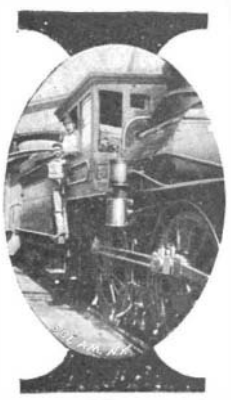
## RAILWAY SIGNALS.

BY C. FRANCIS JENKINS.



IN no other corporate industry have organization and efficiency been more highly developed than in the railroads of the United States. The most perfect illustration of this is the enormous amount of passenger traffic which is safely handled every year over the thousands of miles of rail-girded country. This has become possible only by the development of a system whereby accountability is clearly and accurately defined. Presiding over the great army employed are men of the highest order of ability—men competent to deal intelligently with the varied conditions incident to the smooth and safe movement of the trains. The recent establishment of a schedule of mile-a-minute trains between the Atlantic seaboard and the Rocky Mountains certainly indicates the utmost confidence by both railway officials and the traveling public in the devices employed to safeguard traffic.

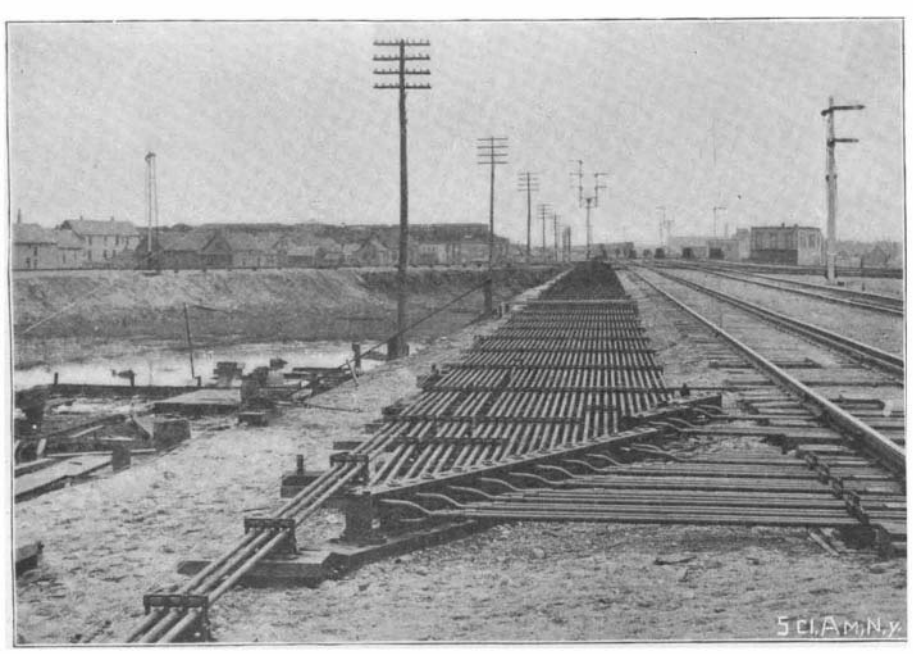
These consist, so far as the public sees, of what is known as the "block system." That is, the entire road is divided into short lengths or blocks marked by towers, each under the immediate charge of a signal operator. Three distinct types of signals are recognized, i. e., telegraphic, automatic, and manual-controlled, the primary purpose of each being the same, namely, the protection of trains from derailment and collision. The earliest and now obsolete form was the "time block," in the operation of which a certain interval of time had to elapse after a train had passed into a block before another was permitted to enter the same block. But as a time interval and not a space interval was the unit of safety between running trains, obviously it didn't protect.

In the telegraphic block system the operator is supposed to keep his signal set at "danger" until notified that the train has passed into the block ahead. But there is nothing to prevent a "clear" signal being shown through mistake or carelessness. This is more or less overcome in the "automatic" system, by which the passing of the train itself into the next block sets the signal at clear. It is necessary, however, to allow the following train to proceed after a time even against a danger signal; for it is impossible to know whether the signal indicates danger because a train remains in the block or because of the failure of the apparatus to work properly.

