not advance rates. It merely maintains them; the public misapprehends a pool. If eight shippers using one railway should have the same rates, then the eight shippers using eight railways should for the same public reasons have the same rates. This axiom has never yet been controverted by any opponent of pools, nor can it be. If the Iowa Commission authorizes certain rates, how are its people harmed or those rates made hurtful simply because they are maintained by the State pools.

Amalgamation and consolidation have long been public benefactors. They have in every case reduced rates and fares by changing the aggregate of various local charges into lower through tariffs; they have increased the speed of all trains, they have bettered facilities, they have put better equipment upon the lines, they have brought Western farmers nearer and cheaper to the seaboard buyers, they have produced safer railroads, they have lessened corporate inference with legislation, and they have made practicable the fairer relation of local to through rates. A manager controlling 5,000 miles is always more conservative than one who controls fifty. He looks at the public interests as related to his own from wider standpoints. Upon the question of trusts a broad field for discussion is open. * * The public, however, has one constant safeguard against railway trusts. If railway rates are put too high the courts will reduce them. If the charges, however, for cotton-seed oil re too high under trusts they cannot be reached.

a If low rates yield large profits, that is no argument whatever, standing alone, why the rates should be reduced, any more than that the patent laws should all be revoked for the same reason. It is clearly to the interest of Chicago that its traders organize as a board of trade. The fact that they push grain or pork up or down in value every day depending upon storms, sunshine, wars, famine, and the caprices or manipulations of its rings, does not detract from its ultimate general usefulness. The fact that a railroad organization, being governed by men with similar minds and objects, permits the same causes to change their rates from time to time cannot be argued as a sin among railroads. It has never been charged that the Chicago Board of Trade attempted in its corporate capacity to extort or do injustice. No railway organization comprising a number of railroads within the United States ever sought to extort or do injustice. In the aggregation of their common interest the majority will always be fair and honorable, and a dishonorable minority will be voted down as quickly by railroads as by merchants.

The fact that the majority of the roads affected by the present tendencies of legislation operate in the more sparsely settled portions of the country, where the demands for improvements in the condition of the roads and the reductions in the rates more than offset all the economies that the railway officers can practice, and the increase of tonnage which they can stimulate, must lead those companies into bankruptcy if they are supplemented by dissensions among the railroads themselves. * * There could be great improvements made in requiring boards of directors to meet more frequently, pay them for their services, require them to scrutinize and audit more closely, and have a greater measure of accountability taken from managing officers by these boards. This is the case in England, and is the case with the larger companies in this country organized to advance other enterprises, like the Equitable Insurance Company of New York and other notable instances of corporate success. It should be more the rule of railroads.

Chairman A. F. Walker, of the Inter-state Commerce Railway Association, said: "Under existing conditions, the association of carriers is an absolute necessity. The act to regulate commerce cannot be enforced without it. The various points necessary to be covered in the establishment of tariffs and regulations controlling transportation are so numerous that harmonious action between carriers is absolutely necessary in order to secure the first step toward the administration of the Inter-state Commerce Law, namely, the establishment of tariffs which, the law says, when established shall be maintained. Since the passage of the act railroad associations have been continued in existence for the above and many other legitimate objects; their administration has usually been intelligent and progressive, and they have been of much assistance to the Commission in the way of what has been accomplished in the enforcement of the law. A consolidated ownership of railroads would radically differ from the usual manufacturing or producing 'trusts.' The latter are practically without control; while Congress has already established an enactment that railroad rates must be no more than what is just and reasonable, and has provided machinery for its enforcement. * * The person who regards the important object of governmental regulation of railroads to be the procurement of lower rates has not passed beyond the primer in his study of the subject. Passengers, shippers and the public generally are interested in safe and efficient railway service more than in extremely low rates. Rates may be so ruinously low as to render such service impossible. English tribunals have affirmed healthy competition to be that in which various transportation routes are kept on foot which are 'practically independent of one another, fairly alternative, and reasonably calculated to keep one another in check.' Yet competition in rates is practically unknown in England. * * Association among carriers is therefore required by sound public policy; it establishes rates coördinated with the value of the service and adjusted to the expenses of the shortest routes. It assists to preserve all lines in competitive existence.

