trucks back to place on the next tangent, that is to say, that the load when unequally distributed will compress the springs more than if each bears an equal share and through this, the height of the difference, the load on those trucks will have to be lifted when the bearings are restored to the centre. In other words, the rollers will have to move up inclined planes, though they are evidently designed for the level, and this is added to by the deflections of the cross-girders under the load, so that instead of having to deal with friction only in determining the force necessary to operate the swinging trucks a part of the weight must also be taken into consideration as having inevitably to be lifted. If the trucks were all exactly in line with the rails, instead of nearly all tending to turn askew in the serious manner pointed out, it is not likely that two engines like those proposed could move it on or off the two-degree curve we are considering. Finally, remembering that the side of the rails is the fulcrum against which all these forces of obliquity of wheels, lateral reaction of swinging trucks, often wedging up the whole load on them, and with an array of grinding flanges such as no other combination of wheels ever before presented, we are confronted by a braking power that it is simply out of the question to overcome by traction. This would be true of any other way that might be devised for moving the trucks sideways by the reaction of the sides of the rails, so no plan can possibly be feasible which does not provide a force for this purpose acting against the body of the car, that is to say, by means of a power located on the car.

It is stated in the report that turn tables connecting stretches of tangent were inadmissible. This car that is designed to run on curves, but so plainly cannot, is the best thing of its kind yet proposed by any engineer. Therefore, it follows that the proposed Boat Railway, although so well designed in nearly all individual matters taken by themselves, is a fore-ordained failure as a means of transporting boats.

yards at Eighteenth street, and will do its own cleaning and repairing.

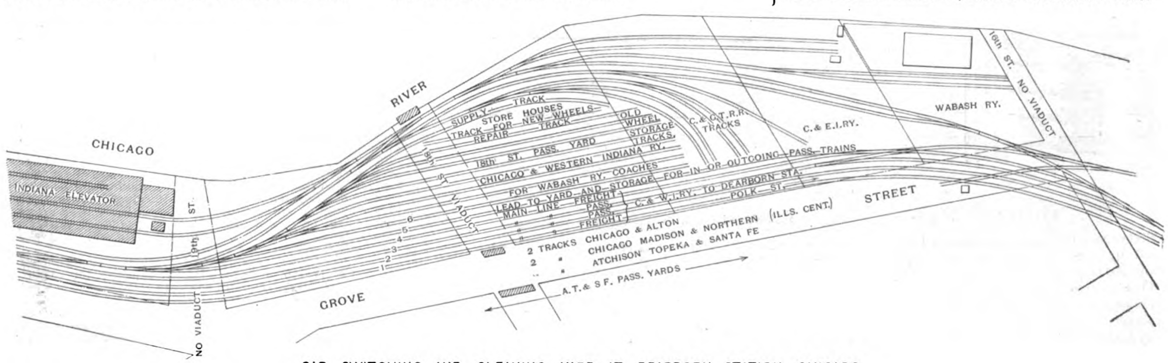
In order to handle this business properly and expeditiously, the Chicago & Western Indiana will distribute the work in the following manner. At the Dearborn Station there are two passenger yards, situated on either side of the main tracks. There is a third yard at Eighteenth street, parallel to that owned by the Atchison, Topeka & Santa Fe, but between it and the river. The two yards at Dearborn street will accommodate 120 cars, and the Eighteenth street yards will hold 75 cars. The cars of the Chicago & Eastern Illinois, Chicago & Erie, Chicago & Grand Trunk, and the Louisville, New Albany & Chicago will be cleaned and stored at the Dearborn station yards, and those of the Wabash will be cleaned and stored at the Eighteenth street yard. All renewals of wheels or heavy repairs to trucks are made at the Eighteenth street yards, except for the Chicago & Grand Trunk cars, which is done at Dearborn yards. The work also includes the sleeping cars run on those roads. The wheel repairs, car cleaning, etc., for the Chicago & Grand Trunk at the Dearborn station include like service for any Pullman or Wagner cars used by that road.

