obtained was lower than if the shoe had been cold, and to eliminate this cause of variation the shoe was cooled between tests, that its initial temperature might always be approximately the same. To insure clean dry surfaces the wheel tread and shoe were sponged with benzine before each test, except in the case of the lower tests plotted in diagram marked "Steel Wheel–65 mi. per hr.–Shoe A."

Transverse tests of samples of soft cast iron, hard cast iron, soft cast steel and hard cast steel, representing shoes "A," B," "C" and "D," respectively.—Made by the Norfolk & Western Railroad Co., at Roanoke, Va.—Each curve represents the average of three tests. —Sizes of bar, 2 × 2 in.; span, 21⅜ in.

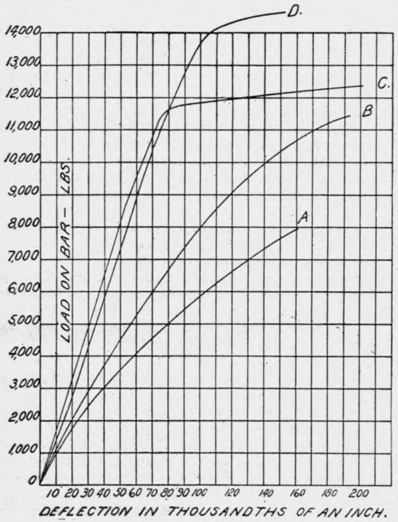


Fig. 2.

Those shoes in which the rubbing surface is cast iron, either in whole or in part, become much hotter during a test do the shoes of wrought iron and steel. With the P shoe practically no heat is absorbed by the composition.

When a cast-iron shoe is used on the chilled wheel small particles broken off of the shoe adhere to the wheel surface and make it rough, the roughness increasing with the number of applications. The hard cast iron shoes B and K do not make the wheel so rough as does the soft shoe A.

Continuous use of a wrought-iron or steel shoe on the chilled wheel makes the latter quite smooth. When these shoes become heated the metal flows and particles accumulate at the end of the shoe last in contact with the wheel. With the hard steel shoe D this occurs to a lesser extent than with the soft shoes C, L and M.

Those shoes of cast iron with wrought-iron or steel insets (H and I) roughen a chilled wheel slightly and the insets flow to some extent and are forced into the cast-iron body of the shoe.

The composition shoe P has no tendency to cut the wheel and imparts to it a high polish.

Cast-iron shoes (A, H and K) tend to smooth a steel-tired wheel when the breaking pressures are light, but in the heavy-pressure tests particles of the iron adhere to the wheel and make it rough, though not to the same extent as with the chilled wheel.

Steel and wrought-iron shoes (C, D, L and M) score the steel-tired wheel and pieces torn off of the shoe become imbedded in the wheel. The hard shoe D scores the wheel worse than the softer ones.

The steel and wrought-iron insets of shoes H, I and R roughen the steel wheel.

Shoe P used on a steel wheel fills irregularities of the wheel surface and imparts to it a polish as with the chilled wheel.

Most of the tests made in 1895 were repeated this year and the results check closely with those previously obtained, except in the case of shoes C and D. It will be remarked that the diagrams illustrating the results with the C shoe on chilled wheel show a great variation in the co-efficient of friction obtained under similar conditions as to pressure and speed. This is due to the condition of the wheel surface; a smooth wheel, such as can best be obtained by the continuous use of this shoe, is necessary in order to obtain the higher values for the co-efficient of friction, and a few tests with a soft cast-iron shoe will so roughen the wheel as to give a low co efficient. The effect of a rough wheel is most marked with light braking pressures. After the cause of this variation was determined, steel and wrought-iron shoes were not tested until the wheel surface had been put in a condition favorable to getting the maximum co-efficient.

The table of results here given has been compiled from the data presented in the revised report of the Brake Shoe Committee, and to be published in the Proceedings of the Association. There are here given the average results of a representative series of tests of each shoe under different conditions as to speed and pressure. As the conditions in practice vary greatly the co-efficients likely to be obtained under favorable conditions will be most valuable, and, hence, these tabulated results are for the higher points of the diagrams.

