates were immersed in an acid electrolyte, by Gaston Planté in 1861. Emile Faure brought out the pasted-plate battery in 1879, and Charles F. Brush in 1881 introduced improvements which made

the lead battery a factor in electric vehicle work, producing a cell which would give eight watts of electric power per pound of material. From these early beginnings, many inventors have sought to increase the electrical efficiency, and the durability or "life" of the cell, and reduce the cost of manufacture.

It was in the early eighties that the public began to think about "stored electricity" which could be bought by the can, as it were, like any other commodity. This dream has come true in the new Edison nickel-iron storage cell. Stored electricity finds its greatest usefulness in propelling cars and road vehicles, and it has been for this application, primarily, that the Edison storage battery has been developed. The need of the electric vehicle was recognized by Mr. Edison nine years ago. He saw that there are two viewpoints: that of the electrical man with his instruments, his rules for efficient operation and reasonable life of the battery, his absolute knowledge that the same care should be given a vehicle battery that is given a valued horse or even a railroad locomotive; and that of the automobile driver, who simply wishes to go somewhere with his car, and who, when he arrives somewhere, wishes to go back. And in this long-promised battery the highly practical nature of Mr. Edison's work is once more exemplified in that he has held uncompromisingly to the automobilist's point of view. The fact to be

faceted, he realized, is that the electric vehicle user will work his car to the utmost, and will be limited only by repairs and breakdowns; just as the average gasoline car driver has always operated his car to the limit of repairs and breakdowns. How well he has succeeded in aligning his battery to this ideal, the automobile driver will appreciate from the figures of actual performance that are now available. A recent average of 144.35 miles on a single charge was made in a family-type electric vehicle equipped with the new battery. This figure is the average of four trips, each with New York city (Manhattan) as the starting point. The longest of these trips, 172.1

miles, was to Babylon, Long Island, by way of Mineola and Plainview, returning by the southerly route through Massapequa and Freeport. The map distance by this route is 90.9 miles, and 81.2 miles additional was covered after the regular run, the average speed being 10.93 miles per hour.

The original Edison storage battery, known as the type E, was put out about seven years ago. The type E cell marked a definite step in invention, in that it proved the commercial success of a wholly new voltaic combination, a radical departure from the lead plates in an acid electrolyte. Believing that the lead cell had too many inherent weaknesses to realize the

full promise of "stored electricity" as a motive power for vehicles, Mr. Edison had set his staff to work on an entirely new line, and the outcome was a nickel-iron element immersed in an alkaline electrolyte, lighter and cleaner than the lead cell, with lower cost of operation and upkeep to offset its higher initial cost, and possessing hitherto unheard-of properties of remaining undeteriorated either by overcharging or being left uncharged. These were the very qualities demanded by the automobile user. The cell developed certain weaknesses in service, which caused the inventor to withdraw it from the market and resume experi-

ments to improve the form of the voltaic combination, in order to obtain better electrical properties and a longer life. The new series of experiments lasted four years, and resulted in the present commercial Edison cell, known as the type A. This cell is now being actively marketed for electric vehicle work in three sizes, the A-4, A-6, and A-8 cells, having respectively 4, 6, and 8 positive plates and 5, 7, and 9 negative plates, the two outside plates of the element being negatives. The normal discharge voltage is 1.2, and a battery is regarded as completely discharged when it shows an average of 1.0 volt per cell. In each size the dimensions of the individual

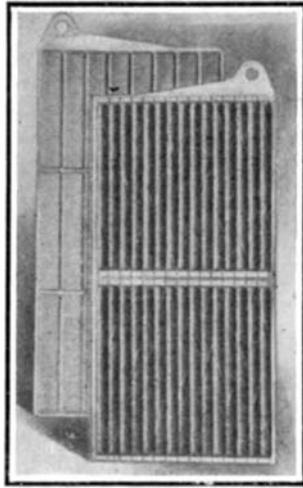
(Continued on page 45.)



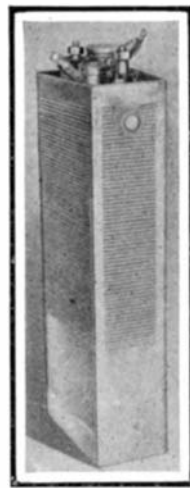
A storage battery omnibus. Mr. Edison is in the front seat.



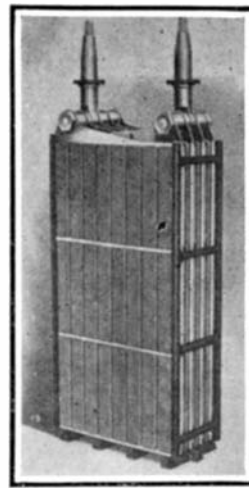
Interior of type 4-A Edison cell and cover of can with terminal stuffing box, gas valve, and filling aperture.



