

PRIMARY BATTERIES

The primary, voltaic, or galvanic cell, as it is variously called, is an apparatus for converting chemical energy directly into electrical energy. A primary cell consists of two conducting elements immersed in a solution that acts chemically on one element only, or on one more than on the other. One of the elements, usually zinc, is called the *anode* and the other, for which various substances may be used, is called the *cathode*. The chemical action incident to the generation of the current consumes the zinc and in the simplest cell liberates hydrogen at the cathode, which tends to adhere to the surface and reduces the E. M. F. of the cell. To overcome this effect of polarization, a depolarizer is often used, which will dispose of the hydrogen as fast as it is formed. Depolarizers may be solid or liquid. When solid, the material is usually placed around the cathode, as in the case of the Leclanché cell. When the depolarizer is liquid, it is sometimes prevented from mixing with the electrolyte by a porous partition; or, if their specific gravities differ sufficiently, they may be kept separate by placing the lighter over the heavier one in the same jar. A battery is generally considered to be a combination of a number of separate voltaic cells properly joined together; the two terms, battery and cell, are, however, used rather indiscriminately. The table on page 160 gives the elements, depolarizers, and the E. M. F. in volts for various cells.

Care of Leclanché Cells.—The amount of sal ammoniac required to charge a Leclanché cell will depend on the amount of water required to fill the jar to the proper height; usually from 4 to 6 oz. is sufficient. It is best never to put in more than will dissolve; 3 oz. of sal ammoniac to a pint of pure water is the best proportion. When the solution is extra dense at the bottom, the top portion of the zinc is eaten away more rapidly than the bottom. There should never be crystals or undissolved salts of any kind in the bottom or around the lower ends of either electrode; all the crystals should be removed by dissolving them in water or scraping them off. The jars usually have printed direc-

tions (which should be followed) pasted upon them for setting up the cells and marks upon the jar to show how much water is required. Where porous cups are used, the liquid should come to within about $1\frac{1}{2}$ in. of the top of the porous cup. Cells with porous cups are not usually in good condition for use until 10 or 12 hr. after setting up, because time is required for the solution to soak through the porous cup. Where there are one or more vent holes at the top, the action may be hastened by pouring some of the sal-ammoniac solution into the porous cup through the vent holes; but the top of the cup should be thoroughly wiped dry to prevent the corrosion and formation of salts around the binding post. If the solution evaporates, pure water should be added from time to time to keep the level up to the proper height.

Directions for Setting up the Crowfoot Gravity Cell.

Proceed as follows: Unfold the copper strip so as to form a star and place it in the bottom of the jar. The point where the copper connecting wire is riveted to the copper electrode should be near the bottom of the cell, and the insulated covering on the wire should come close to the riveted joint. Suspend the zinc about 4 in. above the copper by hooking the lug on the side of the jar. The method of suspending other forms of zincs will be evident from their construction. Pour sufficient clean water into the jar to cover the zinc and drop about 3 lb. of copper sulphate in a cell to be used for heavy, continuous work—for instance, for the local-circuit batteries that run telegraph sounders; for the batteries in a main-line telegraph circuit, a smaller charge will be sufficient, and, in quadruplex-telegraph circuits, the so-called "long" end of the battery will need less bluestone than the "short" end, because the former is not worked as continuously as the latter. The internal resistance may be reduced and the battery made immediately available by drawing about $\frac{1}{2}$ pt. of solution of sulphate of zinc from a battery already in use, and pouring it gently into the jar; or, when this cannot be done, by pouring carefully on top of the solution in the jar 4 or 5 oz. of pulverized sulphate of zinc previously dissolved in a cup of water.