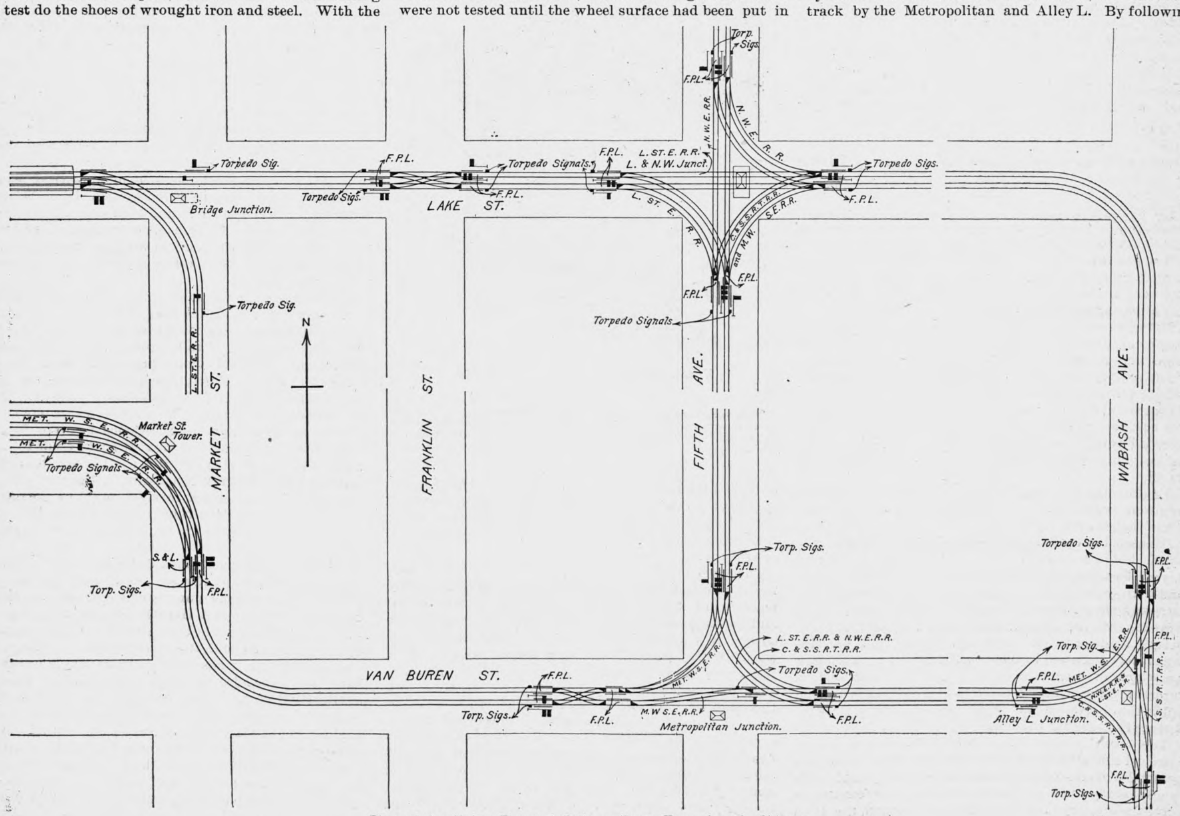
At the Master Car Builders' convention in June the members of the old committee were appointed to constitute a standing committee on tests of brakeshoes, and further tests will be made during the coming year, though the work has not yet been outlined.

Signaling and Interlocking on the Union Elevated or Down-Town Loop, Chicago.

The Alley L, Metropolitan West Side and the Lake Street Elevated Railroads of Chicago, now in operation, and the North Side Railway Company, which is preparing to build from Lake street north, have formed a company known as the Union Elevated Railway of Chicago, for the purpose of building and working a down-town loop, which will enable each of the four roads to deliver passengers in the business district. This down-town loop will consist of a double track with junctions at Wabash avenue and Van Buren, Fifth avenue and Van Buren, Lake street and Van Buren, and the necessary connecting tracks, crossovers, etc. In addition to the three junctions mentioned, the Metropolitan four-track Railroad, which now ends at Franklin street, will be changed so as to carry traffic south on Market to Van Buren, and the present interlocking plant at Bridge Junction will be enlarged to work the double cross-over at Franklin and Lake streets.

The volume of traffic over this loop will be very great. The number of trains now on the three railroads in operation is not less than 1,000 day, and with the addition trains from the North Side, this movement will be at least 1,500 trains a day.