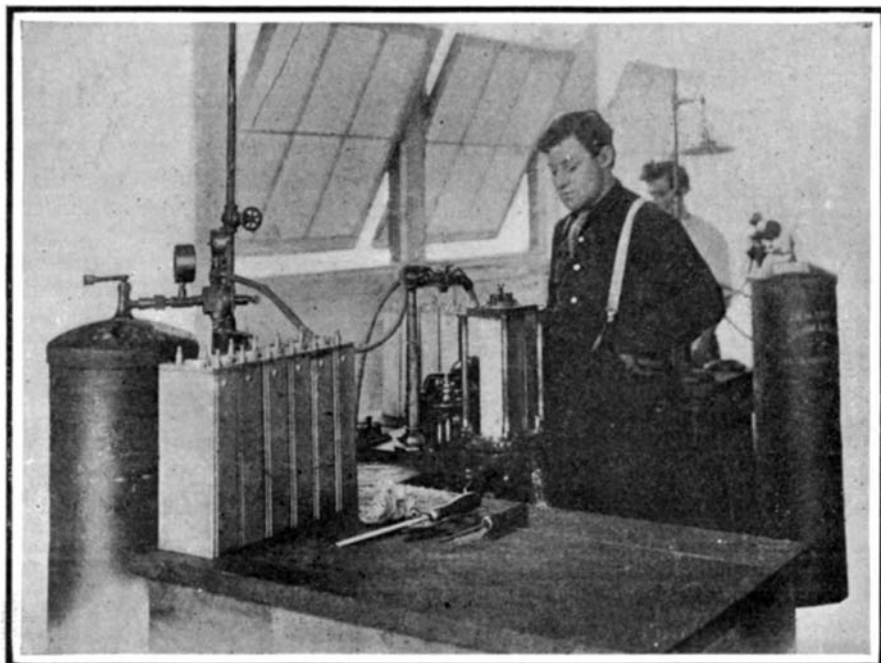
Positive plate at the right with nickel-hydrate active material in perforated tubes. Negative plate at the left with iron oxide active material in perforated flat pockets.



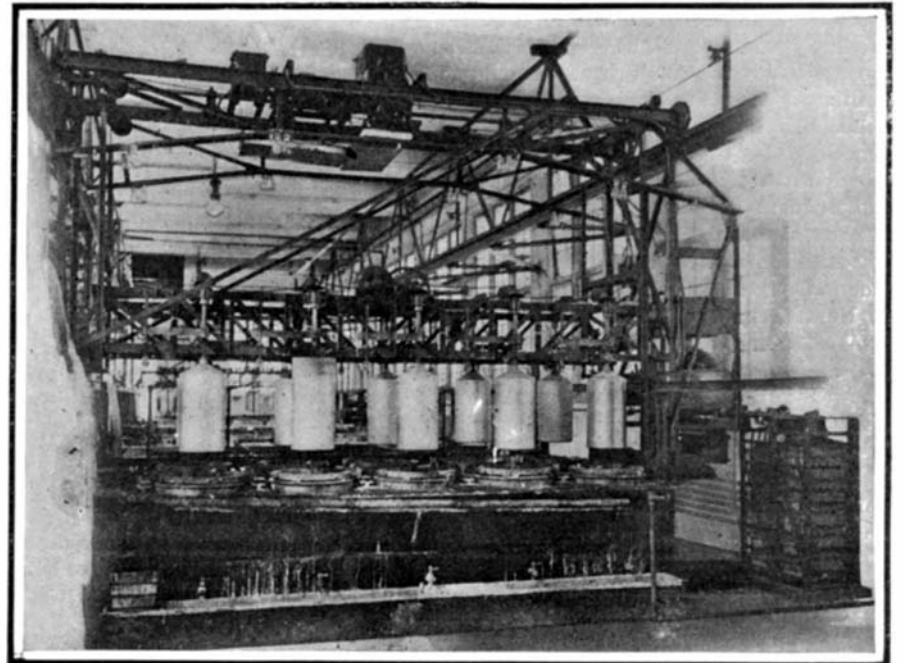
Element removed from can of Edison type A-4 cell. This cell is not in actual automobile use.



Complete 4-plate element of Edison electric vehicle cell removed from its containing can to show the structure.



Welding the steel cans for the cell.



Machine for electro-deposition of nickel for use in positive plates.

(Continued from page 30.)

plates, therefore, the height and breadth of the containing jar or "can" are always the same, and the only variation occurs in the width of the container, which must be increased or decreased according to the number of plates in the element. It will be sufficient, therefore, to describe the A-4 cell. There are also manufactured two cells with smaller plates, for ignition and other light work, the B-2 and B-4 cells, rated at 40 and 80 ampere-hours respectively.

The table below gives the dimensions and the output of the three sizes of vehicle cells:

	A-4.	A-6.	A-8.
Outside measurement of can, inches.....	$2\frac{1}{8} \times 5\frac{1}{8} \times 12\frac{3}{8}$	$3\frac{1}{4} \times 5\frac{1}{8} \times 12\frac{3}{8}$	$4\frac{1}{4} \times 5\frac{1}{8} \times 12\frac{3}{8}$
Height to top of pole, inches.....	13 $\frac{3}{8}$	13 $\frac{3}{8}$	13 $\frac{3}{8}$
Weight of complete single cell, pounds.....	13.34	19.00	25.00
Pounds per cell of a Standard assembled battery.....	14.21	20.09	26.15
Normal discharge rate, amperes.....	30	45	60
Average voltage at normal rate.....	1.2	1.2	1.2
Rated ampere-hour output.....	150	225	300
Rated watt-hour output.....	180	270	360

In accordance with the low weight of the cell, obtained by the special voltaic combination described, a very light but strong wood battery trap is employed, of skeleton construction and with bent-wood instead of dovetailed corners. An assembled vehicle battery is claimed to weigh not much more than half as much as a lead battery of the same output—a 64-cell battery for a one-ton truck weighing 900 pounds, as compared with 1,550 pounds in a 44-cell lead battery of the same capacity.