PRIMARY CELLS

Name	Anode	Electrolyte	Cathode	Depolarizer	E. M. F. Volts	Remarks
Bichromate Grenet, or Poggen-dorff	Zinc	Sulphuric acid, 4 parts; potassium, or sodium bichromate, 3 parts; water, 18 parts; <i>or</i> Chromic acid, 6 oz.; water, 5½ pt.; sulphuric acid, ½ pt.	Carbon	Potassium bichromate; <i>or</i> sodium bichromate; <i>or</i> chromic acid	1.9 to 2.1	Suitable for closed-circuit work. Electrodes should be removed from solution when not in use
Fuller	Zinc; in porous cup containing 6 oz. of zinc sulphate to 1 pint of water and a few drops of mercury	Sulphuric acid, 17 oz.; water, 56 oz.; sodium bichromate, 6 oz.; placed in jar containing carbon element	Carbon; placed in jar containing electrolyte	Sodium bichromate	2.14	Suitable for closed- or open-circuit work. Will furnish current up to .6 ampere. Elements need not be removed from solution when cell is not in use

Bunsen	Zinc; in jar containing sulphuric acid solution	Sulphuric acid, 1 part; water, 20 parts; specific gravity of solution should be about 1.09	Carbon; placed in porous cup containing depolarizer	Nitric acid, specific gravity about 1.33 to 1.4	1.89	Suitable for closed-circuit work. Gives off disagreeable fumes. Elements should be removed from solution when not in use
Partz	Zinc; hung from the lid of the cell	Sodium chloride; <i>or</i> Magnesium sulphate (being lighter, this solution floats on top of the depolarizer)	Carbon; plate slightly raised from bottom of jar	Bichromate solution; <i>or</i> sulphochromic salt solution	1.9 to 2	Solutions kept apart by the different specific gravities. Resistance: with sodium chloride about .5 ohm; with magnesium sulphate, about 1 ohm

TABLE—(Continued)

Name	Anode	Electrolyte	Cathode	Depolarizer	E. M. F. Volts	Remarks
Pabst	Wrought Iron	Ferric chloride	Carbon		.78	Non-polarizing electrolyte
Daniell	Zinc; in porous cup con- taining electro- lyte	Zinc sulphate	Copper; sur- rounded by depo- larizer	Saturated copper- sulphate solution and crystals	1.07	For closed-circuit work. Electro- lyte and depolar- izer kept apart by porous cup
Daniell, gravity, or Crowfoot	Zinc; held in top part of jar	Zinc sulphate; specific gravity not to exceed 1.15; being lighter, floats on top of cop- per-sulphate solution	Copper; sheet shaped, placed in bot- tom of jar sur- rounded by de- polarizer	Saturated copper-sul- phate solu- tion and crystals. 3 pounds of copper- sulphate crystals for 1 cell	1.07	Solutions kept apart by their different specific gravities. For closed-circuit work only. Most economic output is $\frac{1}{4}$ am- pere. Average resistance, about 3 ohms

Leclanché and some dry cells.	Zinc	Ammonium chloride (sal ammoniac) 3 oz. to 1 pt. water	Carbon; usually placed with depolarizer in porous cup; <i>or</i> Carbon forms porous cup containing depolarizer	Dioxide of manganese, sometimes mixed with broken coke	1.3 to 1.7	Suitable only for open-circuit work. Internal resistance, from .4 to 4 ohms
Edison-Lalande	Zinc; plate held between two cathode plates	Caustic potash. 15 per cent. of silicate of soda said to nearly double capacity of cell.	Molded plates of cupric oxide; held in copper frames	Cupric oxide	.7	Electrolyte must be covered with mineral oil. Suitable for closed-circuit work. Internal resistance very low

TABLE—(Continued)

Name	Anode	Electrolyte	Cathode	Depolarizer	E. M. F. Volts	Remarks
Harrison	Zinc; must be amalgamated	Dilute sulphuric acid, or bisulphate of potassium, or sodium; must be pure to avoid local action	Lead	Peroxide of lead; compressed around a conductor of hard lead	2.5	Local action is very likely to cause trouble
Latimer Clark	Zinc	Zinc sulphate, 2 parts; water, 1 part. Saturated at 30° C.	Mercury	Paste of mercurous sulphate and zinc sulphate	1.4333 at 15° C., or as furnished with cell	E. M. F. at t° C given by formula: $E_t = E_{15} - .00119(t - 15) - .000007(t - 15)^2$