All the yards are provided with water and sewer connections, and are piped for supplying cars with Pintsch compressed gas. The Eighteenth street yard, built recently by the Chicago & Western Indiana is so arranged that it may be extended in case the company can secure adjacent property owned by the company but leased and used by other railroads.

the most important parts of the work was the rebuilding of Vauxhall station. New signal cabins and new locomotive sheds have also been built. The Waterloo station, which in 1878 had only ten platforms, was enlarged in 1878 and 1885, and now again, until it has 18 platforms, or rather 18 tracks which run alongside of the platforms. Among the other improvements in connec- with the enlargment of the train shed is the removal of all the telegraph wires so that none are visible in or around the station. This change was carried out as far as Clapham Junction.

It is claimed that this is the biggest station in the world, and the writer of the article referred to says that the largest day's work ever done was at this station, the next largest having been at the St. Lazare station of the Western of France, in Paris in 1889, on the occasion of the Centenary fêtes at Versailles.

The most interesting feature of the new station is the arrangement of signals and switches, and the task of abolishing the old tracks and signals, and putting new ones into use was, perhaps, the most intricate problem in the whole work. A diagram showing the new arrangement was printed in the *Railroad Gazette* of Oct. 2 last, in connection with a statement of the very heavy day's work done on July 11, 1891, when 859 trains ran in or out of the station. The principal tower, Box A, contains 236 levers. *The Engineer* refers to the fact that the signal tower at the London Bridge station, on the London, Brighton & South Coast, contains 280 levers, and that at the Euston station of the London & Northwestern contains 283, but it is said that at Water-



CAR SWITCHING AND CLEANING YARD AT DEARBORN STATION, CHICAGO.

There is a physical difficulty opposed to taking large structures around curves that engineers have not yet learned to surmount and it is only in the abstract that the problem of transporting them along straight lines can be considered solved, for with all due respect to the gentlemen with whom I differ, this whole business is experimental even if some of the processes are old, and I again repeat that a more inexpedient place to experiment with a matter at once so complex and immense, as the one here selected would be difficult to find.

It is scarcely necessary to criticise the estimates—I must say, however, that they seem extraordinarily low. The Chignecto Ship Railway, with a roadway 5 ft. narrower than proposed here, and not quite twice the length, has nine times as much masonry, every important structure of which is faced with coursed ashlar, as should be done, and there is five times the amount of excavation, although the line runs across a country so easy to grade that no cutting or embankment exceeds 40 ft., and lies for miles through a region that is almost level.

The maintenance estimate is too low. The item of renewal of rails each year would be ten times what is estimated for everything together, provided the cars could be made to grind their way several times backward and forward daily, and a single wreck amid the perilous navigation of the curves and switches would cost more for removal and damages than a car and its cargo, besides blocking the road for weeks, so that the amount requisite for operating such an extremely difficult system is very likely to run into large figures.

I may add that I keenly regret that the United States has allowed Canada to precede her in introducing this novel and revolutionizing mode of transportation, a feeling I am sure that every member of your committee shares, but let me earnestly beg that when Congress does come forward in aid of some such enterprise you will see to it that it be given a fair trial in some locality that is suitable, and not impose on this latest and most promising offspring of engineering a task for its infancy that may exceed the greatest resources of its mature development.

I also have the honor of inclosing a short paper which was read last year at the annual meeting of the American Society of Civil Engineers in connection with a longer oral description which may give you a better idea of a practicable ship railway and of the character of the work that is necessary to secure its permanence.

NEW YORK, May 31, 1892.

Switching and Car Cleaning at Dearborn Station, Chicago.

The roads entering Dearborn Station at Chicago have turned over to the Chicago & Western Indiana Railway the care of all passenger trains and cars after arriving at the station. By this arrangement the Chicago & Western Indiana does all the switching and car cleaning as well as all light road repairs, except in one instance. The Atchinson, Topeka & Santa Fe has its own passenger

