a box 4x4x4. A boy then separates the home records from the foreign and private line records, for which two boxes, 3x3x3, are provided. These boxes to be lettered "Home Record" and "Foreign and Private Line Records." The home records will then be separated by the two ending numbers, 100 boxes being provided for this purpose, lettered, "00," "01," "02," "03," "04," and so on, up to and including "99." The foreign records will be separated in accordance with initials, boxes being provided for each road or private car line. After these separations are made the records are then ready for distribution to the clerks in accrdance with work assigned. Duplicate boxes are provided for clerks lettered as above, in accordance with the assignment of work.

The leaves of the local record book are 23 in. long x 24 in. wide, 2 rows of car numbers and days of the month on each page, 75 car numbers in each row, 150 to the page, and 300 numbers in sight all the time, without turning a leaf. The book is arranged so that all of the cars with the same ending number are placed consecutively. Take, for instance, cars ending with "00." Car 100 comes first, followed by 200, 300, 400, 500, 600," and so on, to include all cars in the equipment ending with "00." Then follow with cars ending with "02," "04," etc., if the equipment is separated into odd and even numbers. On a road with 30,000 box cars, even numbers, there would be 300 cars with numbers ending with "00." There would be 300 car numbers in the record book visible at all times, so that, when the record clerk gets his work it can be entered without any turning of pages at all.

The foreign records are distributed to clerks in accordance with the accounts assigned them, each clerk having a separate box for each account. It is not necessary to separate these records according to any numbers, as very often the ending numbers appear on one or two pages.

Under this system a local record clerk can care for 10,000 cars, and a foreign record clerk for 5,000 as easily as 2,500 and 1,200, respectively, under the present system. There is, therefore, a saving of over 70 per cent. clerk hire over the present method.

There is no additional work entailed upon conductors in making up the wheel report with the exception of writing the date on each square, and for this a rubber dating stamp should be provided, with conductor's name on it.

The plan will save considerable office space, which often is valuable.

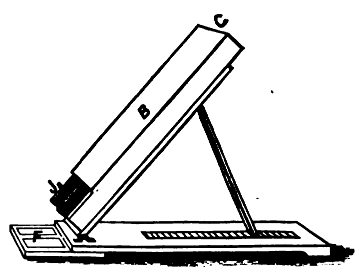
The only offset against the saving made is the cost of extra stationery used, and the wages of the boys to distribute the records. This will vary according to the size of a road; but on a basis of 65,000 cars, home and foreign, a net saving of at least $10,000 per annum can be effected.

On several large railroads the records after receipt in Car Accountant's office are now being transcribed, in order that the work may be distributed direct to the clerks. This is expensive, and productive of error. By using the original reports this expense and liability to error are avoided.

The Tintometer.

The tintometer, devised by J. W. Lovibond, of Salisbury, England, is an instrument by means of which the color of any object, liquid or solid, opaque, translucent or transparent, can be measured and analyzed in such a way as to permit the keeping of a simple and easily understood record; and for facilitating the establishment of color standards and promoting adherence to them. The enumeration below of the uses to which this instrument is put, will suggest various departments of work in which it could profitably be used on a railroad; but it is described here more particularly because it is adapted to testing the colors of signal glasses. A signal engineer having called our attention to the frequency with which colored glasses offered are found to vary in tint from the glasses of the same color already in use or bought from other makers, it seemed proper to call attention to this simple means of establishing standards and of enforcing conformity to them after they are established.