The Alley L., Metropolitan West Side and Lake Street lines are worked right-handed, and in order that the traffic may be divided on the Loop it has been decided to work the Loop left-handed, the outer track being used by the North Side and the Lake Street, and the inner track by the Metropolitan and Alley L. By following



Plan of the Union Elevated Railway (Down-Town Loop), Chicago.

The Equipment of the Various Towers is as Follows:

ALLEY L JUNCTION.

4 levers for 6 switches and 1 torpedo signal.
3 levers for 3 F. P. locks.
6 levers for 6 torpedo signals and 6 detector bars.
10 levers for 10 signals and 3 bolt locks.
—
23 active levers.
5 blank spaces.
—
28 lever frame.
2 additional levers for 3 F. P. locks.

METROPOLITAN JUNCTION.

7 levers for 12 switches.
4 " " 8 F. P. locks.
7 " " 7 torpedo signals and 7 detector bars.
11 levers for 11 signals and 4 bolt locks.
—
29 active levers.
3 blank spaces.
—
32 lever frame.
3 additional levers for 4 F. P. locks.

MARKET STREET TOWER.

2 levers for 2 switches and 1 lock.
1 lever " 1 F. P. lock.
6 levers " 6 torpedo signals and 6 detector bars.
7 levers for 7 signals and 1 bolt lock.
—
16 active levers.
4 blank spaces.
—
20 lever frame.

L. & N. W. JUNCTION.

6 levers for 12 switches.
4 " " 6 F. P. locks.
8 " " 8 torpedo signals and 8 detector bars.
13 levers for 13 signals and 6 bolt locks.
—
31 active levers.
5 blank spaces.
—
36 lever frame.
4 additional levers for 6 F. P. locks.

BRIDGE JUNCTION.

Additions to Present Machine.
4 levers for contact rails.
2 " " 4 switches.
2 " " 4 F. P. locks.
4 " " 4 torpedo signals and 4 detector bars.
6 levers for 6 signals.
—
18 active levers.
6 blank spaces.
—
24 lever frame.

the current of traffic on the several lines as indicated by the arrows it will be seen that the crossing of the several points will necessitate the installation of a very complete system of signaling and interlocking.

The National Switch & Signal Company has the contract for planning the system to be used and for designing and installing all the work, and the General Manager of the Union Elevated, Mr. D. H. Louderbach, has charged the signal company with the duty of presenting the most complete plans necessary to the safe movement of traffic, regardless of cost of installation, and no expense will be spared to make the installation of these five plants complete and perfect.

All switches will be considered as facing-point switches and will be equipped accordingly, and since it is not advisable to provide any physical protection in the shape of a derail or skotch block, the torpedo machine will be installed and worked in the same manner as a derail and each signal will be worked in conjunction with this torpedo signal, all torpedo signals having separate levers and connections from them operating the signal.

The moral influence of this torpedo signal is considered to be very valuable, for since each torpedo machine is provided with a certain number of detonators, and since the operator in charge of the plant is required to keep a complete record of each detonator delivered to him, it is not likely that he will allow an engineer to pass a signal at danger and explode a detonator without reporting it to the proper officer, and since the engineer knows that such report will be filed against him he will not be likely to pass the signal at danger.

The machine at Fifth avenue and Lake street will be placed in a tower spanning the tracks, and will have 40 levers; the machine at Wabash and Van Buren street will be placed in a tower on the deck of the bridge and will contain 32 levers; the machine at Van Buren and Fifth avenue will be in a tower south of the south track, and will contain 36 levers; the machine at Market and Franklin streets will be in a tower between the lines of Franklin street, and will contain 20 levers; the additions to the present plant at Bridge Junction will involve 24 levers. All the signal towers will be fire-proof, the machine carried on steel frames, and the towers equipped in the most complete manner with plumbing, heating and telephone connections.

The working of traffic around the loop will be entirely in the hands of the Union Elevated Railway, and as soon as a train from either of the four lines enter the limits of interlocking all trainmen will be under the orders of the officers of the Loop. It is expected that work will commence at once at Bridge Junction, and Van Buren street and Fifth avenue. The motive power to be used on the Loop will be electricity, as on the Metropolitan West Side, there being a third rail carrying the current which is supplied to the motor through a contact shoe.