In the engraving is shown the arrangement of the Eighteenth street yard, and the main line tracks of the Chicago & Western Indiana, over which run all trains to and from Dearborn Station and all freight trains of the Wabash, the Chicago & Eastern Illinois, the Chicago & Grand Trunk, and the Louisville, New Albany & Chicago. The yard is entered at Nineteenth street from Track No. 5 by means of a ladder track. Track No. 5 is a lead from main line track No. 4, north of Seventeenth street. All trains going to or from this yard arrive or leave by this track, and in case of blockade trains are stored on it temporarily. There are seven wash tracks, one repair track, and one storehouse or supply track. The eight spur tracks terminate at the platform at the north end of the yard. This platform is used for cleaning carpets and cushions. Upon the repair track are placed all cars needing wheel or heavy running repairs. Alongside of this track are a wide platform and a storage track for new wheels. At the end of the spur track beyond the platform are short storage tracks for old wheels, having a capacity for about two carloads. These tracks are assigned to the different roads, and when filled, flat cars are placed opposite them on the wash tracks, and the wheels loaded. This yard being so close to the Chicago River has excellent drainage. There are ample sewer connections provided, but the yards were excavated and filled in with stone, gradually decreasing in size, and finished with a top-dressing of broken ballast. This arrangement insures a reasonably dry yard. At either end of the yard there are placed double cross-overs in the main line tracks to facilitate handling yard trains and making it possible to reach the yard from any main track in either direction.

The basis on which all cleaning and repair work will be charged for according to the new arrangement is, the actual cost of the work done; the wheels and other heavy material for repairs are furnished by the various roads, parties to this arrangement.

Enlargement of the Waterloo Station.

The Engineer of May 20 and 27 contains a brief account of the work that has been done during the past five years in enlarging the Waterloo station of the London & Southwestern in London. The work included the construction of two additional main tracks from the terminus out as far as Nine Elms. The road, for most or all of this distance, is carried on a viaduct, the width of which has been increased from 47 ft. to 78 ft. The openings were formerly covered with cast iron girders, but these have been replaced by wrought iron and steel bridges. One of

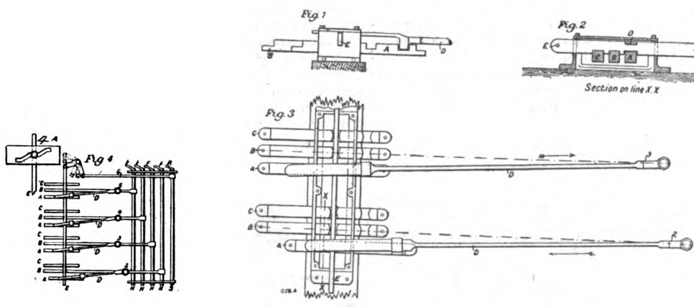
loo many more movements are made with the same number of levers; and that the Waterloo interlocking machine, if arranged on the ordinary plan, would require 400 levers instead of 236.

The article in *The Engineer* is largely devoted to a description of the selector and other "Simplex" arrangements invented by Mr. J. P. O'Donnell and applied in a very complete manner at this tower. The selector is shown in the accompanying illustrations. Fig. 3, which is a plan, shows clearly how the tail bar of the signal lever is moved so as to operate either *A*, *B* or *C*, which actuate, respectively, signals *A*, *B* and *C*. The tail bar *D* is moved by *E* in accordance with the position of the switch rails. Fig. 4 shows how a single lever, attached at *R*, is used to throw the four signal levers, 2, 3, 4 and 5, simultaneously in a certain direction, as, for instance, each of them to the right-hand signal of the three signals which the lever is arranged to operate. Fig. 4*a* shows a motion plate which is used instead of the bell crank to connect lever *R* with bar *E* whenever it is practicable to do so.

The object of this last arrangement seems to be to provide for a way of working which we believe is not in use in this country; that is, the provision of two separate signals for precisely the same route, one to be used for regular train movements, and one for switching movements in the same direction. But, considering the fact that some American roads, as well as roads in England, find it hard to abolish hand signaling in busy yards, we are not sure but this is a wise arrangement; at any rate, the account before us states that hand signaling has been practically abolished at Waterloo. It seems that each route has its levers so interlocked that after the switches have been set, and the locking bars and detector bars also properly set, one lever is unlocked, which can be treated by the signal man as *the* lever for that route in either direction. He then decides, by the use of the special selector lever (*R* fig. 4) whether he will pull off his signal for (1) a regular train movement in the normal direction or (2) a switching movement in that direction, or (3) a switching movement in the contrary or "back-up" direction. There are 72 sets of these "three-throw" Simplex arrangements whereby 72 signal levers perform each a triple duty.

The old cabin and frame and the bridge on which they rested were cleared away and the new tower, frame and signals put in use on Wednesday, May 18, the change having been made gradually during the Sunday, Monday and Tuesday preceding. It is stated that the transition stage was passed "with safety and wonderfully little inconvenience to the public." The new frame was manufactured by Stevens & Son, of Southwark, London.

