piece; it will receive no hammer-refining and the high heat will leave its structure coarse.

I wish to call attention to the use of old axle steel for blacksmith shop tools, when only the factor of battering and abrasion is to be taken into account, such as flatters, fullers, sledges and sets, and all tools that call for from 60 to 70 carbon points in crucible steel. Of course, we know that axle steel containing from 40 to 45 carbon points will not ordinarily withstand battering, but we have experimented, and with good success, in utilizing some of our old steel axles for the above mentioned tools. Our method is simply to harden the head, and on such tools as flatters and sets to harden both the head and face. The process merely involves a determination of the proper temperature which can be permitted for hardening in water, and I find that some caution is necessary to obtain the desired result. If the heat is too low, the temper in the tool will be too soft to withstand battering, and again, if the heat is too high it will hasten the destruction of the tool by causing the head to break away, and for the reason of not knowing the exact carbon points, there is no means of absolutely determining the right heat, and therefore our only guide is to calculate from its action under the hammer. Axle steel containing 45 carbon points should be drawn or tempered to a second blue. This will change the steel from a loose to a combined condition, thus making the working parts, or the parts that receive the blow, more compact. We have in use in our shop tools made from old axle steel that are just as serviceable for the purposes mentioned as any crucible steel of 60 or 70 carbon points.

Schenectady New Double-End Locomotives.

The Schenectady Locomotive Works recently built for the Dominion Coal Co., Ltd., Cape Breton, Nova Scotia, a double-end mogul and a double-end consolidation, an engraving of the former of which is shown herewith. These engines were designed to conform to specifications of the Dominion Coal Company, and were built to meet the particular conditions of service on the company's railroad.

The consolidation weighs 239,000 lbs. and the mogul 172,000 lbs. The cylinders of the former are 22 in. x 28 in., and of the latter 19 in. x 26 in. The working steam pressure of the consolidation engine is 200 lbs. and of the mogul 180 lbs. The descriptive specifications for the consolidation are as follows:

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	239,000 lbs.
" on drivers	170,000 lbs.
Wheel base, driving	15 ft.
" " rigid	15 ft.
" " total	36 ft. 3 in.

Cylinders.

Diam. of cylinders	22 in.
Stroke of piston	28 in.
Horizontal thickness of piston	5½ in.
Diam. of piston rod	3¾ in.
Kind " " packing	Cast iron
" " " rod packing	U. S.
Size of steam ports	18 in. × 1¼ in.
" " exhaust ports	18 in. × 2¾ in.
" " bridges	1⅛ in.

Valves.

Kind of slide valves	American balanced
Greatest travel of slide valves	5½ in.
Outside lap " " "	¾ in.
Inside " " " "	1/32 in.
Lead of valves in full gear	1/16 in.
Kind of valve stem packing	U. S.

Wheels, etc.

Diam. of driving wheels outside of tire	55 in.
Mat'l " " " centers	Main, cast steel, inter. F. & B. steeled cast iron
Tire held by	Shrinkage
Driving box material	Main, cast steel, inter. F. & B. steeled cast iron
Diam. and length of driving journals	Main only 9 in. diam., 8½ in. diam. × 10 in.
" " " " main crank pin journals,	(Main side 7¼ in. × 5 in.) 7 in. diam. × 6½ in.
" " length of side rod crank pin journals,	(F. & B. 5 in. × 3½ in.) inter. 6 in. diam. × 4½ in.
Engine truck, kind	2-wheel swing bolster
" " journals	6 in. diam. × 10 in.
Diam. of engine truck wheels	30 in.
Kind " " " "	Plate

Boiler.