Carhart-Clark	Zinc	Zinc-sulphate solution saturated at 0° C.	Mercury	Paste of mercurous sulphate and sodium sulphate	1.440 at 15° C., or as furnished with cell	E. M. F. at ° C given by formula: $E_t = E_{15} - .00056 \times (t - 15^\circ)$.
Weston	Cadmium; amalgam of cadmium and mercury	Cadmium sulphate saturated, at all temperatures, by presence of excess of cadmium-sulphate	Mercury	Mercurous sulphate	1.0187 at 20° C., or as furnished with cell	E. M. F. at ° C given by formula: $E_t = E_{20} - .00038(t - 20^\circ) - .00000065 \times (t - 20^\circ)^2$ Temperature coefficient is practically negligible

TABLE—(Continued)

Name	Anode	Electrolyte	Cathode	Depolarizer	E. M. F. Volts	Remarks
Gordon	Zinc; in form of hollow cylinder surrounding cathode	Caustic soda	Perforated tinned-iron cylinder	Flaky cupric oxide; held in perforated tinned-iron cylinder	.7	Suitable for open- or closed-circuit work. Very low internal resistance, gives a relatively large current continuously. Solution covered with mineral oil
Chloride of silver	Zinc	Ammonium chloride .8 oz. (avoir.) to 1 qt. water <i>or</i> Zinc chloride or sodium chloride	Silver wire or plate	Chloride of silver covering cathode	1.03; zinc chloride, 1.02; sodium chloride, .97	Cells may be made very small, and are used mostly with portable testing sets

If there is no hurry for the cells, do not put in the zincs until the solutions have had time to settle to their normal conditions, which will require at least 24 hr. This prevents or reduces the formation of a black deposit on the zinc. When there is much of this black deposit, remove the zinc and brush or scrape it off. If no zinc sulphate is added in setting up the cell, it will be necessary to short-circuit the cell for some time (24 hr. will not be too long) before it will be in good condition.

Open- and Closed-Circuit Cells.—For practical purposes, primary cells may be roughly divided into two general classes: First, those capable of furnishing, in a circuit of moderate resistance, a reasonably uniform current for quite a long time; and, second, those capable of supplying a current only intermittently, and then only for a few seconds each time, but able to stand for long intervals on open circuit without consumption of materials due to local action. The former are called *closed-circuit cells*, and the latter *open-circuit cells*. Some closed-circuit cells may be used to supply intermittent currents—that is, they may be used on circuits that are open the greater part of the time—but open-circuit cells should never be used where a continuous current is required—that is, on circuits that are closed the greater part of the time. Some closed-circuit cells deteriorate if left on open circuit too much of the time, and hence they are not suitable for intermittent work, where only small currents are required and the inactive periods are long. Leclanché and dry cells are the best examples of open-circuit cells; and Edison-Lalande, Gordon, gravity Daniell, and bichromate cells are the most extensively used closed-circuit cells. For intermittent work—for instance, for electric bells, and some types of telephones that are not in constant use, or else are not in use for long periods at any one time—good open-circuit cells, such as the Leclanché and dry cells, are the most satisfactory. They are not, however, suitable where a continuous current is required, nor even for intermittent work, unless the idle periods are sufficiently long and frequent to allow the cells time to recuperate.