The yard at this station is sufficiently supplied with cross overs so that every one of the platform tracks may be used for inward trains, and each of the 18 tracks is equipped with "run-in" repeating signals which are electrically interlocked with the lever in the signal tower which works the incoming signals. These repeating signals are 3-position arms, and indicate whether the track is completely vacant or only half vacant. There are small signal boxes inside of the train shed from which these signals are controlled. The men in these small boxes also decide which tracks shall be used by the various trains. They have a very complete electrical apparatus for carrying out their orders, most of the electrical devices being the work of Mr. W. R. Sykes, the inventor of the well known Sykes lock and block system. It appears that the signals to indicate that a track is occupied are not operated by rail circuits, but by means of detector bars and track levers. Mr. Sykes has also equipped some of the semaphore arms with apparatus by which a passing train throws the arm to danger. Each one of the bay or platform tracks has four or more detector bars.



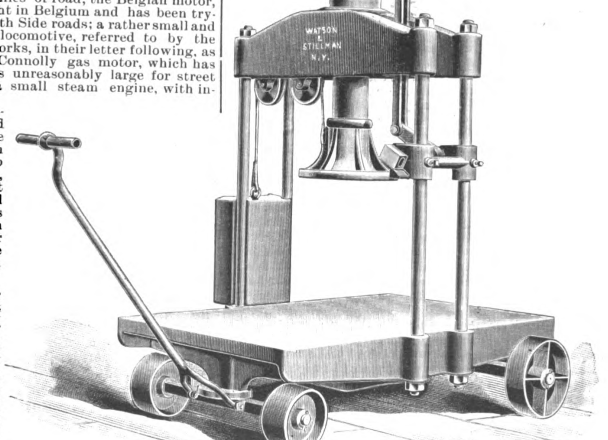
"Simplex" Selector.

Used in Interlocking Machine at Waterloo Station—London & Southwestern Railway.

Sixty-three of the signals operated from Box A are fixed upon an overhead bridge spanning the tracks about 200 ft. from the end of the trainshed, and the same bridge supports the signal box itself. The number of posts on the bridge is 18, every one carrying one or more arms on each side. The arms for switching movements have no lights, but a light for night signaling, governed by the same rod that works the blade, is placed at the *foot* of the post, that is, at the floor of the bridge.

Portable Axle Box Press for Locomotives.

The portable press shown is designed by Messrs. Watson & Stillman for the forcing of the brasses in and out of the boxes of locomotive axle bearings and similar work. The operating power is 20-ton base style hydraulic jack of special make, mounted in the upper platen, with the cylinder and base counterbalanced; and as the operating lever in the regular jack would be too high for convenient manipulation, a special jack is used and a new device is attached to the rods, and at this position the jack is operated the same as it would be at the jack proper. The movement is 12 inches and the full opening between the lower platen and the bars is regularly 18 inches. The lower platen is made 30 by 48 inches and has a hole 4 inches in diameter through its centre for forcing work through it when the plug which fills it is removed. The counterweight is so situated that it is not in the way, and is held in place when moving the press around the shop. The truck wheels are 7 and 10 inches in diameter by by 3-inch face.



Portable Axle Box Press.

Motive Power for Street Railroads.*

After a short review of the various methods of operating street railroads by other methods than animal power, Major. Sears continues with an account of two systems which we give below somewhat abridged:

After careful investigation among a tiresome mass of inventions, some of which show much ingenuity, there have been found two systems which seem to promise, in one form or the other, and perhaps in both, the street motive power of the future. They are, in one case, engines moved by compressed air, and in the other by compressed steam, or water of such a temperature and under such pressure, that when released, it becomes steam, ready for work. The motors for urban use may in both cases be called small packages of condensed power. An advantage of both engines will consist in the fact that they can be built to do a fixed maximum of duty of defined limit, and that this limit is so restricted as to prohibit an attempt to accomplish too much. Thus, the compressed air engine, once charged, is good for a distance of 10 miles without recharging. The compressed steam motor will go 40 miles without reinforcement.

Compressed Air.—A Toledo street railway company after experimenting with the compressed air motor, is so far satisfied with the results obtained that a complete plant is being installed in that city.

