braked on the basis outlined in Mr. Nellis' paper, with highly satisfactory results.

A paper by Mr. R. H. Blackall (W. A. B. Co.) on "The Friction of Brake Shoes" was, in the absence of the author and at the request of the President, presented in abstract by Mr. F. W. Sargent. There was no discussion of this paper nor of the one following, which dealt with the selection of subjects, committee work and the presentation of papers, by Mr. F. M. Nellis. In connection with the latter, however, it was suggested by Mr. F. B. Farmer that all committee reports and papers sum up, in the form of recommendations, the points it is desired to have the association discuss or act on.

In discussing Mr. F. B. Farmer's paper on "Responsibility for Torn-Off Air Hose," Mr. Carlton (C. & N. W.) told of having watched cars being switched in yards in St. Paul and in all cases the hose was pulled apart. They stretched badly, the pipes vibrated injuriously and in one case the lining of the hose was torn. Mr. Greenwade had seen angle cocks pulled off. Rules against pulling the hose apart in uncoupling cars, with penalties in case of violations, appeared to be general among the different roads, but the chief difficulty seemed to be inability to catch the switchmen at it. Some roads have their inspectors part the hose by hand before the train is pulled on to the lead preparatory to distribution, others require the trainmen to perform this duty, while still others have a helper accompany the checker as he goes over the train, and part the hose. The Northern Pacific tried at one point the experiment of detailing one man to this duty, with the result that the hose consumption was cut down 50 per cent. Mr. Burton said the Central of New Jersey gives close attention to the hose question. Inspectors part the hose on incoming trains in the larger yards. Regular inspections and tests of the hose are made periodically, the soapsuds test being used and all hose showing bubbles on being coated from end to end are taken off. All of the equipment is got over about once a year, and the average service of hose with them is 25 to 27 months. The inspectors are all impressed with the idea that the entire train line must be tight, and on their trains they have no difficulty in keeping up the pressure on 80 cars with one pump at ordinary speed. After some further discussion the recommendation of the paper was adopted.

The paper of Mr. S. J. Kidder (W. A. B. Co.) on "Electric Car and Train Brakes," contained no recommendations and was not discussed, being received as information.

A committee appointed to revise the constitution and by-laws in accordance with the President's recommendation, submitted a report recommending a number of changes, important among which was the vesting in the executive committee the authority to select the place of meeting. This has been done by the convention heretofore.

The subjects for the 1905 convention are:

(1) The Air Pump Suction Strainer and Automatic Lubrication of the Pump Air Cylinder.

(2) Train-Pipe Leaks in Freight Service: Effects, Causes, and How to Reduce.

(3) Maximum Braking Force as Regards Foundation Brake for Passenger and Freight Cars.

(4) Best Brake Rigging Design to Accomplish Harmonious Action of Hand and Air Brakes on Passenger and Freight Cars.

(5) Revision of "Progressive Questions and Answers."

Under new business Mr. P. J. Langan (D., L. & W.) spoke at some length of the condition of brakes on private line cars and moved that the committee representing the association at the M. C. B. convention bring the matter to the attention of that body with a view to seeing if something could not be done to remedy the conditions.

Topical Discussions.

On Tuesday a 15-minute topical discussion was devoted to the matter of best method of stenciling brake cylinders, triple valves and high-speed valves. The subject was suggested by Mr. Burton, who stated that not only do no two roads do this alike, but neither do any two points on any one road; and none follow M. C. B. recommended practice. Their scheme (C. R. R. of N. J.) is to show the name of the repairman, name of station at which repaired and date, and the initials of the road —each of these three items being on a separate line.

Mr. Stricklan (D. M. & N.) said their practice was to stencil the month and year of cleaning on the side of the auxiliary reservoir.

Considerable objection is found against the raised cast letters on the side of the auxiliary reservoir, as they interfere with stenciling and it was stated that there is a growing sentiment in favor of the omission of these letters, leaving the side of the reservoir smooth.