INTERNAL RESISTANCE AND CURRENT CALCULATIONS

If a number s of similar cells, each having an internal resistance of b ohms, are connected in series, the total internal resistance B of the battery thus formed is equal to $s \times b$. The total electromotive force of a number of cells connected in series is equal to the sum of the electromotive forces of all the cells. If a number p of similar cells, each having an internal resistance of b ohms, are arranged in parallel, the total internal resistance B of the battery thus formed is equal to $\frac{b}{p}$. If a number of similar cells are connected in parallel, the electromotive force of the battery is equal to that of one cell. If a number $p \times s$ of similar cells are arranged in p parallel rows, with s cells in series in each row, the total internal resistance B of the battery thus formed is equal to $\frac{s \times b}{p}$, and the total electromotive force is equal to $s \times e$; b is the internal resistance and e the electromotive force of one cell. If $p \times s$ similar cells are arranged in p parallel rows, with s cells in each row, each cell having an electromotive force of e volts and an internal resistance of b ohms, the current C that the battery will produce through an external resistance of R ohms is

$$C = \frac{s \times e}{\frac{s \times b}{p} + R}$$

Whenever the external resistance R is very small and negligible compared with the internal resistance of the battery, the number of cells in parallel must be increased in order to increase the current. Whenever the external resistance is very large compared with the internal resistance of the battery, the number of cells in series must be increased in order to increase the current.

The maximum current is obtained through a given external resistance R from a given number of cells, when the grouping of the cells is such that the internal resistance of the battery can be made equal to the external resistance.

That is, so choose s and p that $R = \frac{s \times b}{p}$. The efficiency of such an arrangement is only 50%, because half the energy is expended in the internal and half in the external circuit.

To determine the least number of cells N that will give a certain (maximum) current C through an external resistance R , when each cell has an internal resistance of b ohms and electromotive force of e volts, use the formula

$$N = \frac{4 \times C^2 \times R \times b}{e^2}$$

The number of parallel rows $= p = \sqrt{\frac{N \times b}{R}}$, and the number of cells in series in each row $= s = \sqrt{\frac{N \times R}{b}}$.

The most economical arrangement, so far as the consumption of battery material is concerned, is that in which the internal resistance of the battery is very small compared with the external resistance. This would generally require such a large number of cells that their cost and the space occupied by them would be unnecessarily large.

In telegraph circuits, it has been quite customary to consider the best arrangement as that in which the total resistance of all relays never exceeded the total resistance of the line and internal resistance of the battery. When cells, each having an internal resistance of b ohms and an electromotive force of e volts, are arranged in series, the number of cells s required to produce a current C through a given external resistance R is given by the formula

$$s = \frac{C \times R}{e - b \times C}$$

STORAGE BATTERIES

Storage batteries or accumulators are composed of specially prepared lead plates, placed side by side, in glass or rubber jars or wooden boxes lined with hard rubber or lead, alternate plates being connected together, thus forming two sets, which constitute the positive and negative elements. The plates are entirely submerged ($\frac{1}{2}$ in. below the surface)

in a solution of pure sulphuric acid made from sulphur or brimstone and pure water, both free especially from such impurities as iron, arsenic, nitric acid, or hydrochloric acid. The proper proportion is 1 of acid to 5 of water by volume, which should give at 60° F. a specific gravity of 1.20 to 1.24, as indicated by an ordinary hydrometer or 25° on a hydrometer having a Baumé scale, when the cells are fully charged. Cells should never be allowed to stand over 2 hr. after the electrolyte has been put in before they are charged. The charging E. M. F. is about 2.5 volts per cell, and a cell should never be discharged below 1.7 volts. To make up for the evaporation of water, add pure water occasionally, and to make up for the acid lost in the spray, acid may have to be added every 1 or 2 yr.

The proper rate of charging is usually the same as the 8-hr. rate of discharge specified by the manufacturers. Be sure that the direction of current through the cell in charging is from the positive, or brown, plate to the negative, or gray, one. The charging should be continued until complete according to the signs to be given presently. While it is uneconomical and detrimental to the life of the plates to repeatedly overcharge the cells, nevertheless it is advisable to overcharge the batteries slightly, about once a week, in order to thoroughly stir up the electrolyte and also to correct any inequality in the voltage of the cells that may have developed. At the end of the first charge, it is advisable to discharge the battery about one-half, and then immediately recharge it. Repeat this operation two or three times to put the battery in condition for regular use.