Prof. D. S. Jacobus, of Hoboken, saw the system in operation at Nantes and Vincennes, France, where the roads are five and seven miles long respectively, and have been successfully operating this system for twelve years. At the New York meeting of the American Institute of Mining Engineers, held in September, 1890, that gentleman read a valuable paper, which has been published by the Institute, and is the authority for what is here said of the system.

As that paper is accessible to the members of this society, is sufficiently illustrated, and is carefully elaborated in details, only the general facts are here given, touching its construction; leaving it for those personally interested in the subject to study the minor features in the paper mentioned, or on the ground, at Toledo. In the motor car two small engines are connected, so as to rotate the front axle of the car, a reversing lever being used to alter the cut-off and change the direction. The compressed air is held in tanks under the bottom of the car and is admitted to the engine cylinders after passing through a mass of hot water, which leaves the charging station at the temperature of about 300 deg Fahr., and is reduced to 212 degs. when it has returned to that point. The engine cylinders are $5\frac{1}{4} \times 10\frac{1}{4}$ ins. and the compressed air is charged in its retorts at about 425 lbs. per square inch.

Prof. Jacobus estimates the cost of compressed air motive power, as compared with horse traction in Nantes, to be such that if the cost of animal power is put at 100, the cost of the compressed air power will be 63.33. He is of opinion that for a time this power must be limited to localities unencumbered with snow; and believes that for underground service its ventilating capacity will make it of great practical value. This system is also in use at Nagent, near Paris, where each motor draws after it a train of two trailers, at Marseilles, where the cars are operated under a storage pressure of 1,200 lbs. per square inch, and at Berne, Switzerland.

An interesting and fairly conservative account of the performance of the compressed air engine at Toledo, may be found in the *Chicago Street Railway Review* for January of this year. Snow and cold weather seem not to have troubled the experiment, and the old difficulty of frozen air valves no longer exists. The manufacturers claim a trip of nine miles length as the limit of duration of power, and there seems but little chance of increasing this capacity without lengthening the car or raising its floor higher from the street level.

Compressed Steam.—The last mode of applying power to which attention is invited is in the form of compressed steam, and was studied twelve years ago. Later, the invention was laid aside for want of means to improve the original excellent idea; and during the past year, the tendency to recur to some mode of applying steam directly, in the motor, has led to such improvement on the original design that a fair ground of hope exists, that we have, at last, the motor best adapted to urban travel, in what is still known as the Angamar motor, now the subject of experiment in Chicago. Several other plans are also now being proved in that city, viz., the Patton gasoline engine, wherein a portable dynamo is operated by steam and the product transferred to an electric motor connected by the usual method with the wheels; the Judson compressed air engine having three conduit charging stations for each five miles of road; the Belgian motor, which Mr. Yerkes bought in Belgium and has been trying upon one of the North Side roads; a rather small and somewhat complicated locomotive, referred to by the Baldwin Locomotive Works, in their letter following, as being "too small;" the Connolly gas motor, which has inadequate power unless unreasonably large for street use; the Prouty motor, a small steam engine, with inadequate power.

When the writer's attention had been called to the Angamar motor he wrote to the Baldwin Locomotive Works, to learn the opinion of men, who have probably built more street dummies and very small locomotives than any other factory in the world, to learn their opinion of a machine with such pretensions. They replied:

"We believe that such a motor as you describe can be constructed, and that if satisfactorily developed, a large demand will result. Many roads, which are at present operated by electricity, as well as other roads, which are unable to obtain electrical franchises and cannot make the expenditure involved by the cable, will be likely to adopt them. . . . The demand for a steam motor is so strong that, notwithstanding the admitted objections to these machines, we have constructed upward of 300 of them. During the past winter our attention was strongly drawn to the desirability of designing a condensing motor. We built an 18-ton compound motor in which we sought to accomplish the following: (1) To utilize the steam by expansion to so low a tension that its escape from the cylinders would be accompanied by little or no noise, and at the same time such expansion would so considerably reduce the temperature of the escaping steam as to render it easier to condense; (2) To provide a condenser large enough to condense all the escaping steam; (3) To rely entirely upon natural draft, excepting when unusual power was required, in which case the steam could be diverted from the condenser and discharged in the ordinary manner through the exhaust nozzles into the stack. This motor was measurably successful and accomplished the results intended, but we did not succeed in entirely avoiding the show of steam in bad weather. This was probably due in part to the large size of the motor, requiring the generation of so considerable a volume of steam as to render its condensation more difficult. We look for more satisfactory results from a similar experiment with a smaller motor. Meanwhile that motor was purchased for noiseless switching service in Wilmington, N. C., where it is doing satisfactory work. Some time since the North Chicago Street Railway Company imported a Belgian motor, which is said to accomplish all the results which we sought. We have contracted to duplicate it, and, of course, guarantee equally satisfactory results. This motor is, however, too small. We have also agreed to build, from our design, a somewhat more powerful motor with which we have guaranteed equally satisfactory results.