The question was asked by a member from the New York Central if any roads made a practice of stenciling the date of cleaning the high-speed reducing valve. The N. Y. C. does not.

Mr. Down (W. A. B. Co) was in favor of condemning the practice of stenciling the date of testing only, as productive of confusion, preferring stenciling only for cleaning, oiling and testing. Mr. F. B. Farmer thought that one stencil showing month, year and place is all that is necessary and this should cover minor repairs of the usual kind. Mr. Nellis suggested that the representatives of the different roads state their practice in writing, the whole to be submitted to a committee for study and the evolution of a recommended practice.

In a short discussion on Thursday, the matter of adopting the 1¼-in. air hose as standard was considered. It was recommended that during the coming year members observe the effects on this size hose of the higher trainline pressures and report the results at the next convention.

Exhibits.

The exhibitors at the convention were as follows:

The Ashton Valve Co., Boston, Mass.—Sample air gage.

J. R. Clancy, Syracuse, N. Y.—Sample of "Sure Grip" hose clamps.

Consolidated Car Heating Co., Albany, N. Y.—Sample parts of heating apparatus, hose couplings, etc.

Crandall Packing Co., Palmyra, N. Y.—Samples of Crandall air-pump packing.

The Dukesmith Air-Brake Release-Signal Co., Meadville, Pa.—Instruction car equipped with air-brake apparatus and the Dukesmith air-brake release signal.

John T. Fuhrman, St. Paul, Minn.—Sample triple valve-seat facing device.

The Garlock Packing Co., Boston, Mass.—Samples of Garlock packings for air pumps and throttles.

H. G. Hammett, Troy, N. Y.—Sample triple-valve bushing roller.

Harris Manufacturing Co., Greenville, S. C.—Harris combined train signal and indicator. This device was described in the *Railroad Gazette.*

H. W. Johns-Manville Co., New York.—Train-pipe covering and "Vulcabeston" specialties for air pumps.

John C. Lyons, McComb, Miss.—Improved engineer's brake valve and improved air-pump steam-head using balanced valve.

New York & New Jersey Lubricant Co., New York.—Samples of "Non-Fluid Oil" air-brake lubricant.

Performance of Automatic Signals Under Unfavorable Conditions.*

BY H. S. BALLIET.

III.—Operating and Controlling Mechanisms.

The signal controlling mechanism is a part in which there is room for improvement. The enclosed disk is the oldest form of automatic block signal now in use, and there is no doubt that it is the simplest and most reliable. The parts composing it are few and easily inspected. The method of operating the armature which carries the disks is by magnetic attraction through a curved armature. (See Fig. 2.) The disks are put to "proceed" by energizing the magnet and they are held in that position by the same armature pull. When the flow of current is interrupted, and the magnet de-energized, the disks return to the "stop" position by gravity.

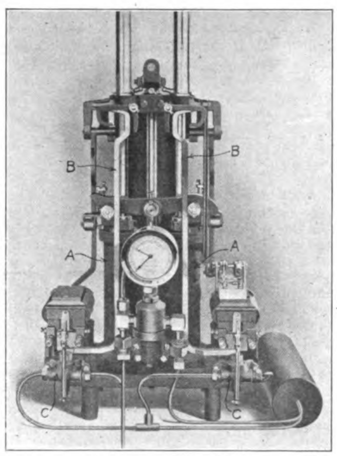

Fig. 1.—Electro-Gas Signal Apparatus.

In the later designs an operating and a controlling magnet are employed, the latter being called the "hold-clear" magnet. (See Fig. 3.) The operating magnet, termed the signal magnet, has a curved armature, and the poles are separated from the armature by an air gap of about $^1/_{64}$ of an inch. This space is designed to be uniform, no matter what position the disk occupies.