The A-4 Edison cell consists of the following parts: The can, a sheet steel receptacle containing the element and electrolyte, and having a top fitted with stuffing boxes for the positive and negative terminal posts, and with a gas valve and filling aperture; the element, consisting of a group of positive plates containing the nickel active material and connected in multiple with the positive terminal by a nickel-plated steel bolt and nuts, the group being intermeshed with a group of negative plates containing the iron active material and similarly connected in multiple and with the negative terminal; and the electrolyte, consisting of a 21 per cent solution of pure potassium hydrate (caustic potash) in distilled water.

The metal of the cell is all nickel-plated iron, so that a pure nickel surface is everywhere presented, protecting the metal from rust or corrosion. The only other visible material is the hard rubber of the stuffing boxes and the soft-rubber top of the filling aperture. The can is of sheet steel, with corrugated walls to give the greatest stiffness with minimum weight. The seams are welded by the autogenous method, insuring safety from leakage that might otherwise develop from the severe mechanical vibration and shocks which a vehicle battery receives. The can is embossed in places to receive hard-rubber buttons, to maintain a slight separation or air-gap between adjacent cans, and to anchor the can to its proper place on the wood battery tray containing the set of cells.

To the automobile owner the vehicle battery certainly looks good. A compact set of metal cans, with no chance of slopping or breaking. The battery has more the appearance of road service, and smacks less of the electrical laboratory, and this highly mechanical look is justified by the internal construction of the element as a working electrochemical machine. The positive plates, containing the positive or nickel-hydrate active material, consist of a grid of nickel-plated steel, holding 30 little tubes packed with the active material. The grid is a double rectangle in shape, with a center rib, and supports the tubes in two rows of fifteen each, set closely together. The

tubes are of very thin sheet steel, perforated with small holes, and packed or "loaded" (very tightly by special machines) with nickel hydrate, interspersed with pure nickel in the form of flakes of extreme thinness. The tubes are formed with a double-lapped spiral seam, and are reinforced by rings or ferrules which maintain internal contact between the nickel hydrate and flake nickel and the internal walls of the tube by preventing bulging of the tube by expansion of its contents. This construction is one of the radical improvements over the old Edison cell. The problem was to bring every part of the hydrate in the plate into active service by insuring permanent electrical contact with its connecting grid, and this result is attained by the thin disks of nickel stacked in the tube in alternation with the layers of hydrate, forming the tube into a mass of intimate physical and electrical contacts between hydrate and nickel and between the edges of the nickel disks and perforated wall of the tube; at the same time permitting intimate contact with the electrolyte in which the tube is immersed, and which seeps in through the perforations. Each of the  $\frac{1}{8}$ -inch tubes in the grid contains about 350 of the tiny nickel disks and their alternating layers of hydrate, so that the maximum distance through which the current has to penetrate, in the charge and discharge of the cell, is only one-half the thickness of the exceedingly thin layer of hydrate.

The thin nickel flake is formed by an ingenious machine which deposits alternate electro-platings of copper and nickel, the copper being dissolved out subsequently. So delicate are the nickel disks cut from this electro-plated sheet that a handful of them is as light as so much feathers.

The negative or iron-oxide plates, of the same length and width as the positive plates, consist of a grid of three rows of eight flat, rectangular pockets, each perforated like the tubes of the positive plate with fine holes to permit contact of the electrolyte with the active material. The latter consists of an iron oxide very similar to ordinary "iron rust," subjected to heavy pressure in the containing pockets, so that each mass of active material is practically integral with the grid.

The plates of each group, positive and negative, are hung on their horizontal connecting rods, with spacing bushings between the lugs of the plates and a nut at each end of the rod. Rising from the middle of the rod is the vertical terminal post, having a taper top for making good electrical contact with the adjoining cell or with the external circuit.

The outer surfaces of the two end plates of the element are securely insulated from the walls of the can by sheets of perforated hard rubber. Rods and cross-pieces of the same material serve respectively to separate adjacent plates of the element and to support the element as a whole above the bottom of the can. It is noteworthy that the element does not have to be supported at a considerable distance above the bottom of the cell, as in the lead storage cell, to prevent short circuiting of the plates by the falling of the active material to the bottom of the jar. In the Edison cell there is little or no loss of active material.

The remaining part of the cell, the top or cover of the can, is welded in place by the autogenous method after the element is assembled in the can. The terminal-post stuffing boxes, the gas valve which separates entrained electrolyte from the spraying of the gas in charging, and prevents it from escaping, and the filling aperture with its automatic spring cap, are water-tight, so as to prevent the leakage of electrolyte in service. The gas valve, by preventing loss of electrolyte during charge, eliminates fuming of the cells, minimizes the amount of filling up for evaporation and renders it unnecessary to add anything but distilled

# Re-sales tell the story of superiority of The New Edison Storage Battery

Whether you are a user or a prospective user of electric vehicles, either pleasure or commercial, read through this chain of evidence:

**The Adams Express Company**, seven years ago replaced lead battery equipment in four of their delivery trucks, with Edison equipment. Since that time they have purchased over 150 cars, all equipped with Edison Batteries.

**Tiffany & Company** replaced lead batteries with Edison Batteries in three of their delivery wagons, seven years ago. They have since bought eighteen more cars, all Edison equipped. The Batteries operating these cars have all been in service over a period of from four to seven years.

**Hearn & Son**, after operating fifteen cars equipped with Edison Battery for three years, discarded lead battery equipment in twelve cars and installed Edison Batteries, making a total of twenty-seven Edison equipped cars.