Indications of a Complete Charge.—A complete charge should exceed the previous discharge, in ampere-hours, from 12 to 15%. The principal indications of a complete charge are: (1) The voltage and specific gravity reach a maximum value that is not necessarily fixed; for example, the voltage at the end of a charge may be from 2.4 to 2.7. (2) The amount of gas given off at the plates also increases. (3) The positive plates become a dark brown, and the negatives a light gray. (4) With all the cells in normal condition,

with pure electrolyte, and no material lodged between the plates or sediment touching them at the bottom, the maximum voltage and specific gravity are reached when, with the charging current constant at the normal rate, there is no further increase in either during a period from $\frac{1}{4}$ to $\frac{1}{2}$ hr. The voltage at the end of a charge depends on the age of the plates and on the temperature of the electrolyte. As the age increases, the full-charge voltage may drop from 2.5, when new, to 2.4 volts. With charging rates lower than normal, the full-charge voltage will be approximately .05 volt less for each 25% decrease in the rate. If the temperature is increased above normal, the final charging voltage is noticeably lowered, and vice versa, irrespective of the age of the plates. The final voltage per cell when charged at the maximum rate, which should be done only in cases of emergency, will be about .05 volt higher than if charged at normal rate. It is understood that all voltage readings mentioned are taken with the current flowing; readings taken with the battery on open circuit are of little value and are frequently misleading.

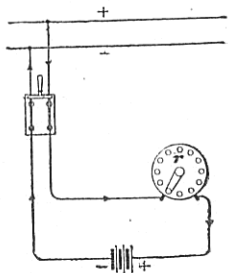
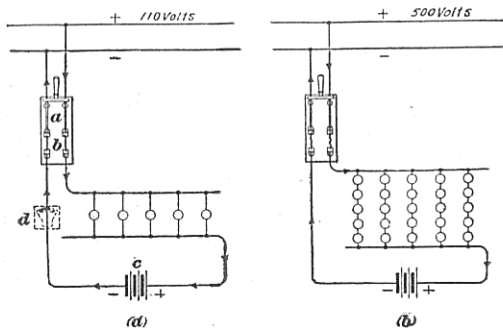
After the completion of a charge and when the current is off, the voltage per cell will drop to about 2.15 volts and then to 2 volts or slightly less, when the discharge is started. Repeated heavy overdischarges are almost sure to injure the cells if maintained for a considerable time. Batteries should be discharged at about the normal rate. A battery should never be discharged below 1.7 volts per cell; and in ordinary service it is advisable not to ever discharge below 1.75 volts per cell. The change in specific gravity, which is even a more satisfactory guide, depends on the quantity of solution compared with the bulk of the plates in a cell. If a cell contains the full number of plates, the change in specific gravity is about 35 points; with fewer plates in the same-sized vessel, the range will be lessened. Also, at higher rates of discharge than normal, the drop in specific gravity will be less because of the smaller number of ampere-hours discharged. As the discharging progresses, the positive plates become somewhat lighter and the negatives darker, so that the color of the plates is a rough indication of the amount of dis-

charge. A battery should never be allowed to stand discharged for a long time.

Each cell should be examined regularly at least once a month for voltage and, by looking between all the plates, for material lodged there; and near the end of each charge to see that all cells are gassing equally. If any cell gives a voltage reading lower than normal and does not gas freely at the end of the charge, examine it for material lodged between the plates or for an accumulation in the bottom of mud that reaches the plates. Readings of voltage and specific gravity should be noted for each cell at the end of a prolonged charge, while the current is still flowing. Recording voltmeters and wattmeters are very useful in a storage-battery circuit, as they show just what the battery has been doing.