Style	Straight
Outside diam. of first ring	72 in.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Carbon steel
Thickness of plates in barrel and outside of firebox,	27/32 in., 9/16 in., ½ in. & 11/16 in.
Horizontal Seams	Butt joint sextuple riveted, with welt strip inside and outside
Circumferential seams	Double riveted
Firebox, length	114 in.
" width	41⅞ in.
" depth	Front, 70½ in.; back, 67½ in.
" material	Carbon steel
" plates, thickness	Sides, 5/16 in.; back, 5/16 in.; crown, ⅜ in.; tube sheet, ½ in.
" water space	Front, 4 in.; sides, 3½ in.; back, 3½ in. × 4 in.
" crown staying	Radial stays, 1⅛ in. diam.
" stay bolts	1 in. diam.
Tubes, material	Charcoal iron No. 12
" number of	348
" diam.	2 in.
" length over tube sheets	13 ft. 10 in.
Fire brick, supported on	Studs
Heating surface, tubes	2512.55 sq. ft.
" " firebox	176.92 sq. ft.
" " total	2,689.47 sq. ft.
Grate "	33.21 sq. ft.
" style	Rocking
Ash pan "	Sectional, dampers front and back
Exhaust pipes	Single, high
" nozzles	5¼ in., 5½ in., 5¾ in. diam.
Smoke stack, inside diameter	16 in.
" " top above rail	14 ft. 9 9/16 in.
Boiler supplied by	Two Hancock Inspirators, Type A, size No. 9 R. & L.

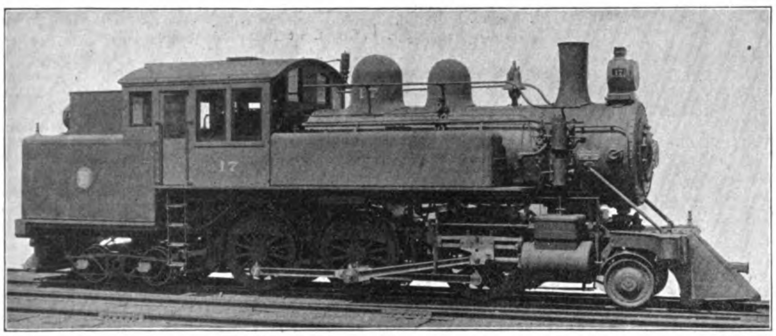
Tender.

Wheels, number of	4
" diam.	28 in.
Journals, " and length	5 in. diam. × 9 in.
Tender trucks	4 wheel center, bearing swing spring bolster carrying back end of engine
Water capacity	4,200 U. S. gallons
Coal "	4 tons

American steam brake on all drivers and on 4 wheel truck. Two headlights; two Crosby 3 in. muffled safety valves; magnesia lagging on boiler and cylinders; Leach sand feeding apparatus; one No. 3 Star 6 in. chime whistle.

The descriptive specifications are about the same for the two engines. Below are given some of the leading dimensions and weights of the mogul:

Weight in working order	172,000 lbs.
" on drivers	122,000 lbs.
Wheel base, driving	13 ft. 2 in.
" " rigid	13 ft. 2 in.
" " total	32 ft.
Diam. of cylinders	19 in.
Stroke of piston	26 in.
Outside diam. of first ring	62 in.
Working pressure	180 lbs.
Thickness of plates in barrel and outside of firebox,	9/16 in., ½ in., 7/16 in. and ⅝ in.
Firebox, length	90 in.
" depth	Front, 66½ in.; back, 56½ in.
" crown staying	Radial stays, 1 in. diam.
" stay bolts	⅞ in. and 1 in. diam.
Tubes, number of	236
" length over tube sheets	12 ft.
Heating surface, tubes	1,472.49 sq. ft.
" " firebox	125.43 sq. ft.
" " total	1,597.92 sq. ft.
Grate "	26.23 sq. ft.
Water capacity of tender	3,700 U. S. gallons
Coal " " "	5 tons



Double-End Mogul, Dominion Coal Co., Cape Breton, N. S.

Railroad Engineering at the University of Illinois.

We have just received from the Railway Engineering Departments of the University of Illinois, some information regarding the course as outlined in railroad mechanical engineering at that University. The undergraduate course in railroad engineering, leads to the degree of B. S. and graduate instruction and investigation in this department have been provided, leading to a second degree. Three leading railroads of the State have promised their co-operation in the work of the department, and the Department of Civil Engineering at the University already furnishes special instruction relating to construction and maintenance of way. In the new course just outlined special attention will be given to the problems of motive power and machinery, including construction, design and the working of locomotives and rolling stock, as well as all tests of fuel, water supply, materials and supplies.