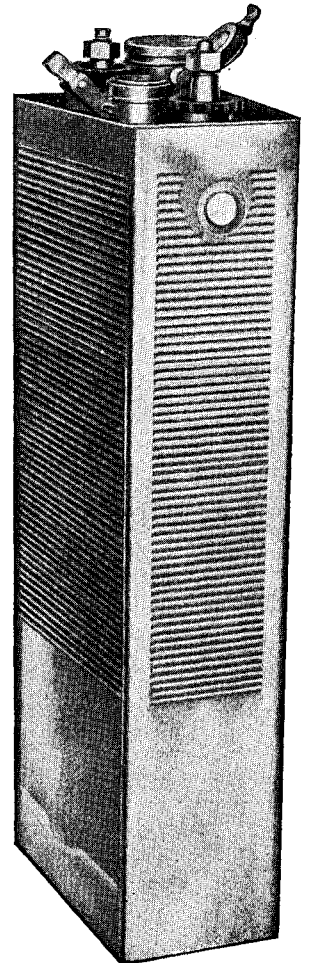
**Frederick Loeser & Company**, of Brooklyn, after operating an Edison Battery for one year in one of their vehicles that was made for lead battery equipment, replaced lead batteries with Edison Batteries in six more cars.

**The United States Express Company** have been operating twenty-five vehicles with Edison Battery for several years.

**Abraham & Straus**, when they decided to put in motor vehicle equipment, purchased twelve vehicles equipped with the Edison Battery

**A. A. Vantine & Son** have been operating thirteen Edison equipped vehicles over a period of four and a half years.

**R. H. Macy & Company** have been operating seventeen Edison Battery equipped cars for the past three and a half years.



Four of the foremost electric pleasure vehicles are now regularly equipped with the Edison Storage Battery—Detroit, Bailey, Baker, and Waverly.

THESE vehicles are today giving more than double the mileage of electric pleasure vehicles with lead batteries—an average well over a hundred miles on a charge, while the lead battery in most instances will not give an average better than fifty miles on a charge.

The weight of the Edison is only about half, per capacity, that of the lead battery. The Edison is not subject to any of the ills of the lead battery—it is not injured by overcharging, by too rapid discharge, by complete discharge nor by standing idle for any length of time either charged or discharged. The Edison is built to withstand the most intense vibration and rough usage. It requires less care and attention than any other battery and its life is many times that of the lead battery.

Write us today regarding the New Edison Storage Battery for electric motor vehicle propulsion, gasoline car or motor boat ignition, incandescent lighting of your motor car, yacht or motor boat—or for any other battery requirements.



TRADE MARK  
Thomas A. Edison

**EDISON STORAGE BATTERY COMPANY**  
132 LAKESIDE AVENUE :: ORANGE, N. J.

**"Star" Lathes** Foot and Power Screw Cutting Automatic Cross Feed  
**FOR FINE, ACCURATE WORK**  
 Send for Catalogue B.  
**SENECA FALLS MFG. CO.**  
 695 Water Street,  
 Seneca Falls, N. Y., U. S. A.

**THE SEBASTIAN 15-INCH ENGINE LATHE**  
**HIGH GRADE LOW PRICE**  
 Automobile Builders, Garages, Repair and General Jobbing Shops find this the ideal lathe for their work. Catalog free.  
**The Sebastian Lathe Co., 120 Culvert St., Cincinnati, Ohio**

**FOR GUNSMITHS, TOOL MAKERS, EXPERIMENTAL & REPAIR WORK, ETC.**  
 From 9-in. to 13-in. swing. Arranged for Steam or Foot Power, Velocipede or Stand-up treadle.  
 Send for Lathe Catalog.  
**W. F. & JNO. BARNES CO.**  
 Established 1872.  
 1999 Ruby St., Rockford, Ill.,

**Our New Non-Inflammable will polish if metal is wet. Will not settle. It's quick.**  
 Write for Free Sample  
 Manufactured by  
**THE HARVEY CHEMICAL CO.**  
 LA FAYETTE, IND.

**AERONAUTICS**  
 250 West Fifty-fourth St.  
 NEW YORK  
 The Oldest, Best, Biggest aero magazine in America.  
 Accepted as the authority. Scale drawings of machine, construction details, subscribers' forum. The Bible of the aero enthusiast, experimenter, builder, aviator and advertiser. Don't take in the side shows and miss the main show in the big tent. Yearly subscription, \$3.00.  
 Send for our Special Offer!

**Automobile Running Gears**  
 WITH PRESSED STEEL OR ANGLE IRON FRAMES  
 Also all styles of bodies.  
 Write for catalogue at once, mentioning this paper.  
**BORBEIN AUTO CO., 2109 North Ninth St., St. Louis, Mo.**

**GRAY MOTORS**  
**6 HORSE POWER COMPLETE \$94**  
 Absolutely Guaranteed by a RESPECTABLE CONCERN.  
 Write for complete catalog today—tells all about how these high grade motors are built in the largest plant in the world devoted exclusively to the manufacture of 2-cycle motors.  
**GRAY MOTOR CO., 11 LEIB ST., DETROIT, MICH.**

Equip Your Car With the  
**"Webster" Safety Starting Handle,**  
 positive in its action, absolutely prevents injury from back-kicks, adopted as part of regular equipment for "Alco" cars. Ball-bearing, safety starting handles for all makes of cars.  
 Manufactured by the  
**The Keystone Safety Starting Handle Co.,**  
 411 Walnut Street, Philadelphia, Pa.