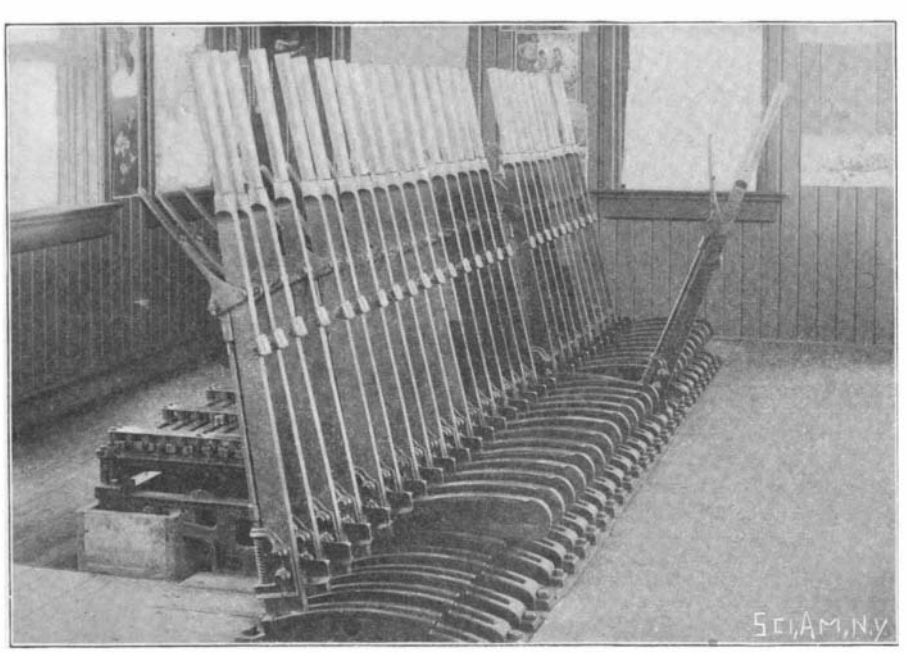
The latest and by far the best system in use is a combination of the manual and automatic. In this system the signals are set by hand, but are locked and released electrically by the operator in the next tower as well as by the passing of the train itself, the track being divided into electrically insulated sections for the purpose. Thus, it will be seen that it is almost impossible for a signal to be improperly displayed.

The signals or semaphores are paddles normally standing out at right angles to the supporting pole, indicating danger, and variously known in railroad parlance as "home," "advance" and "distant" signals. The home blade is square-ended, and, like the pointed advance blade, is painted red with a white band. The distant blade is "fish-tail" and painted yellow and black. The reverse of each is painted white with a black band. The opposite end of the blade has a little glass window which shows red at night. When the outer end is dropped it indicates clear track, and for the same purpose the light shows white at night. The light behind the distant blade is normally green, and means "caution." The signals are counter-balanced so that they always return to danger position, horizontal, if anything goes wrong with the controlling apparatus. This, too, aside from the consideration of human life.

When the third-rail system of power distribution has become universal, as it most assuredly will, the running of each train will be under the direct supervision and immediate control of the train dispatcher himself. The towers, signals, and operators will continue as now, but the train dispatcher will know from personal observation the exact location of each train. Thus, in the train dispatcher's office will be a working model of the entire division over which he has jurisdiction. On each track is a miniature duplicate of each train speeding across the country. These miniatures start, run and stop in exact synchronism with the trains on the big tracks, so that the speed, location, progress, and condition of every train on the division is known to the dispatcher at a glance. On the table in front of him are a number of "keys." If a train passes a tower against a signal, he is able to



Semaphore, Switch, and Machine Connectors.



The Interlocking Machine Controlling Semaphores and Switches.

"Distant" Signal Set at Danger.

"Home" Signals. Top Blades for Passenger and Bottom Blades for Freight Tracks.

"Advance" Signal, Dropped to Indicate Right Track Clear.

bring it to a standstill by simply pressing the proper key, thus cutting off the current from the offending train and preventing collision. It is only another means by which the controlling mind is more effectively employed to still further reduce the number of accidents, which are now but one passenger killed to one hundred thousand safely carried.

For the illustrations accompanying this article, the writer is indebted to the Signal Engineer of the Chicago, Milwaukee and St. Paul Railway.

## EDUCATION BY CORRESPONDENCE.

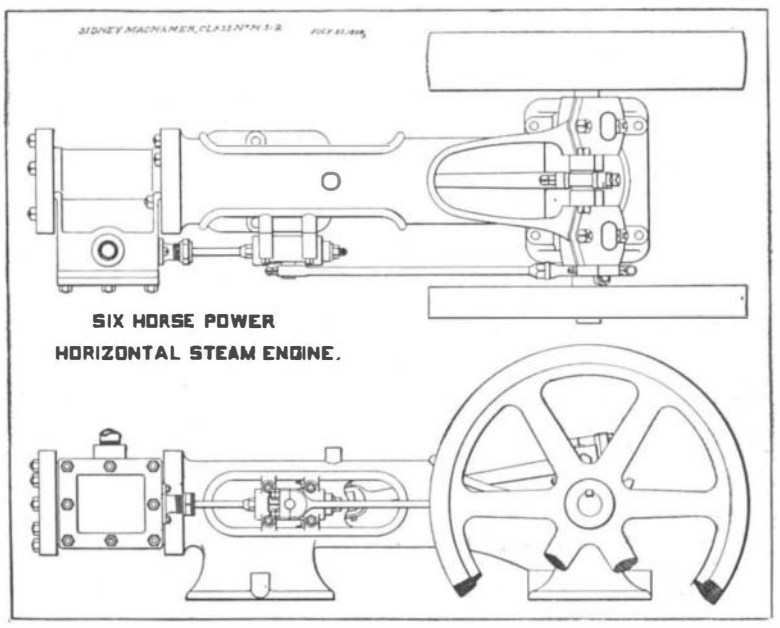
The rapid growth and remarkable popularity of schools of correspondence prove that this new system of education meets a distinct want and has come to stay. Their raison d'etre is to be found in the desire of the industrial classes to meet the demand of the technical trades for skilled workmen and foremen, whose education shall include something more than the three "R's" of the district school.