There are eight distinct courses covering some theoretical but more practical work. For example, in course 5 compressed air in railroad service will be studied. This will include such topics as the construction and operation of air brakes. The air brake instruction cars of the Illinois Central and the Cleveland, Cincinnati, Chicago & St. Louis railroads, which make frequent stops at these points, will be used in connection with the course. Also in this course the students will study various signal systems and methods of car heating and car lighting. Courses 4 and 8, which will be under the direction of the Railroad Engineering Department, and Mr. J. A. Barnard, General Manager of the Peoria & Western Division of the Big Four Railroad, have been outlined as follows:

1. Calibration of oil cylinder of dynamometer.
2. Experiments to determine relative resistances of the same cars, loaded and empty: (a) On level. (b) On curves. (c) On grades.
3. Experiments to determine relative resistances of different loads at the same speed.
4. Experiments to determine relative resistances of the same load at different speeds.
5. A series of tests to determine the comparative fuel economy of the "consolidation" and "ten-wheel" locomotives.
6. A series of tests to determine the comparative values of different fuels with either the "consolidation" or "ten-wheel" locomotives.
7. Completion and installation and trial of track inspection apparatus. This is a new form of track inspection apparatus, now being made. The mechanical principles upon which its action depends are the same as those which are used in the dynamometer now in operation. The deviations from gage and from surface alignment cause lateral and vertical motions in a pair of wheels hung, on a divided axle, midway between the main trucks of the dynamometer car. These motions are transmitted to the pistons of hydraulic cylinders which are placed on the wheel axles and in communication with the boxes respectively.

These cylinders are in hydraulic communication with other smaller cylinders whose piston-rods carry the marking points which make their record on a moving chart, driven off the main axle.

Upon this chart are recorded, simultaneously with the records of gage and surface alignment, the speed, grade, curvature, time, and the position of mile posts.

8. Examination of water-supply apparatus on the Cleveland, Cincinnati, Chicago & St. Louis Railway.

This will include:

(a) Examination and report of local conditions.
(b) Estimates of cost of all forms of present installation.
(c) Series of tests to determine cost of operation.
(d) Estimates of cost of maintenance and repairs.
(e) Report on the relative efficiency of the different plants.
(f) Analyses of water from various supply tanks.

Mr. Edward C. Schmidt, Instructor in Railway Engineering, is in charge of the work which is under the general supervision of Prof. L. P. Breckenridge.

Progress in Signaling.

By H. M. Sperry.*

Great progress has been made in the practice of signaling, and the present year has been a most active one in signal construction. The signal departments of our railways are growing, and a number of new signal departments have been created on railroads heretofore without them.

In March, 1897, in a paper before this Club, I summed up some of the questions of interest to signal engineers. Some of these problems are much nearer solution that they were in 1897. A green light is now pretty generally conceded to be the proper one for the clear indication; opinion differs, however, as to the proper color for the distant signal. The New York, New Haven & Hartford has made a strong effort to establish yellow as the proper light for distant signals, and a number of roads are anticipating a change by putting up double light semaphore castings in connection with all new work. . . .

There has been little or no change in the practice in regard to derails, except a tendency to make the distance greater between the derail and the fouling point, in order to provide for the increasing speed of trains. In many of the arguments against the use of derails, reference is made to the fact that they are but little used in Great Britain, but the English protect junctions and crossings by means of block signals. The rule is that no two trains shall be allowed to approach a junction at the same time, either upon converging or crossing lines.

It would be very awkward to carry out this system in this country, especially on lines that are without block signals, and even in Great Britain it is frequently a cause for delay, and a modification is permitted. Trains are allowed to approach the junction after notification that the junction is blocked. There can be no question that the derail has proved its efficiency in this country. We must either continue its use or find a method that will give the same measure of safety.

Improvements have been made in switch and lock movements by increasing their stroke. The improvements are not recommended, however, by the American Railway Association. For facing switches in main lines an improvement in facing point locks is still to be desired, so as to make it impossible to lock a switch in the wrong position. Some effort has been made in this direction in Great Britain, but it is the exception in this country. Some of our most progressive lines are now specifying bolt locks on all facing main line switches, whether they be operated by switch and lock movements or locked by facing point locks. This is a step in the right

*A paper prepared for the Railway Signaling Club and to be read at the Boston meeting, Nov. 14.

direction as a bolt operated by the signal connection is a most efficient check on the proper operation of the switch.