**DO YOU HAVE KNIVES TO GRIND, SILVER TO POLISH, SMALL TOOLS TO OPERATE, WASHING MACHINES OR WRINGERS TO RUN? LET THE RED DEVIL**  
**Water Motor Do Your Work**  
 Attached to any water faucet will develop up to 3 H. P. according to size of pipe and water pressure. Only perfect small motor made. Improved bucket wheel construction. 6 in. Motor for Mechanics and Tradesmen. Washing Machine, 1/2 H. P. on 1/2 in. pipe, 80 lbs. water pressure; 1 H. P. on 3/4 in. pipe, 2 in. pipe. Net price \$5, cash with order. No. 1492—4 in. Motor for grinding, polishing, fans, sewing machines; for Doctors, Dentists, Druggists, etc., with emery, buffing wheel, silver polish and pulley, \$3. No. 1438—4 in. Motor and pulley only \$2.50, cash with order. Money back for any reason. Order your motor from dealer or from us. Send your water pressure and size of supply pipe. Active Agents wanted. Catalog free.  
**DIVINE WATER MOTOR CO.**  
 DEPT 12, UTICA, N. Y.

**LUFKIN TAPES AND RULES**  
 ARE THE BEST.  
 For sale everywhere. Send for Catalog No. 16.  
**LUFKIN RULE CO.**  
 Saginaw, Mich., U. S. A.  
 New York and London.

**GOES LIKE SIXTY SELLS LIKE SIXTY \$60**  
**GILSON GASOLINE ENGINE**  
 For Pumping, Cream Separators, Churns, Wash Machines, etc. **FREE TRIAL**. Ask for catalog—all sizes.  
**GILSON MFG. CO., 308 Park St., Port Washington, Wis.**

**BABBITT METALS.—SIX IMPORTANT formulas. SCIENTIFIC AMERICAN SUPPLEMENT 1123.** Price 10 cents. For sale by Munn & Co., Inc., and all newsdealers. Send for catalogue.

**Civil Engineering and Surveying Instruments**  
**DRAWING MATERIALS AND SUPPLIES**  
 BLUE PRINT PAPER, TRACING CLOTH, ETC.  
 "FREE" Write for Catalogue. Sent "FREE"  
**A. S. ALOE CO., 507 Olive Street, St. Louis, Mo.**

**Every User of Blue Prints**  
 Should Investigate the New "EXPRESS" System of Blue Printing  
 Automatic, saves half the cost. One boy does the work of four men. It makes Blue Prints, Back Prints and Brown Prints. Works day or night—makes prints any length. For users of Blue Print Paper we supply coating machines for making blue print paper or linen. *The Express System Saves Money. Let us explain.*  
**WILLIAMS, BROWN & EARLE, Inc., Dept. 6, 918 Chestnut St., Philadelphia, Pa.**

**5 Years' Absolute Guaranty**  
 On this Wonderful **Detroit Marine Engine**  
**YOU ARE THE ONLY JUDGE** of the engine and its merits. 25,000 satisfied users. Material and workmanship guaranteed for five years.  
**Greatest Engine Bargain Ever Offered!** Starts without cranking. Reversible while in motion. Perfectly counterbalanced. No vibration.  
**30 Days' Trial** Try the engine for 30 days. If you are not fully satisfied, return it and we will promptly refund all money paid us. Demonstrator Agents wanted in every boating community. Special wholesale price on first outfit sold. Single cylinder, 2.8 h. p. Double cylinder, 8.20 h. p. 4 cylinder, 20.50 h. p. Thoroughly tested before shipment. Comes to you complete with boat fittings and ready to run. Write for free catalog, testimonials and details of the greatest protective guaranty ever offered. Suitable for any boat from canoe to cruiser. Also railroad track car. All sizes in stock. Write today for our wonderful demonstrator offer. (59)  
**DETROIT ENGINE WORKS**  
 1322 Jefferson Ave., Detroit, Mich.

**THE EDISON CONCRETE HOUSE**  
 How it is constructed, how much it will cost, is it practical from an architectural and engineering standpoint? These and other important questions relating to the structure are discussed in a good, thorough, illustrated article published in *Scientific American Supplement 1685*. Price 10 cents by mail. Order from your newsdealer or from  
**MUNN & COMPANY, Inc., Publishers**  
 361 Broadway, New York

**HOLTZER-CABOT**  
**GAS ENGINE** **MAGNETOS**  
**JUMP SPARK** **FOR MARINE**  
**and** **AUTOMOBILE**  
**MAKE** **and**  
**BREAK** **STATIONARY**  
**TYPES** **ENGINES**  
**SEND FOR LATEST BULLETIN 1557**  
**THE HOLTZER-CABOT ELECTRIC CO.**  
 BROOKLINE, MASS. and CHICAGO, ILL.