On the strength of various representations, a series of experiments, at the writer's request, have been made with a motor built by the Kinetic Power Co. in Chicago, having the Angamar boiler, the results of which are here presented. The writer places such confidence in them that he has recommended the system to his company as the proper and only solution of the street motor problem in all ordinary cases.

This motor is a contrivance for using compressed steam. Water is heated at a "charging station," to the temperature of 387 deg. Fahr. (200 lbs. steam pressure). This station consists simply of furnace and boiler. A plant of 400 H. P. will be ample for about 100 motors of 50 H. P. each. This stationary boiler is tapped on the low water line for connection with the retort of the motor, and also in the dome. Water may thus be charged above, or steam or the two together when it is requisite to quickly produce the maximum pressure in the retort, which, with all its connections of pipes, dome and firebox, are thoroughly jacketed to prevent loss of heat by external radiation. When the retort of the motor has been charged with hot water and steam, a few shovelfuls of burning anthracite coal are thrown into the firebox.

The example now under experiment in Chicago has a pair of 9 × 10 cylinders; the retort, having a capacity of 263 gallons, is charged with 160 to 170 gallons of water, heated, as already said, to nearly 400 deg. Fahr., and is rated by indicator test at 43 H. P.

By this system it is seen in experience that while the quantity of water in the retort is evaporated and the rapidity of steam-making tends to increase, the fuel in the firebox has been decreasing by consumption in amount and heating power, and thus reduces the tendency to excessive pressure. As the highly heated water is conveyed from the charging boiler to the motor, it first becomes steam vapor and as such enters the retort; but as the injection is continued, a water level becomes established, showing that a portion of the steam under such pressure has returned to the form of water.

The driving wheels are of 31 in. diameter, and thus 1,303 cylinder volumes of steam per mile are used up by each of the two cylinders. Or, the capacity of the cylinders being 636 cu. in., the volume of steam used per mile will be $636 \times 2 \times 1{,}303 = 1{,}657{,}416$ cu. in.

The 160 gallons of compressed hot water contains an energy of 37,000 cu. in. × 1,642, the capacity for expansion, or 60,754,000 cub. in. of steam. If this value were maintained, the motor has a traveling ability of about 37 miles under the charging above mentioned. The actual experience in a course of eight days shows that it may be relied on, starting with 155 lbs. pressure, to make 20 miles without new charging and return to the shop with a pressure of 142 lbs. after such a run, using 30 lbs. of anthracite coal in the trip and carrying 80 passengers on motor and trailer, moving sometimes at 18 miles per hour.

Captain Charles F. Thomas, the Consulting Engineer of the Kinetic Power Company, estimates the cost of power alone per car mile at $1\frac{1}{10}$ cents, which is about one-third the cost of electric power on the West End system of Boston.

*Extracts from a paper by Alfred F. Sears, M. Am. Soc. C. E., presented at the Old Point Comfort Convention.

Tests of the Standard Car Coupler at the Saratoga Convention.

During the recent railroad convention at Saratoga the Standard Car Coupler Co., of Troy, N. Y., fitted up at considerable expense a complete drop testing apparatus according to the proposed standard drop tests of couplers given in the M. C. B. Committee's report. The apparatus consisted of a 1,640-lb. drop mounted in a suitable vertical frame and raised by a hoisting engine. The foundation consisted of 5 ft. of masonry, 5 in. of timber, bolted together to form one solid floor, and 8 in. of cast iron in a block weighing 2,600 lbs. The tests were