rugated boiler tubes and a hydraulic machine for testing their expansion.

Page Car Company, Winterport, Me.—Models of dumping cars.

Peck, Stow & Wilcox Company, New York.—Wrenches, braces and chisels.

Peckham Manufacturing Company, The, New York.—Taylor non-chattering brake hanger, photographs and blue prints of electric and steam railroad trucks.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.—Chipping, calking and riveting hammers, yoke riveters, rotary drills, breast drills, foundry rammers, air hoists and complete pneumatic equipments; also a Herron & Bury compressor.

Post & Co., E. L., New York.—Post "Zero" metal for car and locomotive bearings.

Pyle-National Electric Headlight Co., Chicago, Ill.—See exhibit of Commercial Acetylene Co.

Railway Appliances Co., Chicago, Ill.—Oldsmobile railroad inspection car.

Rostand Manufacturing Company, New Haven, Conn.—Model of extension hat and bag rack for passenger coaches.

Schoen Steel Wheel Co., Pittsburg, Pa.—Exhibit of Schoen solid rolled and forged steel wheels.

Charles R. Silkman, New York.—An exhibit of samples of "Pluviusin," an artificial leather.

Smart Car Door Co., Nashua, N. H.—Model of Smart flush car door.

Spiral Journal Bearing Co., New York.—Exhibit of new and worn journal bearings.

Standard Brazing Co., Boston, Mass.—Brazing process.

Standard Paint Co., New York.—Refrigerator car models showing insulation sheeting and insulating paper, iron and wood preservative paint, car flooring and "Ruberoid" roofing.

The Standard Steel Works, Philadelphia, Pa.—The Standard rolled steel wheel.

Stannard & White, Racine, Wis.—Exhibit of locomotive cab seats.

Star Brass Manufacturing Co., Boston, Mass.—Steam gages, pop safety valves, lubricators, renewable seat and disc globe valves, angle valves, blow-off cocks, water gages, recording gages patent cylinder relief and vacuum valves.

Templeton, Kenly & Co., Ltd., Chicago, Ill.—Simplex jacks.

Trammell, E. R., Lakeland, Fla.—Safety device for holding up drawheads where pulled out.

Underwood, H. B., Philadelphia, Pa.—Catalogue of special tools, boring bars and valve seat facers, and a quartering level.

Washburn Company, The, Minneapolis, Minn.—Freight couplers, flexible head passenger couplers and switch engine couplers.

Watters, J. H., Augusta, Ga.—Automatic pneumatic track sanders.

Waugh Draft Gear Company, Chicago.—Full size model of spring cushion draft gear.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. The Wellman-Street cast-steel bolsters.

Wheel Truing Brake Shoe Co., Detroit, Mich.—Samples of wheel truing brake shoes.

J. T. Williams & Sons, New York.—Exhibit of fancy woods for interior finish and decoration of cars.

Performance of Automatic Signals Under Unfavorable Conditions.*

BY H. S. BALLIET.

IV.—Batteries and Their Enclosures.

The gravity cell is the most common type of battery in use for working track circuits, being best adapted to heavy discharges and frequent short circuits. Generally speaking, two such cells are placed in multiple; this is done in order to keep the voltage as low as is practicable (about one volt being available). This arrangement of cells is considered necessary in order to avoid the possibility of failure to operate the relay in case one jar breaks.

This cell is easily maintained, it being necessary to renew the sulphate of copper about once every four weeks. A 4-lb. zinc of good quality will wear three months. These zincs should not be used after they are worn thin; for the internal resistance of the cell is then increased and in case of heavy rain or poor track insulation from any cause there are likely to be numerous interruptions, due to the insufficient voltage. Practice indicates that no zinc should be kept in service for a track circuit if it weighs one pound or less.