Past and Present Tendencies in Engineering Education.*

BY MANSFIELD MERRIMAN, *Professor of Civil Engineering in Lehigh University; President of the Society for the Promotion of Engineering Education.*

The present status of engineering education in the United States is the result of a rapid evolution which has occurred in consequence of changes of opinion as to the aims and methods of education in general. . . . Thirty years ago public opinion looked with distrust upon technical education. Its scientific basis and utilitarian aims were regarded as on a far lower plane than the well-tried methods of that venerable classical education whose purpose was to discipline and polish the mind. What wonderful changes of opinion have resulted, how the engineering education has increased and flourished, how it has influenced the old methods, and how it has gained a high place in public estimation, are well known to all.

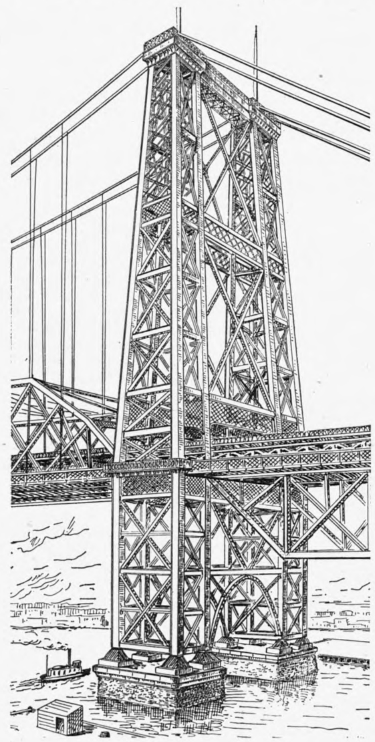
Engineering courses of study a quarter of a century ago were scientific rather than technical. It was recognized that the principles and facts of science were likely to be useful in the everyday work of life and particularly in the design and construction of machinery and structures. Hence mathematics was taught more thoroughly and with greater regard to practical applications, chemistry and physics were exemplified by laboratory work, drawing was introduced, and surveying was taught by actual field practice. Although engineering practice was rarely discussed in those early schools, and although questions of economic construction were but seldom brought to the attention of students, yet the scientific spirit that prevailed was most praiseworthy and its influence has been far reaching.

This scientific education notably differed from the old classical education in two important respects. First, the principles of science were regarded as principles of truth whose study was ennobling because it attempted to solve the mystery of the universe; and second, the laws of the forces of nature were recognized as important to be understood in order to advance the prosperity and happiness of man. The former point of view led to the introduction of experimental work, it being recognized that the truth of nature's laws could be verified by experience alone; the latter point of view led to the application of these laws in industrial and technical experimentation. Gradually the latter tendency became far stronger than the former and thus the scientific school developed into the engineering college.

*Presidential address before the Society for the Promotion of Engineering Education at the meeting in Buffalo, N. Y., Aug. 20, 1896.

The very great value of laboratory experiments, and of all the so-called practical work of the engineering school of to day, is granted by all. Principles and laws which otherwise may be but indistinct mental propositions are by experimentation rendered realities of nature. The student thus discovers and sees the laws of mechanics, and is inspired with the true scientific spirit of investigation. It should not, however, be forgotten that if such practical work be carried beyond the extent necessary to illustrate principles it may become a source of danger. The student of average ability may pass a pleasant hour in using apparatus to perform experiments which have been carefully laid out for him, and yet gain therefrom little mental advantage. Especially is this true when the work assumes the form of manual training, which, however useful in itself, is properly considered by many as of too little value to occupy a place in the curriculum of an engineering college.

The tendency toward the multiplication of engineering courses of study has been a strong one, especially on the part of the public. This has resulted in a specialization that, as a rule, has not been of the highest advantage to students. In some institutions this has gone so far that the student of civil engineering learns nothing



Tower of the New East River Bridge.

The engraving shows the design of the towers for the new East River Bridge. We have no description other than what appeared in our issue of July 31, to which the reader is referred.

of boilers and machines, while the student of mechanical engineering learns nothing of surveying or bridges. The graduate is thus too often apt to lack that broad foundation upon which alone he can hope to build a successful career.

The development of the scientific school into the engineering college has been characterized throughout by one element of the happiest nature, that of hard work and thoroughness of study. The numerous topics to be covered in a limited time, their close inter-relation, and the utilitarian point of view, have required many hours per week and earnest work by each student in preparation for each exercise. The discipline of hard and thorough work is one whose influence can scarcely be over-estimated as a training for the duties of life, and in every university it is found that the activity and earnestness of the engineering students is a source of constant stimulus to those of other departments. Thus scientific and engineering education has tended to elevate the standard and improve the methods of all educational work.