From among the many institutions that are giving instruction by correspondence, we have selected for illustration the International Correspondence Schools, of Scranton, Pa., for the reason that they are the original institution of the kind, and the largest and most representative of the many that are now in more or less successful operation. The Scranton establishment has 130,000 students on its books and is rapidly adding to this enrollment. Starting in 1891 merely as a school of instruction in mining, the scheme of education has widened to include practically the whole field of technical instruction, the intending students having the choice of some sixty separate courses, conducted by a corps of 226 professors and assistants. These figures are surprising and certainly go to prove that instruction by correspondence forms one of the most valuable educational agencies of the day.

Although the roll of the International Correspondence Schools includes the names of many people who are holding responsible positions in the various professions and are already possessed of a liberal education, the chief aim of the schools, as expressed by Mr. T. J. Foster, their founder and present manager, is "to enable people who are engaged in the industrial trades to supply deficiencies in their education due to lack of opportunity or application in their younger days." As thus defined, it is evident that the movement is operating in an entirely new field, being in competition neither with the high school, the technical school, nor the university. There is no question that the ambition of the average American to become a wage-earner frequently leads him to exchange the school for the workshop long before the former has had the necessary time to give him his proper equipment; and while he may for the first few years consider himself financially the gainer, it frequently happens that his advancement in his trade is brought to a full stop by the lack of technical knowledge. It is too late for him to "go to school again," for he can neither afford the expense nor is he willing to give up a position which he may not again be able to secure. The night-school, of course, in many cases affords a partial solution of the difficulty; but there are multitudes of workers for whom these admirable institutions are not available, especially in the thinly-populated and rural districts. Another type that is beginning to avail itself of correspondence instruction is the professional man who wishes to acquaint himself with the principles of a kindred profession, whose work at times overlaps his own. Such a case is that of the architect, who finds that a knowledge of the principles of engineering as applied to the design of framed metal structures is necessary if he is to be full master of his own profession. Many of the students, again, are educated men who wish to study special branches of engineering, or make a thorough review of their former studies; and hence, while the bulk of the students of these schools are drawn from the artisan and farming classes, there is a considerable and increasing number of students of broad education who are taking special courses in the more advanced branches.

The test of eligibility to become a student is that the candidate must be able to read and write English. The schools, to use the language of their prospectus, undertake to teach him "whatever he needs to know." In taking him through a course, the instructor proceeds upon the curious assumption that his pupil knows absolutely nothing about the subject. The assumption is curious and original, but thoroughly philosophical; for, if the student is acquainted with the earlier stages, he passes quickly through them, merely refreshing his memory, while the instructor is certain that in every case the student lays a proper foundation for future work. Starting, then, with the assumption that the student knows nothing of the subject, the schools send him his first and second Instruction and Question Papers.

After studying the first paper, he returns his written answers to the questions asked in the Question Paper to the schools, and proceeds with his second paper. At the schools the answers are corrected in red ink and returned to the student, accompanied by the third Instruction and Question Papers and a letter explaining the errors and corrections in further detail than is possible on the answer sheets themselves. If the student secures ninety per cent on his first paper, it is entered on the books as passed; but if he fails to get this percentage the paper is returned, and he is obliged to review the incorrect portion. This system is followed until the course is completed, when the schools' diploma is granted after a final examination. Although students are not limited as to the time required for the completion of a course, those that meet with difficulties are assigned to "special instructors," who are skilled in dealing with such cases.




DRAWING TO SCALE, MADE BY A SIX MONTHS' STUDENT.

One of our illustrations shows a corps of women examiners at work, making preliminary corrections of such errors as occur in arithmetic, spelling, punctuation, etc. The papers are then submitted to the principals and male instructors for final inspection and the correction of such subjects as the women examiners are not qualified to correct, before being returned to the student. The transfer of papers is so arranged that the student has always something to study while the preceding papers are being corrected.