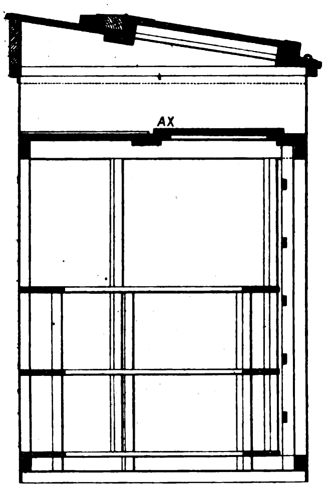

Fig. 1—Iron Battery Well.

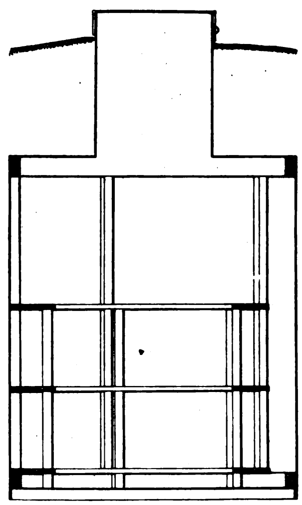

Fig. 2—Battery Well with Small Opening.

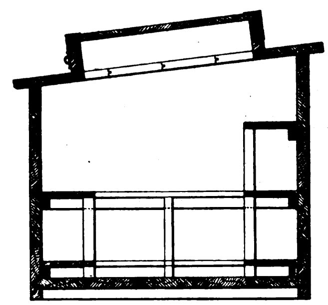

Fig. 5—Wooden Battery Well.

In some sections these cells are kept in good condition by the frequent use of a hydrometer, the density of the zinc solution being maintained at a specific gravity not to exceed 1.15, which is equivalent to about 24 per cent. of zinc sulphate plus 7 molecules of water. While this may work out to a nicety, a better way is to adopt stated periods for renewing the cells, say, once in four weeks, if the traffic is reasonably heavy and once in six weeks if it is not over 30 train movements in 24 hours. It can be said, however, that when working under such conditions cells should be inspected at least once between renewals. If there is too much zinc solution it should be diluted with water. Care should be taken to thoroughly screen and wash all sulphate of copper in a cell when it is renewed, also to remove all collections of copper so as to discourage the so-called "caking." Zincs should be kept scrupulously clean, so that there may be free action. This battery, being made of a solution of sulphate of copper, freezes when the temperature falls below 32 deg. F. To anticipate this condition, the cells are kept in iron pipes called "chutes," set in the ground, which brings the lowest cell about 7 ft. below the surface; deep wooden wells are also used and sometimes surface battery houses. With these precautions, generally speaking, there have been no interruptions to the continual flow of current, but the last winter made new disclosures, and it will be necessary to try new preventives.

A number of gravity cells were frozen for the first time because frost penetrated the earth farther than ever before—from six to eight feet. These conditions have been met successfully by using a liberal amount of mineral wool about 10 in. thick around the chute for a depth of four feet. One very trying case of frozen track battery was that where the temperature remained at from 28 deg. F. to 32 deg. F. below zero for several days. It was impossible to keep the circuits in service without the aid of heat, which was supplied by putting kerosene lamps within the chutes. In another instance the thermometer registered from 10 deg. F. to 20 deg. F. below zero for a period of ten days, the frost penetrating to a depth of five feet. This cold spell was followed by a rising temperature for a period of three days, the thermometer on the third day reaching 50 deg. F.; then there was a steady thermometer ranging from 32 deg. F. to 40 deg. F. for a period of three days at the end of which the cells in six chutes were frozen solid. The failure of the track section due to this freeze-up occurred on the ninth day following the breaking up of the cold spell. It is proposed to meet this condition by putting a liberal quantity of manure around and over the tops of these chutes. It is believed this will be an absolute protection. This conclusion seems warranted from experience gathered on another section of the same road, where under parallel conditions, the cells worked without interruption, having been protected by piling manure around iron battery wells in which were cells of several different designs. In the case of the six chutes frozen, it is known that the earth was not closely packed when the chutes were set.