A cell that is lower than normal will require more than the usual charge to restore it to a proper condition after the cause of the trouble has been removed. Care must be taken to remove sediment in cells before it reaches the bottom of any plate. When a battery is used occasionally only, it should be given a weekly freshening charge. If the use of a battery is to be discontinued for a considerable time, give it a complete charge, draw off the electrolyte, refill immediately with water, discharge at normal rate to 1 volt per cell, and draw off all the water. To use again, put in the electrolyte, charge at normal rate, taking care that the current flows through the battery in the proper direction, as the polarity of the charging source may have changed in the meantime, until completely charged, which usually requires 25 to 30 hr. In case white, insoluble sulphate appears on the plates, give the battery a long-continued charge at a rate somewhat below the normal 8-hr. rate until the cells give all signs of a full charge and the plates have resumed their normal color. In badly sulphated cells, the color of the positive plates becomes lighter than normal and the negatives considerably darker. The most frequent causes of sulphating are overdischarging (below 1.7 volts) frequently, too strong an electrolyte, and allowing the battery to stand discharged for too long a time.

Charging Connections.—A storage battery may be charged from a 110-volt, direct-current circuit as shown at (a) in



(c)

FIG. 1

Fig. 1, in which *d* represents an ammeter, *c* the storage battery, and the circles 110-volt incandescent lamps. Use as many 32-candlepower or twice as many 16-candlepower

carbon-filament lamps as there are amperes in the normal charging rate. Fig. 1 (b) shows a similar arrangement for charging the same battery from a 500-volt circuit. There are five 110-volt lamps in series in each row, there being as many rows of 32-candlepower, or twice as many rows of 16-candlepower, carbon-filament lamps as amperes are required. Fig. 1 (c) shows an arrangement for charging where an adjustable rheostat r is used. The resistance required in the rheostat is $R = \frac{E - 2N}{I}$, in which E is the line E. M. F., N is the number of cells in series, and I is the charging current.

Fig. 2 shows about the simplest arrangement for charging from a dynamo A , having a rheostat f in series with its shunt field. It is desirable to have an automatic underload-

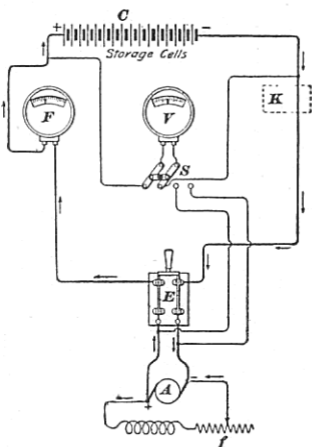


FIG. 2

and overload-circuit breaker at K , where the battery is not watched constantly. Fig. 3 shows a simple switchboard where the battery or charging mains may be used separately or in parallel to supply the current required. The voltmeter V may be connected by switch p across either the dynamo or battery b ; r is the handle of the rheostat in series with the shunt field of the dynamo. When the battery is being charged, the switch k is open and s closed. When the battery alone is furnishing current to the lines, s is open

It is desirable to have an automatic underload- and overload-circuit breaker at K , where the battery is not watched constantly. Fig. 3 shows a simple switchboard where the battery or charging mains may be used separately or in parallel to supply the current required. The voltmeter V may be connected by switch p across either the dynamo or battery b ; r is the handle of the rheostat in series with the shunt field of the dynamo. When the battery is

and k closed. If both dynamo and battery are to furnish current to the lines at the same time, both switches are closed.

The intensity of the hum sometimes produced in telephones when the battery is being charged while supplying current to the circuits in central energy telephone exchanges may be eliminated or at least reduced by connecting choke coils R, R' and a condenser C , as shown in Fig. 4. Each coil may consist of 20 turns of No. 4 B. & S. copper wire wound on a straight core of iron wire 8 or 10 in. long.