The question of better construction has received considerable attention and many lines have abandoned the use of wooden foundations, substituting cast iron or concrete. As the average life of a wooden foundation does not seem to exceed five years, the increased expense in the use of iron or concrete is more than justified, when the expense of renewing wooden foundations of a plant in service is considered.

There have been some serious failures of pipe connections, and a number of railways are now specifying longer pipe couplings, plugs, and either larger rivets, or four in place of two. As a change of this kind not only means a change in the pipe coupling but in all jaw and other connections, it is to be hoped that our signal engineers will agree upon a form of reinforced coupling that can be used by all. This is a most important detail in signal construction.

The boxing of interlocking connections is being largely done away with, except near stations, etc., where unboxed connections might lead to accidents. Signal wires are now successfully run under ground in small pipes filled with oil.

The subject of proper maintenance is receiving increased attention. Regular inspection more or less frequent, dependent upon the amount of wear and tear to which such apparatus is subjected by reason of the traffic; this, supplemented by prompt repairs, the whole work being in the hands of competent men, means satisfactory results. It is to be regretted that this is not generally recognized, inspections not being made in a systematic way. As a result, repairs are frequently neglected, or in some cases inspections are omitted entirely, and repairs only made after trouble is reported. Some effort should be made toward a uniform system of maintenance, and the club could engage in no better work than to prepare a code of rules, forms, etc., both for interlocking and block signals.

For large installations, such as terminal stations, power plants are rapidly increasing in favor, and this year marks the completion at Boston of the largest plant in the world; also, the first power plant in Great Britain, taking the place of two mechanical plants.

In automatic signaling the semaphore is rapidly displacing the disc, largely due to the fact that it is now possible to operate the semaphore by electric motor.

There is still a field in signaling that has been little touched upon, and that is signals for electric railways. Numerous accidents on these lines have shown the necessity of block signals. The problem, however, is not an easy one to solve, as on account of the use of electricity for motive power, the operation of automatic signals by track circuits is made impossible. This is a rich field for the inventor. Grade crossings of electric and steam lines are easily cared for by interlocking, and as these crossings are frequently more dangerous than the crossing of two steam railways, proper signals should always be installed.

In order to form an estimate of the amount of work to be done in signaling it is interesting to note that on one of the railways of Great Britain in 1891 there were 1,482 cabins containing 31,500 levers and some 17,000 signals; the wires from the signals alone would reach from Liverpool to New York. A comparison with this country shows that the signaling on this one road was more than all in the entire United States. The field, it will be seen, is a most promising one for our signal engineers. The members of the Railway Signaling Club should not fail to grasp the opportunity to place the signaling of this country on the highest possible plane.

The Erie Railroad Gas Engine nstallation.

In our issue of April 14, 1899, we described the coal and ash handling plants which had just been installed at the Jersey City yard of the Erie Railroad. It may be remembered that the machinery in these plants was driven by gas engines working with illuminating gas. Since then there have been installed two Taylor gas producers about 1,800 ft. from these plants, which were illustrated and described in our issue of Sept. 29. These producers now supply gas for these two engines and also for five others used every day. This installation is interesting in many ways, but more especially because it has been shown from the working of this producer plant that where the right kind of fuel is available, power from producer gas used directly in gas engines costs about one-half as much as the same amount of power produced by a good steam engine and boiler and at about the same first cost.

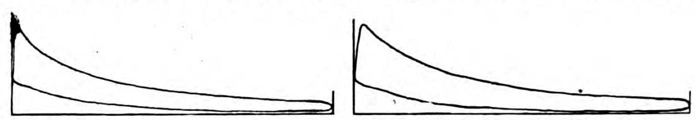
The producer plant develops about 12,102 B. t. u. per pound of buckwheat coal. The guarantee was for 10,000 on gas having 125 B. t. u. per cu. ft. The tests show that 1 i. h. p. can be developed from this plant on 1.03 lbs. of coal per hour, whereas the guarantee was for 1¼ lbs.