The gravity cell is also used for operating signal magnets, clutches and locks. When used for this purpose, the cell need not have so close inspection as when it is used for track circuits. The cells are connected in series; with the higher voltage and freedom from polarization under a heavy and continued current output the cell is popular. The labor involved in making renewals when the cells become exhausted is somewhat greater than for cells using soda or potassium. The objections to the cell are briefly: 1, liability to freeze; 2, expense of renewals. To anticipate freezing, many designs of cellars or wells have been devised. Those made of iron are generally like Fig. 1. In this design, boiler iron ¼ in. thick is used. The

*Previous articles on pages 137, 242, 287 and 382.

well is circular with the bottom riveted in so as to guarantee a water-tight enclosure. The shelves on which the cells are set, the "frost-breaker" and the top are made of wood. These wells are usually 7 ft. deep and 5 ft. in diameter.

There is also a design of cellar, or "tub," as it is usually termed, made of wood of the same general appearance as the iron well just described. In both designs of cellars, it is necessary to provide frost doors or breakers, A X Fig. 1. Where this is not sufficient protection manure must be piled around and over the top of the well.

There is in service a cellar constructed on lines corresponding closely with Fig. 2; in this design, it will be seen that the opening is only 2 ft. square. I have never heard of a frozen gravity cell in such a well; a number are in service in the west and northwest.

Where, because of quicksand, rock or swamp, it is not expedient to use the cellar, it is advisable to build shelters on the surface. Of this type of shelter the most common is a small frame building with double thickness wall and an air space of 3 in. filled with sawdust; double floor and double ceiling lined in same manner. The roof is generally of shingle. This box has withstood temperatures as low as zero, but where the thermometer drops below that point, artificial heat must be provided. This is usually done by burning a kerosene lamp within the shelters. Several railroads have surface enclosures built of concrete. This has been found to meet the conditions quite well. Fig. 3 shows a circular brick shelter with a concrete roof; this is of recent design and is believed to be one of the best shelters in service.

Fig. 3—Brick Battery House.

Cells in surface house shelters are renewed with less labor than cells in cellars or wells, for with the latter all materials must be carried to the bottom or the cells must be carried to the surface of the ground. When gravity battery is used, these interruptions may cause delay to trains, unless they are quickly anticipated, and then only at an increased cost for both labor and material.

Of the second objection, it might be briefly stated that the amount of labor employed to keep in operation 3,000 cells of gravity battery on a certain road originally cost 30 per cent. more than it does at the present time with more improved designs of battery.

The gravity cell is gradually giving way to the more improved types of so-called "acid primary batteries," of which there are two distinct classes; those consisting of a solution of potassium hydrate and those consisting of a solution of sodium hydrate. It is probable that there are in service more cells of the former type than any other except the gravity. The most prominent type of this class is the "Edison Primary Cell." Its general design is too well known to require description. Of the second class there are now four prominent types in the market—Waterbury, Gordon, Nungesser and Gladstone-Lalande. In the first three, the cathode or copper element is in the form of scale instead of a compressed plate as in the Edison. The use of scale makes it necessary to use a perforated basket or cylinder.

In the Gladstone-Lalande, the mechanical construction compares favorably with the Edison Primary, differing from that principally in its solution, which is a 20 per cent. solution of caustic soda. Gravity cells are being replaced by cells of the acid type and frequently they are placed in the enclosures formerly used for the gravity. In many cases it is deemed necessary to keep them underground, so that their solutions can be kept from congealing, which action reduces the e.m.f. Carefully compiled records show a diversity of opinion as to best practice in this direction. During the past winter the potash solution, when used underground, *i. e.*, below the frost line, did not congeal enough to cause a noticeable decrease in e.m.f. This appears to be true of all cells, whether they had recently been renewed or had been in service for a year. These cells had the best protection possible short of applying artificial heat.