It is most economical to have only one storage battery in a telephone exchange and to charge it sufficiently during the busiest part of the day to carry the night load alone. It is advisable, especially in smaller exchanges, to install a

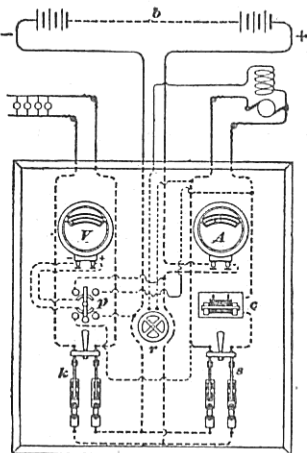


FIG. 3

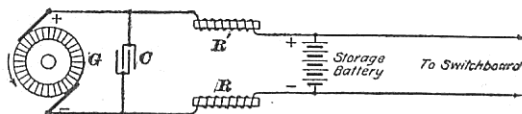


FIG. 4

battery large enough to carry the load for 36 and even 48 hr. If two batteries are used, each should be kept between three-fourths and full charge for best efficiency. The

average efficiency is between 75 and 80% in telephone systems.

Ampere-Hour Capacity.—The number of cells required in a battery is usually considered to be one-half the voltage required; more accurately, the number required is the voltage required divided by 1.75. The ampere-hour capacity may be determined with the aid of the following data: The current required for each subscriber's transmitter is from .05 to .1 ampere, the average length of conversation 3 min., and the average number of connections per subscriber per day is from 5 to 15. The current required by each operator's transmitter is about .12 ampere throughout the day. Line and supervisory lamps require about .06 ampere for 6 sec. for each call. Cut-off relays require about .05 ampere for 3 min. for each call. Pilot lamps require about .06 ampere for 7 hr. each day. The current required for each conversation varies from .08 to .04 ampere in the different systems.

GENERAL DATA ON STORAGE CELLS

In order to give an idea as to the size, capacity, weight, etc. of storage cells, the following three tables are given. In each table, the first cell of a given type is the smallest size made in that type, and the last given is the largest. The number of plates per cell is always an odd number, because there is always one less plate in the group of positives than in the group of negatives. For example, a 13-plate cell would be made up of 6 positives and 7 negatives. The capacities of cells with a number of plates different from that shown in the tables can be easily calculated. For example, in the first table, the 9-plate, type F, cell has an 8-hr. capacity of 40 amperes and a 15-plate cell of the same type has a capacity of 70 amperes. The addition of 6 plates or 3 pair of plates increases the capacity 30 amperes; hence, the capacity per pair of plates is 10 amperes. A 27-plate cell has 13 pair; hence, its capacity is $13 \times 10 = 130$ amperes for 8 hr. In making estimates of the room occupied by a given battery, about $1\frac{1}{8}$ in. clearance should be allowed between glass jars, $2\frac{1}{4}$ in. between metal tanks, and 2 in. between wooden tanks.

GENERAL DATA ON CHLORIDE ACCUMULATORS

Type of Cell	Size of Plates Inches	Number of Plates	Normal Charge Amperes	8-Hr. Discharge Rate	Weight of Cell Complete With Acid, Glass Jar Pounds	Weight of Cell Complete With Acid, Metal Tank Pounds	Weight of Cell Complete, Lead- Lined Tank Pounds	Outside Dimensions of Glass Jars Inches			Outside Dimensions of Lead-Lined Tanks Inches			
								Width	Length	Height	Width	Length	Height	
C	4	4	1	1	11			3	5	7				
C	4	4	2	2	15.1			4	5	7				
C	4	4	3	3	19.2			4	5	9				
C	4	4	2	2	20			4	7	9				
D	6	6	5	5	28			6	7	9				
D	6	6	7	7	38			6	8	9				
D	6	6	7	15	63			11	9	11				
D	6	6	10	10	49	85		5	9	11				
E	7	7	10	20	74	124		8	9	11				
E	7	7	20	35	112	180		11	9	11				
E	7	7	40	40	174.5	256	250	11	12	17	13	15	20	20
F	11	11	70	70	260	377	372	12	12	17	18	15	20	20
F	11	11	70	70		618	615				28	15	26	26
F	11	11	130	130			568				15	19	26	26
G	15	15	100	100							27	20	27	27
G	15	15	240	240			1,165				28	21	27	27
G	15	15	540	540			2,475				53	21	27	27
G	15	15	740	740			3,300				69	21	27	27
H	30	21	400	400			1,967				25	21	48	48
H	30	21	800	800			3,538				41	21	49	49
H	30	21	1,480	1,480			6,215				69	21	49	49