The controlling magnet is an ordinary electro-magnet wound to a given resistance, and is used to hold the disks in the proceed position. The armature of this magnet, about $^1/_{16}$-in. thick and 6-in. long, is fastened to the revolving armature of the operating magnet in such a manner as to allow the latter to rest on the ends of the control magnets, an air gap of only about $^1/_{32}$ in. being maintained so as to get along with the least practicable amount of energy. The control magnets are so situated that a contact spring is opened when the revolving armature has reached the position to correspond to the proceed position of the disk, and this puts the operating magnet and the control magnet in series. The resistances of the magnets are usually arranged so as to consume, while the disk is being drawn from the stop to the proceed indication, about .150 ampere at 4.5 volts and .015 ampere after it has reached the end of its movement.

The control magnet thus saves much energy which otherwise would be wasted. In many instances the life of primary cells has by this means been prolonged 60 per cent.; when a signal battery is known to have operated a signal two years, its life has been extended to about 3¼ years. This saving is, of course, very tempting to the signal superintendent, but there is a new possible danger added by its introduction; the liability of the armature for this control magnet to become wedged or possibly frozen fast to its pole pieces.

To obviate this difficulty, a new design of control magnet has been introduced (see Fig. 6), and its location with reference to its armature has been changed. In this design the magnets are fixed in a horizontal plane, with their poles facing the edge of the armature and separated from it by an air gap of about $^1/_{16}$ in. The chance of interruption by wedging or freezing is anticipated. The magnets are wound to 600 ohms resistance, which further reduces the current needed. Only a small part of the enclosed disk signals now in service are equipped with the controlling magnet.

To make this design of signal as economical as possible from a maintenance point of view, the air gap between the curved armature and the poles has been made so small as to elicit criticism. The construction of the cloth or aluminum disk is such as to allow but very little counterweight when the magnets are de-energized and therefore a slight friction will cause the disk to remain at "proceed." Flies, spiders, grit, coal dirt and particles of steel broken from screw heads have lodged in the armature interrupting its operation. It may be said that neglect in maintenance is the cause of these interruptions, but as a practical matter most failures of this kind are beyond anticipation. A maintainer or repairman in making a systematic inspection must open the signal enclosure and not infrequently the faults are developed while the case is thus open. The obstructions may not lodge on the armature or pole piece while the inspection is in progress, but it is the open door that makes the trouble. Particles of coal or similar substances, scarcely perceptible to the naked eye, have been found to make trouble with these armatures. The air gap might be increased to $^1/_{16}$ in. with but slight increase in the cost of maintenance. A few of these instruments with $^1/_{16}$ in. air gap are now in service and are working satisfactorily. These instruments are on circuits where the current is .130 amperes at 4 volts. The test thus far indicates no increased cost in maintenance, but as it is unquestionable whether this will hold

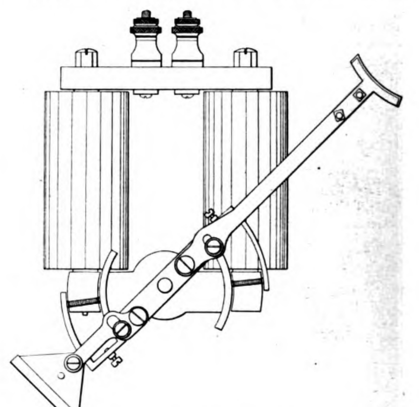

Fig. 2.—Signal Magnet for Enclosed Disk Signal.

good in all cases, it will be best to allow an increase of one volt per circuit. This increase appears justified in the increased safety afforded.

As noted in a previous paper, moisture is collected within the enclosures containing these electro magnets and their armatures. These deposits occur at any season of the year, when conditions are favorable. When the moisture is thus collected and remains on the magnets, the wire terminals are slowly destroyed; corrosion sets in where they pass through the end pieces of their respective magnets, and it is necessary to renew them once in about every four years. A number of things have been tried to anticipate this interruption. Thus far shellac has proved best. It should be applied and thoroughly dried, before the magnet is installed. This will materially prolong the life of the wire. During the winter this moisture is liable to freeze the poles and the armature, thereby preventing the proper operation of the armatures.