In describing a curriculum that includes no less than sixty separate courses, ranging from Arithmetic to Civil Engineering, it must suffice to take a single subject and let that stand for the whole. One of the most interesting and successful courses is that of Mechanical Drawing. In this, as in all subjects, it is presupposed that the student requires instruction from the ground up. He is furnished at nominal cost with a set of drawing tools, and his first lesson, consisting of exercises in drawing lines, circles, etc., is sent to him. Upon the receipt of his sheet of drawings, corrections with elaborate pencil notes are made, indicating where a full line is ragged, or a dotted line irregular in length or spacing, or defects occur in the lettering. To prevent mere copying, the instruction charts are printed out of scale, and the students are at all times obliged to draw from scale. One of the last exercises of the course is to draw a complete steam engine from rough pencil sketches of the parts which have the dimensions upon them. The progress in this department is often remarkable, as may be seen from the accompanying drawing, made from rough dimensioned sketches, which was done by a student whose earlier drawings, made only six months before, are extremely crude and rough.


RAILROAD INSTRUCTION CAR.

In the chemistry, metal mining and electrical courses, as in that of mechanical drawing, the students can secure from the schools sets of apparatus which are put up specially to meet the requirements of the particular courses. Thus the student in telegraphy is provided with a telegraphic outfit, and the student of chemistry with the necessary reagents and apparatus to cover the experiments included in the course. The accompanying photograph shows a student in chemistry experimenting.

The courses of study are laid out with a view to giving special training in subjects which in a school or college course merely form incidental features in what is known as a broad education. In the International Correspondence Schools system these courses are divided into two classes, one including a thorough training in the principles of the subject, the other class including courses for those who wish to make a more special and advanced study of the subject. Thus, under the first head may be mentioned the mechanical and electrical engineering courses, and under the second the stationary engineering and locomotive-running courses. The last course includes the study of everything connected with the running of trains, including, besides the locomotive, the air brake, train heating and lighting and the kindred subjects. In connection with this course the schools keep three instruction cars on the road, the first of which is herewith illustrated. These cars are fitted up with complete air brake and other equipments, in the manner adopted by the chief railroads of the country for the instruction of their own employes.

The corrected papers become the property of the student, and if at any time he should be in difficulties, he can turn to his old records and refresh his memory with the corrections made for him during his course. He is also furnished, as he progresses with his work, with a complete duplicate set of all the instruction and question papers, drawing plates and keys, covering the course, which are bound in half leather and form a valuable reference library for use in his future studies, or in connection with his trade or profession.

To the textbook department falls the important work of preparing the instruction and question papers, all of which are the work of the regular professional staff of the establishment. The selection of these gentlemen has been made with a view to giving to the instruction that practical character which is such a valuable feature of the schools. In every case they have been actively engaged in business, either for themselves or in the employment of well known industrial concerns, and they are thus well qualified by their training to prepare textbooks adapted to the special and practical needs of the student. Most of the faculty are graduates of leading American and European colleges. Among them are to be found former city engineers, ex-chief engineers or ex-chief draftsmen of bridge companies, electrical companies, and general engineering firms, and to this practical experience is to be attributed the clearness, directness, and simplicity which characterize the instruction papers.

Mention of the instruction papers suggests the important matter of illustrating, to which the schools have paid special attention. The excellence of the cuts which appear in the papers is due to the care exercised in the selection of competent draftsmen, and a staff of fifteen (shown in one of the illustrations of the front page) is steadily employed on new work.

It will readily be understood that to carry on a correspondence instruction with over 100,000 students calls for an extensive printing establishment. This work is carried on in five divisions in a separate building. The press rooms, which are located on the first two floors of the building, contain ten cylinder and four job presses. The third floor is occupied by the bindery; and the fourth floor by the book composing room and the proofreaders' room. Work is about to be commenced on a new building, covering over an acre of ground, which will accommodate a printing plant capable of executing all the work of the schools, three-fifths of which at present has to be done in New York and Philadelphia.

From what has been said it will be evident that the new method of instruction as carried out by the Scranton establishment is qualified to rank as one of the most important educational agencies of the day. As long as it is prosecuted along the practical and very thorough lines above described, it cannot fail to exert a helpful and lasting influence upon both the characters and fortunes of thousands of students who devote their leisure hours to its work.

## Dwarf Habit of Plants.

M. P. Gauchery has made an exhaustive study of the phenomenon of "manism" in the vegetable kingdom. His general conclusion is that the peculiarities which distinguish the external form and the internal structure of plants are, like other characters, largely dependent on the environment, and are displayed more strongly in the vegetative than in the reproductive organs. A dwarf plant is not a miniature of the species with all its organs developed in the same proportion as they are in a plant of normal size.—Ann. des Sciences Nat. Bot.