The length of the course of study in engineering colleges has generally been four years, and whatever tendencies have existed toward a five-years' course have now for the most part disappeared. With higher requirements for admission, particularly in English and in modern languages, a reduction of the length of the course to three years may possibly be ventured in the future, particularly if the long summer vacation be utilized for some of the practical work, as indeed, is now the case in several institutions.

There has been and now is a strong tendency to a reduction in the length of the college year; . . . yet the fact remains that it is not good business economy to allow the buildings and plant of a college to lie idle for so large a part of the year. It is perhaps possible that in the future the summer schools may be so developed that the work will be practically continuous throughout the year, thus giving to students the option of completing the course either in three or four years.

The report of the committee on requirements for admission, which will be presented later in the session, sets forth many facts which show the tendencies now existing. Almost without exception a higher standard is demanded, both that students may enter with better mental training, and that more time may be available in the course for technical subjects. While the general line of advance is toward an increase in mathematics and in modern languages, there is also found, particularly in the central states, a demand for broader training in science. It has already been pointed out that our early engineering schools were strong in scientific training, and that the tendency had been to replace this by industrial applications. If the requirements for admission can be extended to include the elements of chemistry and physics, with some botany or zoology, the engineering student will enter with broader views, a keener power of observation and a scientific spirit, that will greatly increase his chances for success in technical studies. . . .

Having now considered some of the general elements and tendencies in engineering education, it will be well to take up the programme of studies. . . .

Mathematics is undoubtedly the most important subject in all courses of engineering study, and it has been demanded for years that it be taught with great thoroughness. This demand has been met more completely in the independent engineering colleges than in the engineering courses of the universities. Much, however, remains to be done in this direction, and probably it cannot be satisfactorily accomplished until a change in method has been effected. The fundamental element in the change of method must be, it seems to me, in a partial abolition of the formal logic of the text-books, and an introduction of historical and utilitarian ideas. Mathematics is a tool to be studied for its uses rather than for its logic or for the discipline that it can give; hence let its applications be indicated frequently and not be systematically kept out of view. If the student gains the impression that his mathematical exercises are merely intended to train the mind, his interest and his progress will usually be slow. If, however, he learns what mathematics has done in the past, how it joins with mechanism to explain the motions of the distant planets, as well as to advance the material prosperity of man, there arise an interest and a zeal that help him to overcome all difficulties.

The great advantage of numerical exercises in all branches of pure and applied mathematics, and the deplorable lack of good preparation in arithmetic have been expressed by many educators. In numerical computations the average engineering student is weak in spite of the numerous exercises in his practical work. To remedy this defect better instruction in arithmetic is demanded in the common and high schools, while in engineering colleges the teachers of mathematics should constantly introduce numerical work and insist that it be done with a precision corresponding with the accuracy of the data.

Next to importance in mathematics comes mechanics, the science that teaches the laws of force and motion. In most institutions the rational is separated from the applied mechanics, and often taught by the mathematical department. Probably less improvement has resulted in the teaching of rational mechanics during the past quarter of a century than in any other subject. That mechanics is an experimental science whose laws are founded on observation and experience is often forgotten, and the formal logic of the text-books tends to give students the impression that it is a subsidiary branch of mathematics. The most interesting history of the development of the science is rarely brought to the attention of classes, and altogether it appears that the present methods and results are capable of great improvement.

It should not be overlooked, however, that in recent years the so-called absolute system of units has been introduced into mechanics, and is now generally taught in connection with physics. Here the pound or the kilogram is the unit of mass, while the unit of force is the poundal or the dyne. Although this system possess nothing that is truly absolute, it has certain theoretical advantages that have commended its use, notwithstanding that no practical way of measuring poundals has been devised except by the action of the force of gravity on the pound. Engineers have continued to employ the pound weight as the unit of force, and the calculations of the physicist must be translated into the units of the engineer before they can be understood. The student of rational mechanics thus has the difficulty at the very outset of two systems of units, and great care should be taken that each be thoroughly understood and the relations between them be clearly appreciated by application to many numerical problems. In view of these and other difficulties and of the novelty of the subject in general, it appears that some engineering colleges do not give to rational mechanics as much time as its importance demands.

Physics in some colleges is taught by a course of five or six exercises per week, extending over a year, while in others the elements are required for admission and the regular course is correspondingly abridged. The marvelous development of electrical theory and practice