The construction of the tintometer is shown in the illustration. The box B is a rectangular tube black on the inside for cutting off side lights. The tube is divided in the middle lengthwise. In the right-hand side at the lower end is placed the standard glass J. 2 in. x ¾ in., and in the left-hand side the object to be tested. The observer looks into the box at C and sees the standard glass and the glass to be tested side by side and readily notes any difference that may exist; and by successively using standards of different degrees he can measure such difference. The illustration shows in the left side a square glass cup for holding liquid, as, for example, impure water, or oil, or wine. When a very pale liquid is to be tested the instrument is provided with a glass receptacle made very long, so as



to enable the observer to see through a large mass of the liquid. Where necessary, a reflector is placed in front of the lower end of the box. The manufacturers of the tintometer make a series of standard glasses in which the colors are accurately graded from .006 to 20 units. These glasses are of three colors, red, yellow and blue. To make orange, red and yellow are used together: to make green, yellow and blue are used together, and to make violet, blue and red are used. The standard white is pure precipitated limed sulphate, pressed to an even surface. Each of the three colors of a given number has the same color value as either of the other colors of the same number. For example, five units of orange are made by taking five units of red and five of yellow, and looking through both together. By taking equal units of all three colors the light will be entirely absorbed and the result will be black. There are 155 gradations for each color, so that there are 465 different glasses; but for ordinary uses only a small portion of these are needed. A glass with .006 units is so pale that the color is barely recognizable. Experience with these glasses has shown results corresponding to those found by Aubert, who found that a normal eye would detect an admixture of one part of white light in 360 parts of color.

The tintometer is used by dyers of silk, wool and cotton; by painters; by makers of dyes, yarns, and cloth; paper makers and stainers; by steel makers for measuring the color of metals, both cold and when melted, and for estimating the percentage of carbon in steel; also for estimating the percentage of sulphur in steel and iron and in copper ores; by oil refiners and soap makers; by chemists for measuring the turbidity of waters; by bakers for ascertaining the color value of dough; and for many other uses. In testing color-blind persons it affords an accurate means of finding and recording the degree of color perception and of measuring the difference of color vision between two eyes.

The tintometer is sold in America by Eimer & Amend, of 207 Third avenue, New York City, and costs from $21 upward. Standard glasses cost 72 cents each.

Performance of Automatic Signals Under Unfavorable Conditions.*

BY H. S. BALLIET.

V.—BATTERIES (CONTINUED.)

The storage cells in most general use for signals belong to the class known as "lead accumulators." In these cells, strips or plates of lead separated by strips of rubber or suitable insulating material are placed in an electrolyte consisting of sulphuric acid diluted to about 1.17 specific gravity, which density corresponds to about 23 per cent. of acid in the liquid. When charging an accumulator, the passage of current through the cells causes the accumulation of sulphuric acid, which in turn produces a phenomenon known as gassing or boiling, which is an indication that the cells are about charged. In addition to noting this gassing point, it is well to observe the color of the plates, which should be a deep velvety brown for the positive and a slaty gray for the negative. This condition also is a sign that they are properly charged. Not infrequently there is present an insoluble sulphate which forms on the edges of the plates; it resembles a white coating or glaze. This condition should be avoided and if it occurs should be treated by prolonged overcharging and discharging to about 1.8 volts per cell.

It will be noticed as the charge continues that the density of the electrolyte increases; it should in all cases gradually rise from the normal (1.17 specific gravity) to about 1.21 specific gravity, indicating the presence of about 28 per cent. sulphuric acid when the charge is completed.

The e.m.f. of the various cells which have been mentioned is approximately as follows: Gravity, 1 volt; potassium hydrate cells, .7 volt, and sodium cells, .7 volt while that of the accummulator is approximately 2 volts. It is 2.05 when slightly discharged and gradually falls to 1.90 volts when nearly discharged.

The acid must be diluted with pure distilled water and the acid itself be made from sulphur; not from pyrites, as is frequently done. In the maintenance of these cells, great care should be exercised that the acid is properly diluted and that it is free from impurities such as copper, iron, arsenic and nitric and hydrochloric acids, otherwise the plates are apt to be injured.