**UNIVERSAL SCRAPER**  
 Neatest, simplest and best on the market. Eight sharp cutting edges, each brought instantly into use by ball joint connection. Easily locked or released by turning handle.  
**PRICE \$1.00**  
 Send for 232 page catalog No. 18-B.  
**THE L. S. STARRETT CO., Athol, Mass., U. S. A.**

**WELL DRILLING MACHINES**  
 Over 70 sizes and styles, for drilling either deep or shallow wells in any kind of soil or rock. Mounted on wheels or on sills. With engines or horse powers. Strong, simple and durable. Any mechanic can operate them easily. Send for catalog.  
**WILLIAMS BROS., Ithaca, N. Y.**

**HELMETOIL LUBRICATES SEND FOR SAMPLE FREE**  
**ANYTHING**  
 118-124 North Clinton St.  
**CH. B. ELY & CO. CHICAGO, U.S.A.**

**Legal Notices**  
**60 YEARS' EXPERIENCE**  
**PATENTS**  
**TRADE MARKS DESIGNS COPYRIGHTS & C.**  
**INVENTORS** are invited to communicate with **Munn & Co., 361 Broadway, New York, or 625 F Street, Washington, D. C.,** in regard to securing valid patent protection for their inventions. **Trade-Marks and Copyrights** registered. **Design Patents and Foreign Patents** secured.  
**A Free Opinion** as to the probable patentability of an invention will be readily given to any inventor furnishing us with a model or sketch and a brief description of the device in question. All communications are strictly confidential. Our **Hand-Book on Patents** will be sent free on request.  
 Ours is the **Oldest** agency for securing patents; it was established over sixty-five years ago.  
**MUNN & CO., 361 Broadway, New York**  
 Branch Office, 625 F St., Washington, D. C.

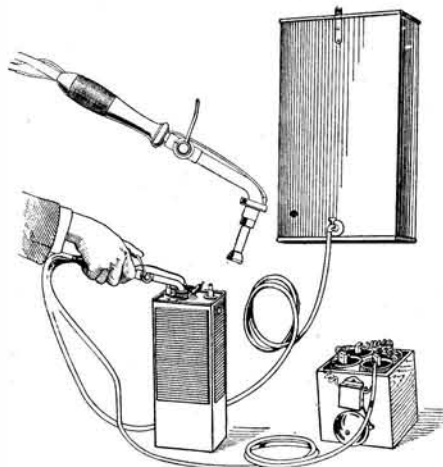
water during long periods in the life of the cell.  
 Connections between the cells of a battery and with the external circuit are made by means of heavy nickel-plated copper-wire connectors, with steel lugs swaged on the ends and fitting on the taper terminal posts.  
 The element is made very compact, with no provision for circulation of electrolyte because the latter is constant, chemically, electrically and physically. In this "can of electricity" the solution is a mere liquid carrier of ions—it has, so to speak, no moods and tempers of its own to be catered to by the battery user. Whereas in the lead cell the constitution (proportions of acid and water), conductivity and specific gravity all undergo definite change during the cycle of charge and discharge, in the Edison cell these qualities remain unaltered. On account of the low voltage of the cell, a vehicle battery of given voltage must contain a larger number of cells than a lead battery, twenty-four lead cells being equivalent to forty of the nickel-iron cells of same ampere-hour capacity; but the low voltage and comparatively high internal resistance are disadvantageous from the purely electrical rather than the vehicle point of view. The cost of charging current, and hence also the efficiency of its recovery in the discharge circuit, is a minor part of the total expense of operating the vehicle; and the low electrical efficiency of the battery is offset by its extremely light weight—which not only lightens the construction of the vehicle, but increases the proportion of "paying load" carried by the same—and by its ruggedness in service. In estimating the true commercial efficiency of a road-vehicle transportation, the ton-miles obtained must be compared with the total cost of operation of the vehicle, with due allowance for all-around reliability. The nature of the support materials and the method of applying the active material to the plates enable the cell to stand dead short circuits without injury. It is stated that the cell improves in use, instead of deteriorating, and the company guarantees to renew any battery at any time for half the cost of a new battery.  
 In charging, the rate can be varied through a wide range, and may be far higher than would be safe with the lead battery. "Boosting charges"—given a vehicle battery when partially discharged, so as to carry it through a longer period than its prescribed day's work—may be given for an hour's run at a rate two or three times the normal charging rate; and a regular charge may be completed in a hurry by starting at a high rate and gradually decreasing the rate. A vehicle manufacturer using the battery reports that he charged an exhausted battery of A-4 cells at the rate of 100 amperes for a short time, and states that it pays better to put in over

**WHAT IS 3 IN ONE MAGNETO OIL?**  
 3 in One is a clear oil compound absolutely pure with just enough body to oil perfectly the most delicate bearing or sensitive action point.  
 3 in One is not too heavy—will positively not gum or clog, collect dust or dirt, harden or dry out.  
 3 in One is not too light to properly lubricate and keep lubricated any bearing (ballbearing or ordinary bearing). It will not run out and leave contact points dry.  
 3 in One contains no carbon, no residue, no foreign matter, no acid, no impurities like all cylinder (mineral) oils. Sold at all garages, auto supply dealers, hardware and general stores—10c., 25c., 50c. bottles.  
 Don't scoff. Try 3 in One. Write at once for generous sample bottle and Magneto Bulletin. Both free.  
**3 IN ONE OIL COMPANY, 14 BROADWAY, - - - New York City.**  
**BUY THE LOWEST COST ENGINE** **MADE.** Lowest fuel cost; lowest up-keep cost; easiest on the machine it operates, delivering steadier power than any other gasoline engine, adapting it especially for operating farm machinery, with better results and least waste of grain. Lowest fuel cost for it runs on Gasoline, Kerosene, Distillate, Gas or Alcohol and has perfect lubrication. Lowest cost because it delivers greatest available power per horse. A slow speed, high duty engine. Starts easier and quicker than any other engine, occupies less space, is less cumbersome, with less vibration, therefore adapting it for either stationary, portable or traction use. **IT IS THE POWER CONTRACTOR'S FAVORITE ENGINE.** No engine made has so wide a range of use. **YOU WILL MAKE A MISTAKE IF YOU DO NOT WRITE US FOR INFORMATION.** 1 1/2 H. P. to 5 1/2 H. P. single cylinder. 6 to 20 H. P. two cylinder. 30 to 50 H. P. four cylinder. State your requirements and get our advice.  
**THE TEMPLE PUMP CO., Manufacturers, 417 West 15th St., Chicago, U. S. A.** This is our 58th year.