The electric semaphore has now reached a good degree of perfection. In a general way, there is probably but little room for criticism, except in the motor and the parts controlling it. With the vertical rods and their connections within iron masts reduces the interruptions. In order that the semaphore arm may be quickly returned to the stop position when the clutch magnets are de-energized, sufficient weight is added to the spectacle casting, and the vertical rods and their connections to

*Previous articles on pages 137, 242 and 287.

compensate for any excessive weight which may be caused by the accumulation of wet snow or sleet on the arm. These counterweights are generally arranged so as to require a weight of two pounds at the extreme end of a 4½-foot arm to deflect it one degree. In the earlier designs of electric semaphores the arm is returned to the stop position by employing a 20-lb. oval shaped casting fastened to the balance lever supported several feet down on the outside of the mast. An automatic semaphore signal, which is so designed as to require a dead lift of 100 to 110 lbs. on the vertical rod when the arm is started from the stop to the proceed position, will require a coating of sleet, ice or snow of not less than two inches over its entire surface to cause it to remain at proceed. How much accumulation would be necessary to deflect the arm downward 10 or more deg., when so weighted is not known, as no records are available.

There are few instances where semaphore signals fail to return automatically to the stop position when conditions are favorable; but conditions do arise when the arms will remain at proceed.

In all the electric signals there is to be found an arrangement of gears, arms or other mechanical contrivance in conjunction with an electric armature (see Fig. 4), through which the arm is set to the proceed position by power transmitted from the motor. Not infrequently, the clogging of some part or parts through the medium of a stray screw dropping into moving parts, or absence of lubrication or the presence of frost and ice or rust, caused by water continually dropping from within the mast, cause failures in operation. Usually these failures do not cause a dangerous indication, but this is not unknown. There is but little weight available to start the arm from the proceed to the stop position unless everything is in good working order. Careful and regular inspection is the remedy.

On account of the numerous connections and contacts required in the various circuits operating electric motor signals, not a few failures are caused by sparking and dirty contacts. This trouble, unless anticipated, becomes a serious annoyance. Brushes on motor commutators have worked out of their holders and caused unnecessary stoppage of trains. Owing to the small power available, on account of the limited voltage generally employed, high resistances are not infrequently noted between commutator and brush.

The general practice of trying to operate the semaphore signal too cheaply is a cause of much unsatisfactory service. It is the custom to employ motors of about $^1/_6$ h.p. to perform this function. Seven to 10 volts and 2 to 3.2 amperes are generally required to set the signal to the proceed position. The energy is supplied by 14 to 16 cells of primary battery capable of delivering between 8.4 and 10.6 volts at about 4 amperes for 300 ampere hours. This tendency toward cheap maintenance compels the reduction of the safety factor very perceptibly; for to make the air gaps and armature adjustments capable of working on a very little current, usually about $^1/_{10}$ of an ampere, they are made too small to be

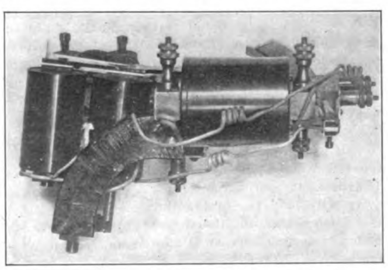

Fig. 3.—Signal Magnet and Hold-Clear Magnet—Old Style.

reliable. Secondary cells are installed at a few points, usually four cells, practically eight volts, being available.

If signals are to be relied on under all conditions motors of greater efficiency must be employed, so as to make available more current and voltage for the clutch armature; enough so that it may be farther removed from its pole piece, thereby decreasing its liability to remain in an improper position when the track section is occupied.

The most delicate part of the electric semaphore signal is the motor armature or commutator. In addition to interruptions previously noted, the accumulation of moisture on these armatures brings about many bad effects; it not only tends to destroy the insulation of the various connections, but it starts corrosion of the terminals and brushes. These conditions occur in the summer principally. In the winter the trouble is due to precipitation and afterwards freezing. While much has already been said about commutators, it may not be amiss to refer to the subject again, as my assertion in a previous article is now disputed in some quarters; I refer to frost on glass-enclosed commutators. In defense of this earlier statement, it may be well to inquire a little more closely into the construction of these so-called sealed or frost-proof commutators.