The experience of the past winter has refuted many claims which have been advanced to discourage the general adoption of accumulators for signal purposes. It has been stated that these cells should be placed in 7-ft. wells, like the gravity battery, on account of their liability to congeal. Readings taken at various times and in widely different localities indicate that the drop in 55 cells was less than one volt for the 110 volts represented, *i. e.*, the nest measured 110 volts before the cold wave set in and during its progress; the decline due to the cold was about one volt, apparently. These records come from points where the discharge rate

*Previous articles on pages 137, 242, 287 and 382; also p. 102, Vol. XXXVII.

averages 5 amperes for 4 seconds. A number of these readings were taken with the thermometer registering 20 deg. F. below zero. A few cases are on record where accumulators are used to deliver approximately .5 ampere continually; these are protected with nothing but a 1-in. hemlock partition, and the temperature is known to have been 10 deg. F. below zero for four days, with no apparent reduction in e.m.f. From these records, it seems justifiable to use these cells within shelters like numbered 5 in my last article. If this conclusion is correct, it indicates the possibility of great improvement in the operation of electric signals during severe winter weather, owing to the higher voltage available.

It has been the general belief that accumulators should be kept in cool places, but experiments carried through two years show that no ill effect results from exposing them directly to the rays of the sun. A curious result of the change in capacity by the application of heat is that by this means we can apparently get more current out of a cell than is put in.

A well known storage battery authority reports as follows: "A cell was charged at 14 deg. C. with 61.9 ampere hours at a rate of .109 amperes per square inch. The cell delivered on discharge after being heated to 45 deg. C. 96 ampere hours. Charged at a rate of .0685 amperes per square inch and temperature of 14 deg. C., 76 ampere hours were put into the cell and it discharged 108.3 ampere hours on being heated to 45 deg. C."

To apply charging current to a number of sets of accumulators through line wires a central station is necessary; or the current can be purchased from some convenient power company. It is not always economical to establish a central station, especially when current can be bought at four cents or less per kilowatt hour and the service is available under all circumstances. When a system of signals extends through many towns and power of suitable potential is available, it is better to charge in small sections, as the use of a number of different sources reduces to a minimum the danger of interruption.

There are in service at this time three distinct methods for operating automatic block signals when accumulators are used: (1) Power-charged cells by line wire, (2) power-charged cells (portable), (3) by employing primary cells. When power lines are installed the wires used in transmitting the charging current to the various sets of batteries are placed on the poles carrying the telegraph and telephone wires, the cost of a separate pole line being thus avoided. These line wires are generally .165 inch in diameter, being hard drawn copper with either double or triple braid weatherproof insulation and each wire weighing between 520 and 600 lbs. per mile. In case of sleet or high wind storms, these wires are subjected to many chances of interruption and unless the system is designed to work in spite of occasional breakdowns of the pole line, there is likely to be unnecessary detention to trains owing to the accumulators becoming exhausted. Cases are on record where pole lines have been washed away by floods so that they could not be restored for a week. In cases like this, it may become necessary to put in primary cells temporarily. Such a condition has repeated itself in certain sections of the country for two seasons, and without the aid of primary cells the automatic block signals would have been out of order at least 12 hours after traffic was resumed; but by the use of primary cells trains were run by the signals (track-circuit) while there was still one or two feet of water covering the track.

According to the report of a committee of the Railway Signal Association, power lines are only applicable where three, four or more parallel tracks are signaled, the blocks being approximately one mile in length. Figures quoted by this committee and data supplied by those operating such a system show great economy as compared with a primary cell installation. As a rule, on a four track road six cells (approximately 12 volts) in series are installed, thus making it possible to operate four signals from one battery if necessary. Also at terminal stations or yards and in special outlying cases where many signals are required in order to move a large number of trains close together, the total number of cells to operate them can be reduced, thereby effecting a saving as compared with primary cells. Where conditions are favorable, accumulators are used for track circuits. Where conditions warrant the use of power line and accumulators the decrease in the labor charge is very perceptible.

When portable accumulators are used, it is customary to install four cells (approximately 8 volts) at each signal. These cells should be of sufficient capacity to furnish current for at least one month. At the expiration of this period, the cells are removed and taken to a designated central station where they are charged. If signals are 1½ miles apart and only one or two tracks are signaled, the portable accumulator system is preferable.