Weights of type C cells complete with electrolyte in rubber jars are: C-3, 6½ lb.; C-5, 10 lb.; C-7, 13

GENERAL DATA ON GOULD STORAGE CELLS

Type of Cell	Size of Plates Inches	Number of Plates	Normal Charge Amperes	8-Hr. Discharge Rate Amperes	Weight of Cell Complete With Acid, Rubber Jar Pounds	Weight of Cell Complete With Acid, Lead Lined Tank Pounds	Outside Dimensions of Rubber Jar Inches			Outside Dimensions of Glass Jar Inches			Outside Dimensions of Lead- Lined Tank Inches		
							Width	Length	Height	Width	Length	Height	Width	Length	Height
K	3	3	1.75	63	4		3	3	5	3	4	12	14	20	
K	3	3	1.5	125	7.5		3	3	5	3	4	18	14	20	
L	4	4	1.5	125	6.5		3	4	6	3	5	18	14	20	
L	4	4	4.5	375	16.5		5	4	6	7	8	21	20	28	
M	6	6	3	2.5	14.0		2	6	8	3	5	9	20	29	
M	6	6	9	7.5	35.0		2	6	8	7	8	9	20	29	
M	6	6	15	12.5	55.5		5	6	8	11	8	9	21	29	
N	7	7	10	10	39.		6	6	8	11	8	9	21	29	
N	7	7	20	20	73.		6	8	10	15	9	12	21	29	
N	7	7	30	30	107.		4	8	10	15	9	12	22	29	
O	10	5	20	20	112.5		12	8	10	15	6	10	22	29	
O	10	11	50	50	208.		12	8	10	15	6	10	22	29	
O	10	17	80	80		285									
S	15	7	60	60		420									
S	15	19	180	180		370									
S	15	35	340	340		934									
S	15	67	660	660		1,654									
S	15	11	400	400		3,178									
T	15	11	1,040	1,040		1,950									
T	15	53	1,040	1,040		4,850									
T	15	83	1,640	1,640		7,475									

GENERAL DATA ON ELECTRIC VEHICLE CELLS

Type of Cell	Size of Plates Inches	Number of Plates	Discharge for 4-Hr. Amperes	Weight of Cell Complete With Acid Pounds	Outside Dimensions of Hard-Rubber Jar Inches		
					Width	Length	Height
Oxide M V	5 8	7	21	22	2 1/2	6 1/8	12
Oxide M V	5 8	9	28	28 1/2	3 1/4	6 3/8	12
Oxide M V	5 8	11	35	35	4	6 3/8	12
Oxide M V	5 8	15	49	46 1/2	5	6 3/8	12
Oxide M V	5 8	19	63	60	7 1/4	6 3/8	12
Oxide P V	4 1 1/2	5	12	14 1/2	2	5 1/8	11 1/2
Oxide P V	4 1 1/2	7	18	19 1/2	2 1/2	5 1/8	11 1/2
Oxide P V	4 1 1/2	11	30	29 1/2	4 1/4	5 1/8	11 1/2
Gould T P	5 8	7	28	24 1/2	6	3 1/4	12
Gould T P	5 8	9	35	31	6 1/2	3 1/4	12
Gould T P	5 8	11	42	38 1/2	6 1/2	4 1/4	12
Gould T P	5 8	13	42	45	6	5	12