In the construction of any motor, it is practically impossible to cut off the circulation of air along the armature-winding where it passes between the poles. The practice is to place extra collars on the poles and on the commutator in such a manner as to make a good, close fit, but not an air-tight fit. To the upper collar is screwed the glass cover (B, Fig. 4). This same defect is found where celluloid and brass commutator covers are used. To do away with precipitation within these enclosures, it will be necessary to form a vacuum which cannot be accomplished in the present design of motor. Every design of motor, whether its commutator is open or closed, has failed from frost accumulation in given localities; though of course it must not be assumed that all motor signals are condemned by a few extreme cases.

It has been suggested that the frost conditions which cause so much annoyance are mostly due to the fact that mechanisms are not properly protected with reference to their connection with the earth. But I can cite the case of a certain signal which, when first installed, was frequently interrupted owing to frost accumulations; the mast being so designed as to allow communication with the ground. The following season, this mast was renewed and its mechanism placed within an iron case and all communication with the earth apparently cut off; but still there were failures from this same cause. Two seasons have now passed, and the interruptions do not appear to be any less than three seasons ago. In another instance, it was suggested that the motors be placed underground to get below the frost line. A test of this theory brought no better results.

The electric semaphore, as well as the enclosed disk, is subject to criticism because so little room is left between the armature (C, Fig. 4) which engages the vertical rods (commonly known as slot or

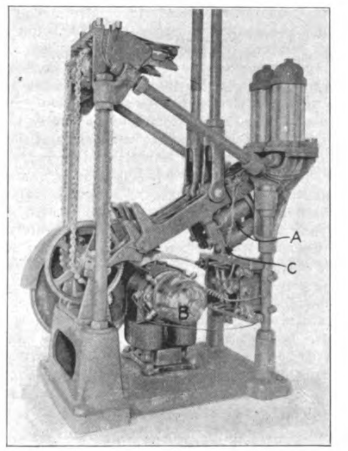

Fig. 4.—Electric Motor for Semaphore Signal.

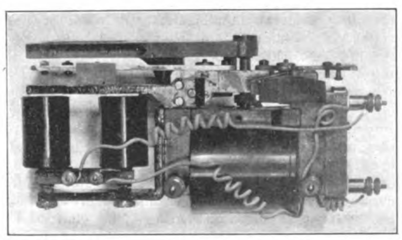

Fig. 6.—Signal Magnet and Hold-Clear Magnet—New Style (Top View Looking Down).

clutch magnet armatures) and the pole pieces of the magnet (A, Fig. 4). Not a few cases are reported where the moisture accumulated at this point has frozen the armature to the pole piece, making it impossible for the same to disengage and thus allowing the semaphore arm to return to the stop position. To meet this difficulty, thermal coils were arranged around the poles of the magnets and an effort made to keep them dry by heat, but it was only partially successful.

In justice to the various designs of slots and clutches, it can be said that with a little more air gap to guard against freezing, they can be made practically perfect. There is no chance for clogging or interruption as in revolving armatures, such as are employed in the enclosed disk.

To surely maintain the space between armature and pole piece, there should be a stop so fixed that the armature plate can never touch any part of its poles. It is this contact between armature and poles that causes the sluggish return or the freezing fast of the armature plate.

Practice indicates that the resistance of slot or clutch magnets should be low. The many turns which are necessary in high windings cause the slow release of the armature and in many instances appear to promote residual magnetism.

The electro gas semaphore overcomes many of the deficiencies noted in other designs. A few of these signals have been in service for two winters, but it was not until this season that the number was sufficiently large and their locations distributed over sufficient territory to give a good test of their efficiency.