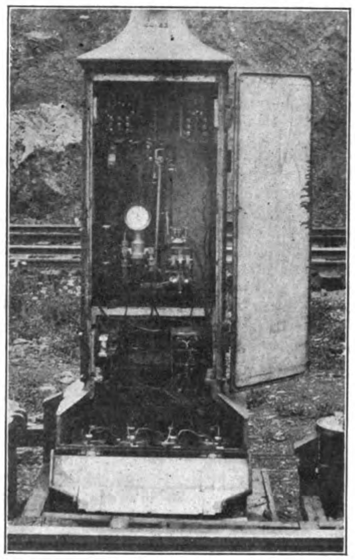

Fig. 4—Iron Battery Enclosure.

There are, however, on record, a large number of failures of this type where the cells were installed within iron enclosures like Fig. 4. The drop in e.m.f. varied in different localities and under different temperatures. In a region where the temperature ranged from 10 deg. F. to 20 deg. F. below zero, many of these cells were frozen into a solid mass and ceased to deliver current; in other localities, the thermometer went as low as 36 deg. F. below zero, but not enough congealing took place to cause the flow of current to cease, although the signals moved slowly; where, under favorable conditions, a signal will move from the stop to the proceed position in 3 to 6 seconds, the time was increased to 30 and even 45 seconds.

As to the cause of this congealing, there is a diversity of opinion. Some claim that it is due to the age of the solution and advocate the renewal of all cells in the fall, so that in cold weather the benefit of the new solution may be had; others think it is the very nature of the solution and that unless heat is applied it cannot be prevented; still another opinion is advanced that the solution is not properly prepared by the men who do the recharging—that they use too much water for the quantity of potash.

A number of cells having a solution of 20 per cent. potassium hydrate with a specific gravity of 1.175 show a decrease of .1 volt per cell in 24 hours with the thermometer at 20 deg. F. below zero. When this drop in voltage was noticed, the specific gravity of the cells was 1.25, they having been in service about six months. As to the renewal of the cells in the fall, opinion differs very much, some claims being made that there is no difference. Cases are cited where renewed cells were placed within the same enclosure with old cells and they all suffered alike. Tests carried through two winters indicate that the trouble is traceable to the density of the solution, principally. It is likely that most of this trouble can be anticipated if the proper strength of solution is used; the trouble with a weak solution being its liability to freeze and with a strong solution to crystallize out.

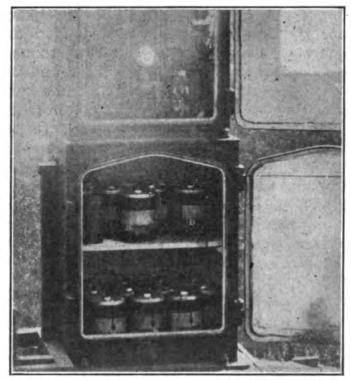

Fig. 6—Iron Battery Enclosure.

The cells in which a solution of sodium is used have shown remarkable qualities to withstand severe declines in temperature. On a large installation where all of the cells are in enclosures like Fig. 6 and in wooden battery wells like Fig. 5, no case is recorded where there was congealing sufficient to reduce the e.m.f. more than one volt for every 20 cells installed. The temperature ranged from zero to 42 deg. F. below; the specific gravity was 1.25, the cell having been in service about five months. These figures apply to a 25 per cent. solution with a specific gravity of 1.29 when installed.

This record is from sections separated many miles and the solutions had been in service anywhere from a few days to about three years; in one exceptional case the cells had delivered current uninterruptedly for a period of 43 months. This particular battery is still in service and operates a home and a distant enclosed disk signal with an average train movement of 30 trains every 24 hours.

Of the cells using sodium over 100 were in service during the past winter for track batteries in exposed places and no failures occurred. Many were in tunnels and on bridges where the gravity cell could not be kept from freezing even by the use of lamps. But to convey the impression that such cells will not congeal, and even freeze, would be wrong; they are thus affected when too much water is used in the solution.