nine-tenths of the normal capacity in a short charge at a high rate than to give the long, slow charge traditionally deemed advisable for lead cells. A commercial vehicle battery of high capacity will give the best results with a 75 to 80 per cent charge at high rate every day, thereby avoiding the loss of efficiency of charging that comes at the end of a "normal" charge at the prescribed rate. A battery showing about 100 volts when charged can be thrown directly on the 110-volt mains without resistance in the series.

It is the discharge performance of the battery, of course, expressed in "miles in the battery," that the auto driver is most interested in. Hill climbing is a favorite test of an automobile power plant, and the performance of the Edison battery in this respect is a good indication of its road ability. An electric pleasure vehicle equipped with the battery, the total weight being 2,387 pounds, has climbed Fort George Hill, a distance of 2,138 feet with 11 per cent grade, twenty-one times on a single charge. Another interesting performance of the battery in city work, on a single 7½-hour charge, is a "run-about" of an hour and a half to two hours every day for seven days. The total weight of the car and two passengers was 2,470 pounds, and a total of 120 miles was made at an average speed of 12.32 miles per hour. The cost of the charge was \$1.42, which comes to about 21 cents per day.

The garage work other than charging is simplified by the absence of corrosive



Filling up an Edison cell for evaporation. Fitted with thumb valve and connections to bell circuit.

fumes, the substitution of bolt-and-nut connections for lead-burning, the good retention of the active material by the plates and the absence of "sulphating" and similar troubles, and the non-fragile nature of the cans and elements. It is claimed that a single garage man can readily take care of a very large number of batteries; and in fact the Edison battery is not regarded as very attractive business by the public garages accustomed to doctoring lead cells which have been abused, or worn out, in vehicle service. The cells are filled with electrolyte and assembled in trays before leaving the factory, and the sealed top when making a turn might throw one entirely off the course and cause much trouble.

One card serves for only one route, and if this route is more than 100 miles long but less than 200 miles, the card is reversed and the directions on the back are followed. The manufacturers of the instrument supply cards covering all known touring routes in the United States, including several transcontinental routes, and also principal touring routes in Europe. About 600 routes are catalogued for this country alone. The cards can be ordered by number as wanted, and kept in good order in a cardboard case furnished by the manufacturer.

rent than in lead cells. Continuous working at high temperatures has an injurious effect tending to shorten the life of the cell, but a temperature of 100 degrees is not critical. In hot weather an electric fan may be turned on the battery when charging, to keep down its temperature. The metal cans and the small amount of solution invite more rapid chilling in a vehicle standing idle in winter than the heat-insulating hard rubber jars of the lead battery, and is to be avoided by properly inclosing the battery trays, sealing up all holes or openings to avoid the entrance of the cold air. In charging, however, the battery compartment must be left wide open. The small amount of electrolyte and the liability of heating on charge at the high charging rates which are permissible, give rise to another sensitive point in the handling of this type of cell, namely, "low electrolyte," i. e., exposing the tops of the cells, and causing loss of storage capacity. In active service it is necessary to "fill up for evaporation" every few days, using distilled water only (ordinary water, which is more or less impure or which has been aerated by absorption of carbonic acid from exposure to the air, being injurious to the cell), and putting in the water just before giving a charge, to avoid the false level due to gas bubbles in the electrolyte. Since the closed and sealed top of the cell prevents a view of its contents, a special filler is provided by means of which water may be added to the same height in a large number of cells in rapid succession. This filler is connected by a flexible rubber tube to an overhead covered tank of distilled water, and is also wired to an electric bell and dry battery. The filler spout is inserted in the aperture of the cell, and a thumb-valve on the filler is operated to allow the water to flow into the can. The stream of distilled water presents a high resistance in the bell circuit, but when the level of the electrolyte has risen into contact with the end of the spout, the bell rings. It is important to avoid filling the cans too full, for this leaves no room for the gas to escape during charge and the electrolyte is liable to be forced out in bubbles—a cause of low electrolyte.

The potash solution becomes contaminated in time, from impurities that have accidentally gotten into the cell either directly or by way of the filler spout (which may be laid down carelessly on a dirty bench), or by absorption of gases in the garage. It therefore needs to be replaced by fresh electrolyte about once in eight months for a commercial-vehicle battery or once a year for a pleasure-vehicle battery.

**Some Mechanical Road Guides**

(Continued from page 33.)

road maps and guide books is that one must first know his precise location on the road before he can tell when and how to proceed; a mistake of even half a mile in the distance from a given point when making a turn might throw one entirely off the course and cause much trouble.