There is little doubt that frost accumulations on motor commutators is responsible for this latest innovation. The liquid carbonic acid gas or carbonic dioxide gas possesses the property, if perfectly free from moisture, of absorbing vapor from air. Then again the low temperature of the chemical tends to keep the metallic parts at a uniform temperature, doing away with contraction and expansion.

But the gas cylinders (A, Fig. 1) by which the rods are operated by the admission of gas under a pressure of from 30 to 40 lbs. to the square inch, become chilled in extreme cold weather, and it is necessary to add extra counterweight to assist in the return of the semaphore arm to the stop position; and in such weather the discharge of gas into the enclosures when moisture is present in the gas causes large quantities of frost to be deposited on all moving parts, thereby interrupting their proper operation. With the use of levers (B, Fig. 1) to mechanically shift some parts, there is trouble because when frost is present the valves remain partly open, thus allowing a free escape of gas from the tank through the valve, without performing a function. In one design of these signals, the number of moving parts is reduced to a minimum, and there is little to be said against its general design. The magnets (Fig. 5) are properly located with reference to the gathering of moisture on pole pieces and armature plates are built on a horizontal plane. A good air gap is provided, making it practically impossible for it to become interrupted by freezing. These clutches and slots require an average of eight volts and .190 amperes of current to engage them and successfully operate the valve.

In the other design, the slot magnet is built on a vertical plane, and there is the liability to interruptions on account of frost and ice described in a previous paper.

The clutches or slots require more voltage and current to engage them owing to the pressure of gas on the diaphragm. When, however, the signal has been set to the proceed position, the energy can be reduced to a minimum by introducing extra resistances into the clutch or slot, thereby reducing the cost of maintenance somewhat. The cost for battery energy is greater for gas than for enclosed disks or electric semaphores, but this is warranted because of the extra protection guaranteed. The location of the clutch magnets, in the gas mechanism, is such as to discourage the accumulation of moisture on the pole pieces, what small quantities are collected readily dropping down between them and the armature plate. The air gap (A, Fig. 5) being very great, the drops of moisture will not lodge on the plate. This protection is a distinct departure from other forms of electric clutches or magnets thus far employed.

The experience of the past winter has shown that this gas will freeze at the valves, either at the reservoir or the signal mechanism (C, Fig. 1), interrupting operation; and it is necessary that the gas be used in an absolutely dry state if it is to meet extreme weather conditions. Probably the only way in which this dryness can be assured is by means of electrodes placed within the tanks. The expansion of this gas in warm weather causes the pressure to rise rapidly, and it is often the case that the

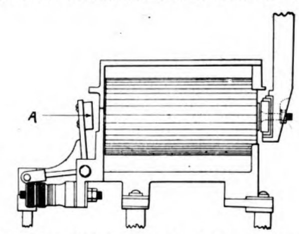

Fig. 5.—Clutch Magnet of Signal Motor.

pressure at the cylinder is raised from the normal 30 lbs. to 90 and even 100 lbs. This causes the arms to move too quickly, and is likely to bend or break different parts. It is impossible to maintain a reasonably even pressure during the summer. In the winter the sudden drop in temperature contracts the gas enough to cause the arms to operate very sluggishly, and unless a high pressure is continually available, there will be failures.

Circuit breakers located at switch points or on signal masts and used to open and close the various circuits are also subject to much interruption due to the accumulation of frost. It is a common sight to see these contacts completely covered with ice and frost. This condition is noted principally where an effort is made to keep the boxes air tight. All manufacturers as a rule supply rubber packing between the lid and the frame so as to exclude any water in case of flood. This condition is the direct cause for many unnecessary failures.

During the early morning hours in the summer the arms and contact springs will be found completely covered with dew and cases are on record where well defined leaks in circuits occurred on account of the presence of this moisture. Where these circuit breakers are used to control a distant signal, by repeating the position of the home arm, these springs are open for some time and it is a common occurrence to have a small coating of ice form on the contact blocks, insulating them and thereby causing the failure of the distant signal to move to the proceed position.