The brick building containing the producers is divided by a wall and in the engine room are two No. 12 and two No. 11 Otto engines,* each of the former of which develops 90 h. p. and the latter 45 h. p. when working with producer gas having 125 heat units per cubic feet. The 90 h. p. engines are connected up so that either can be used to drive a 450 16 c. p. incandescent lamp machine or a 1,120 2,000 c. p. arc machine. The 45 h. p. machines run the coal elevator in the producer plant, one Ingersoll--Sergeant compressor, two Pintsch gas compressors, the pump for salt water for cooling the gas engine cylinders during the summer, and the automatic feed on the producers. The two 400 h. p. Climax boilers in the brick building containing the producer machinery supply during the winter steam for warming the buildings and coaches in the yard and for the producers. During the summer a small auxiliary boiler is used to supply steam to the producers and for working the pump which takes salt water from the river to cool the cylinders of the gas engines. In the winter, the cylinders are cooled by city water which passes into a tank from which it is pumped into the boilers.

The producer plant has an estimated capacity of 471.4 h. p. and Messrs. R. D. Wood & Co. claim it will produce 500 h. p. Before the 8 in. pipe was laid this plant produced gas for engines generating about 270 h. p. A part of the 201 h. p., which the plant is capable of producing above the 270 h. p. but which until very recently was not used, now runs the engines of the ash and coal handling plants (the former being a 19 h. p. and the latter a 36 h. p. engine) and also a 19 h. p. engine in the machine shop. To carry the gas from the producer plant to these engines, about 1,800 ft. of 8 in. pipe was required.

The total estimated annual saving for these three engines, due to the use of producer instead of illuminating gas, was $2,024 when using buckwheat coal at the producer plant. The cost of running the three engines with illuminating gas was $16.80 a day; with producer gas $1.40.

Tests were made June 10 last to determine the capacity of this producer plant and the actual output of one of the engines rated at 90 h. p. The engine



Card No. 9, Spring 202, Rev. 164. *Card No. 15, Revolutions 166.*

Cards from Lower Cylinder of 90 H. P. Otto Gas Engine at Jersey City.

test lasted 30 minutes. The cubic feet of gas used during this time was 2,417,455; pressure of the gas in the gasometer, 2½ in. of water, and the calorific power of the gas per cubic foot, 136,273. The following was determined from some of the indicator cards:

No. of Card.	M. E. P.	H. P.
10 (lower cylinder)	54.54	49.163
11 " "	54.944	51.858
12 " "	57.347	52.910
13 " "	54.55	54.62
14 " "	60.80	55.45

Cards Nos. 9 and 15, both taken from the lower cylinder, are shown herewith.

The average horse power for one cylinder from these and other cards was found to be 52.186. The cubic feet of gas per h. p. per hour was (2,417.455 × 2) ÷ 52.186 = 92.6. The horse power of the engine (two cylinders) equals 104.372.

On the basis of the 30-minute test the makers considered it safe to guarantee 52.186 h. p. with 92.6 cu. ft. of gas per h. p. per hour, 21.831.6 (cu. ft. of gas generated per hour) ÷ 92.6 = 235.7 = horse power generated per hour by one of the producers with bird's-eye coal.

The test of the plant was made during the past summer. The test was begun by placing a known quantity of coal in the hopper over the producer. The thickness of the coal bed in the producer was noted and the gasometer was emptied, and as soon as the weighed coal was fed into the producer the test was begun. A simple device was used to take the place of a meter so that the quantity of coal produced could be accurately determined, it being impossible to obtain a meter that would do the work satisfactorily. The producer was shut off and the safety valve on top of the gasometer opened, allowing the gas to escape; after it had emptied the readings from the scales were again taken in order to determine the quantity of gas made and the time noted. As all the gas could not be measured at the time of the test, one of the engines being in operation, a proper allowance was made for the gas thus used. While the test was being made a chemist took samples which show on analyses the following results:

C O (carbonic acid)	8.2	Per cent.
O (oxygen)	0.8	"
C O (carbonic oxide)	19.4	"
H ((hydrogen)	16.6	"
C H (marsh gas)	2.8	"
N (nitrogen by difference)	52.8	"

The calorific power per cubic foot figures to 142.94.