Should the tourist wish to make a detour from the regular route or take a side excursion, the instrument can be reset by means of the screw in the back to bring the card to correspond with



—“And you must take Sanatogen regularly for several weeks”

THIS urgent advice is given by physicians day by day in every civilized land—wherever sufferers from starved nerves and poor digestion seek relief. There is a reason for this. Physicians know that Sanatogen is a substance capable of supplying the real needs of a starved, overwrought nervous system—that it is a scientific combination of albumen and organic phosphorus—a compound eagerly absorbed by the hungry tissues and possessing unique tonic and reconstructive qualities. They also know from their own observation what Sanatogen has done for others. They have watched its revivifying action upon persons whose nervous strength had been undermined by overwork, worry or disease, they have observed how it has infused renewed energy, life and elasticity into starved nerves, how it has regenerated the appetite, digestion, in short, how wonderfully it has helped to make the human machinery fit to perform its functions in the most perfect manner.

There are on file with the owners of Sanatogen no less than 15,000 letters from practicing physicians praising, endorsing Sanatogen. Truly, a magnificent monument to the value of this food tonic.

But no less impressive is the enthusiastic testimony of patients themselves. Men and women in the forefront of human endeavor, statesmen, prelates, authors, lawyers, have written above their own signatures of the wonderful benefits received from Sanatogen.

We ask you earnestly to get acquainted with Sanatogen. Investigate our claims first, if you like, and we are only too glad to have you do so. Ask your doctor about it, and in any case write at once for our book "Our Nerves of Tomorrow" the work of a physician-author, written in an absorbingly interesting style, beautifully illustrated and containing facts and information of vital interest to you. This book also contains evidence of the value of Sanatogen which is as remarkable as it is conclusive.

Sanatogen is sold in three sizes, \$1.00, \$1.90, \$3.60

Get it from your druggist—if not obtainable from him, write

The Bauer Chemical Company, 515 EVERETT BLDG. Union Square, New York

Prof. C. A. Ewart  
Of Berlin University, Doctor honoris causa Johns Hopkins Medical School, Baltimore, writes: "I am able to speak from my own observations made at the bedside of patients, and I can say that I have used Sanatogen in a great number of cases (that is, in those disturbances of metabolism which were mainly of a nervous or neurosthenic origin) and have obtained excellent results."

Hon. Wm. L. Chambers  
Former Chief Justice International Court, Samoa, says: "Sanatogen has been used in my family with the most excellent results, and I do not hesitate to recommend this valuable remedy to those whose systems need building up. It is a most invigorating tonic."

Harrison Fisher  
The well-known artist, says: "I have used Sanatogen since the first of the year and find it a wonderful tonic. I am recommending it to my overworked friends."

U. S. Senator Wm. Warner  
Writes from Washington: "I have used Sanatogen, and found it to be a most excellent tonic. To those whose nervous systems need building up, there is nothing better."

S. B. M. Young  
Lieut.-General U. S. Army, retired, says: "I find Sanatogen is a wonderful remedy for building up a run-down system. I can cheerfully recommend it to those who may be suffering from exhaustion or nervousness."

**THE BEST TEST**  
of an engine's efficiency is its long time record in the hands of users. Most any engine will run alright for a period of thirty or sixty days, but that is not a real test. To be sure of a permanent satisfaction choose one from the many famous

**IHC GASOLINE ENGINES**  
Their economy and dependability have been proved by years of successful service. They are a practical insurance against financial loss due to delays, breakdowns, and other power troubles.

Made in different sizes—one to forty-five horse power in vertical and horizontal, stationary, and portable traction types. Investigate their superior design, workmanship, and material—note their rugged strength—secure a copy of the IHC catalogue today to aid you in your selection. Address:  
International Harvester Co. of America, (Inc.)  
15 Harvester Building Chicago, U. S. A.

**Elbridge Featherweight Engines**  
hold every novice record made in America in 1910.  
Made more successful amateur flights than all other makes of engines combined.  
Used successfully in Farman, Greene, Curtiss, Voisin, Santos-Dumont and Blériot types of aeroplanes.  
Send six cents in stamps for catalogue.

**ELBRIDGE ENGINE COMPANY**  
4 Culver Road, Rochester, New York

**6 Month's Free Trial**  
Sharpen your tools on this machine for six months—then if you haven't found it a work and time saver, send it back at my expense. Fitted with genuine Carborundum wheels—25 times faster than grindstones, 6 times faster than emery—will not draw temper—no need of water cooling—attachment for sharpening all kinds of tools, chisels, twist drills, etc.

**LUTHER DIAMOND TOOL GRINDERS**  
are built like high grade lathes, hand and foot power. Takes two minutes to do what would take half hour with grindstone. Guarantee Five Years. No strings to this free six months' trial offer. Write for particulars and reprint from McClure's Magazine telling story of Carborundum.

**Luther Grinder Mfg. Co.**  
70 Madison St. Milwaukee, Wis.

**\$40.00 MOTORCYCLE**  
We are the largest and only exclusive motorcycle house in the country, and carry the most complete line of new and used motorcycles, parts and supplies.  
Send us your machines to be overhauled. We carry in stock repairs for every motorcycle.  
Motors and Castings for airships.  
**HARRY R. GEER CO., 851 McLaran Ave., ST. LOUIS, MO.**

**"POROX" Storage Batteries**  
The best for ignition and light. No loss of current. Absolutely reliable. Transparent jars are used for all batteries. 6 volt. 8 ampere hour battery. Price \$24.00.  
Send for catalogue  
**ALBERT MÜLLER**  
Hoffman Boulevard, near Hillside Ave. JAMAICA, N. Y.  
Sole Agents for China, **ULDERUP & SCHLÜTER,**  
21 Connought Road, Hong Kong.