Under such a system all cells can have a regular inspection and the life of the plates can be much extended by having expert attention. The rapid increase of the "all-electric" power-operated interlocking plants has made portable batteries popular because there is no need of installing special central stations. These all-electric plants are being rapidly introduced at isolated places on many railroads, so that the question of distributing cells every 30 days becomes an easy problem. By supplying a full set of 55 or 56 cells of accumulators, they can be charged in multiple with the regular quota of cells used for the interlocking plant, with no additional expense for fuel or attendance. These cells are always available for renewal of those which are exhausted. The cost of transportation of the cells is practically nil, when a regular routine of renewals is established. Work trains on congested parts of the road and tricycle speeder cars on less busy sections can be used for this purpose. On a large road the maintenance force can often be reduced as much as 40 per cent; *i. e.*, a road employing a signal repairman and a batteryman for every 15 miles of double track can reduce the force in almost every case so as to require only one batteryman for every 30 miles. Such a system has advantages over the line wire system because there is no pole line to interrupt the regular charging; neither are crossed overhead circuits causing short circuits or grounds. In case of serious floods or other interruptions it is probably less annoying and there is less delay in getting signals in working orders.

When accumulators are charged by primary cells, it is customary to use the gravity cell, four being required for each accumulator. Such records as are available indicate that the cost of maintenance on such a system is less than with primary cells used direct and more than by either the portable or the line wire charging systems.

Objections to such a system are (1) the fact that the gravity battery needs frequent renewing, (2) liability of broken jars in the charging battery and (3) possibility of freezing of the charging battery, unless extraordinary measures are taken, as mentioned in the beginning of this article. There is one advantage gained by such a system as compared with a primary cell system, and that is the increased amount of current available at all times. In a system of electric semaphore signals, this is very necessary where weather conditions are variable.

The question is frequently asked as to the advantage of having the battery or power localized at each signal, as compared with the systems using a common source of current or power. The subject should be considered in two distinct parts: First, signals worked by battery; second, those worked by power. When battery is employed and the current for each block is localized (whether it be at the signal it operates or at the next signal in advance with the signal-operating current transmitted by line wire) the delay to trains is reduced to a minimum, because an exhausted battery, a broken cell or a broken line wire interrupts but one signal. When a common battery is used for several signals, all of them are interrupted.

When air is used a broken main pipe or a shut-down at the pumping station affects all the signals dependent on that pump or that pipe. When compressed air in reservoirs or liquid carbonic or dioxide gas is used, with a supply at each signal, the delay or interruption is limited to one signal.

High winds in summer and sleet or snow in winter are responsible for many broken line wires and not a few detentions to trains are charged to this cause under the battery system. Floods have caused the stoppage of many trains and under a common battery system would cause no end of complaint from the transportation department, whereas if each signal has its own battery, the failures are reduced to a minimum and in many cases the signals are in perfect working order long before the track is ready for service.

During the past winter many main air pipes were pulled apart on account of contraction; and not a few cases are recorded where many miles of signals were out of order for hours from this cause. What little damage is incurred by high water when air or gas is provided in cylinders at each signal is inconsiderable, and the detention to trains is even less than in the battery system.

Master Mechanics' Reports.

Last week we printed a number of reports and papers presented to the Master Mechanics' Association. Others will be found below:

COAL CONSUMPTION OF LOCOMOTIVES.

One of the most thorough and comprehensive reports presented was that of the committee appointed to consider the above subject. The report is subdivided under four general heads as follows:

1. Is the operation of large engines what it should be from a standpoint of engineers and firemen?

2. Are the present tendencies as to large grates and heating surfaces disadvantageous? Are the proportions correct?

3. Is the large locomotive giving results in operation which would be expected from the large increase in capacity?

4. Is the operating department of railroads deriving the amount of assistance and relief from large locomotives which may be justly expected? If not, how should the attention of the locomotive designers be directed?

Operation of Locomotives from Standpoint of Engineers and Firemen.

Theoretically, the pooling of locomotives is advantageous, but there are many conditions which detract from the theoretical benefit of such method of handling, when applied in practice. It may happen that en-