The B. t. u. generated per hour were found on calculation to be 3,120,827.22 and the cubic feet of gas generated per hour, 21,831.6.

*A 36-h. p. gas engine was shown in our issue of Feb. 11 1898.

Normal Safety vs. Normal Danger.

By A. J. Wilson.*

Mr. Wilson began by calling attention to the fact that the idea of keeping automatic signals normally at danger is not new. Hall automatic signals were used on the Eastern Railroad and on the New York & Harlem in 1871, and two signals were used for each block, the first being called the home signal and the second, several hundred feet beyond it, the safety signal. This latter stood normally at caution and did not change to permit the passage of a train until after the first signal had changed to the "danger" position, thus giving the engineman a sure indication that the rear of his train was protected by the signal. This same plan was also used on the Boston & Albany and the Old Colony.

With an automatic signal worked on the normal danger plan the battery is in use only while the signal is clear, thus saving a considerable amount of material and labor. On a certain road in Massachusetts there are signals worked on both plans; and those normally clear have to have their batteries renewed every eight to ten weeks while the others run from 12 to 18 months. This longer service effects a considerable saving. A 4-lb. zinc costs 35 cents; 4 lbs. of vitriol, 24 cents; breakage of glass jars (one in 20), one cent per cell. Coppers need not be considered, as old material will pay for new; and zincs can be used twice, making the cost 17½ cents per cell. This makes a cost for material of 42½ cents per cell each renewal, and this, if the battery is renewed every 10 weeks, or 5.2 times yearly, makes the cost per cell per year for material $2.20. If the signals are worked on the normal danger plan and the zincs are used only once, the whole being renewed every 12 months, the cost, it will be seen, is only 60 cents a year, leaving a saving of $1.60; or on 1,000 cells, $1,600 a year. Besides this there is, of course, a large saving in labor.

Objections to normal danger are: more expensive to construct, more chances of trouble, more difficult to maintain and possibility of combinations which will show a clear signal while the block is occupied. It is to be admitted that the first cost is $25 more per signal (using 15 cells of battery); but a saving of $1.60 per cell per year will defray practically all of this additional cost in one year. It is true that the extra contact is an objection, but in spite of this a comparison of records has shown that there is a difference in efficiency in favor of the normal danger. Mr. Wilson has never heard of a maintainer, having had experience with both kinds, who objected to the normal danger system.

The Embellishment of Railroad Station Grounds.

By A. Reinisch.†

The last quarter of the Nineteenth Century has witnessed great activity and progress in landscape development. Many private grounds have been made gems of beauty. Cities have spent immense sums in creating public parks, and have succeeded in a manner to even invite the envy of European cities which had a start of centuries, and had far better advantages, natural as well as economic. Most of these parks deserve the highest praise as regards the conception and execution of the subject. It is lucky that the individual who is such a lover of nature that he even contracted the tree-pruning habit, has laid out but very few and small grounds. To him no tree is perfect until trimmed into some fantastic form.

Within the last few years, or probably since the World's Fair, a better taste is noticeable. The once common habit of representing words, animals, insects, portraits of men, etc., by the use of bedding plants has almost entirely disappeared, and in its stead we find very attractive geometrical designs with a careful study both of outline and harmonious grouping of color. This progress is evident also in the park proper. Here more attention is given to distance, effects and perspective. More shrubbery and hardy perennials are planted as a fringe for clumps and belts of trees, bringing down the masses of foliage from the sky line to the rich, velvety lawn. The perennials have a double value as, together with the shrubs, the group produces constant flowers and color effects from the beginning of growth in spring until the heavy frosts in early winter.

Next to the city parks, railroad station grounds attract our attention. A beautiful park, however small, is most refreshing to the mind and restful to the eye, after traveling for some time through an

*Abstract of a paper on Automatic Block Signals, read at the meeting of the Railway Signaling Club, Boston, Nov. 14, 1889.

†Landscape Gardener, Atchison, Topeka & Santa Fe Railway, Topeka, Kan.