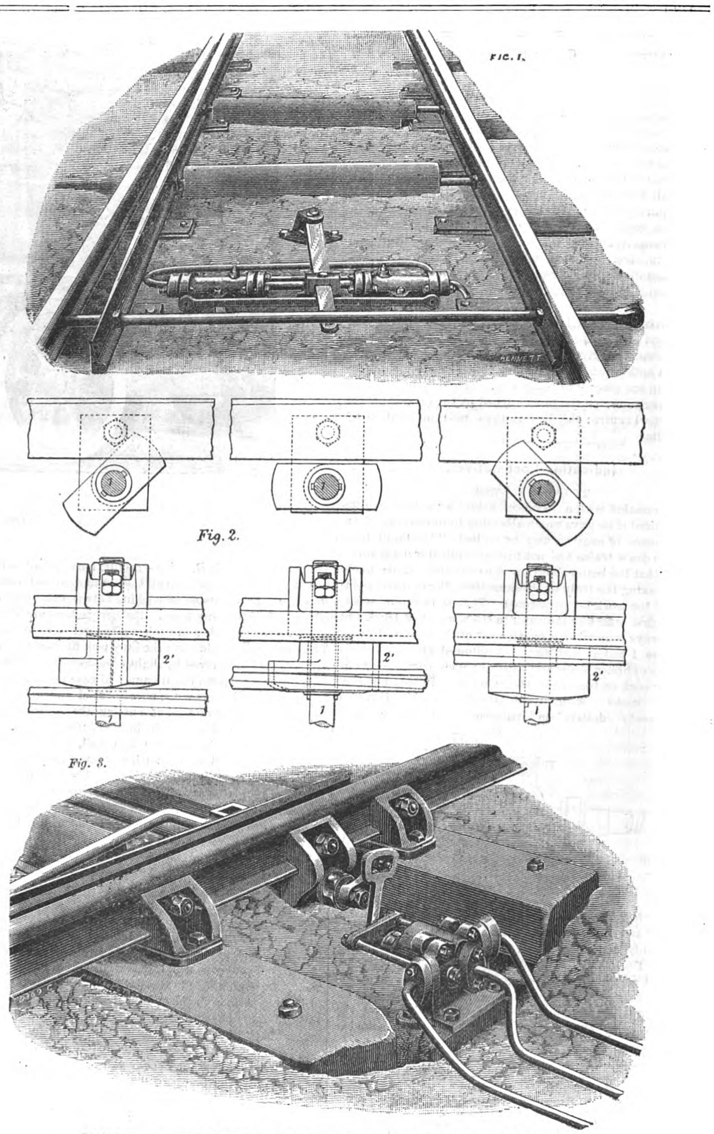
No one would admit the desirability of railroad bankruptcies; few would support any project for state control; a combination of railroad owners would be the most natural result of the failure of the present experiment in the statutory regulation of railways through the assistance of railway associations. While this experiment is pending, and while a reasonable prospect for its success continues to exist, I must decline to discuss the question of a railway trust."

General Manager E. P. Ripley, of the Chicago, Burlington & Quincy says: "We try to agree among ourselves as to rates with just the same success—and no more—as attends similar efforts in other lines of business. Ask any merchant on the street what has been the history of agreements to maintain prices. He will tell you that such agreements have never been kept and never can be, and that they have been so invariably broken as to make most men now unwilling to enter into them. If such agreements cannot be kept as between two or three dealers on the same street, how is it possible to maintain them among railroads, involving not only the competition of railroad with railroad, but of city with city, state with state, and commodity with commodity?"

General Manager E. T. Jeffery, of the Illinois Central, says: "If the general government does not, through its board of railroad commissioners and through its courts, take control of all traffic, state and inter-state, there is no possible solution of the present embarrassing difficulties of railroad carriers except by combination. Duties on imports and exports between states are no more indefensible than legislation by a state to advance its interests commercially at the expense of its sisters and their citizens by passing selfish and narrow transportation laws."

General Manager E. St. John, of the Chicago, Rock Island & Pacific, speaks in a similar vein on this point.

H. H. Porter, President of the Chicago & Eastern Illinois, says: "I think the attitude of the press and the consequent temper of the people are breeding a greater panic than the country has ever seen."



BIANCHI & SERVETTAZ'S HYDRAULIC INTERLOCKING MACHINE.

Bianchi & Servettaz's Hydraulic Interlocking Machine

In the Italian Section of Class 61 of the Paris Exhibition, devoted to railroad material, the above named persons exhibit the apparatus shown in the accompanying illustrations, for moving switches and signals with the aid of hydraulic power. The system was tried some time since at the station of Abbiate Grasso, on the line from Milan to Alexandria and Mortara, and the results obtained were so satisfactory that the Italian Railway Co. of the Mediterranean system decided to adopt it at several stations, while the Paris, Lyons & Mediterranean, and the Paris & Orleans, of France have also obtained several sets of apparatus. Complete models illustrating this system are exhibited in the northwest corner of the Machinery Gallery.

The switches are operated by means of two plungers mounted on the same rod, but of unequal diameter, so that when the cylinders are put into communication either with the accumulators, worked to a pressure of 650 lbs. per sq. in., or with the discharge reservoir, the plungers travel toward the right or left, and give a corresponding motion to the switch rails. Fig. 1 shows the arrangement adopted for operating an unlocked switch. The apparatus is placed between the rails, and as no special arrangements for control are required, there are only two lines of pipe, one communicating with the accumulator and the other with the discharge reservoir. Locking is effected by means of cams which operate independently for each rail; they are mounted on the ends of a rod that is caused to rotate by means of a crank rod moved by the plungers themselves; these cams have the form and occupy the position shown in fig. 2. When it is desired to lock by a separate lever, a small supplementary apparatus, as shown in fig. 3, is placed on the outside of the track in the extended axis of the locking cam rod; the controlling mechanism makes communication by a third and so-called return main with the pressure main in such a way that the movement is repeated within the signal cabin. If the operation is complete, and the switch is properly locked in its new position, the repeater unlocks all the levers locked with that of the switch. From this it will be seen that if the control is inefficient, and if the point does not answer to the movement, or if the locking is not perfect, the signalman is apprised of the fact by the impossibility of operating the other levers that are not unlocked. The semaphore signals are operated by a single cylinder, the plunger of which lifts the counterweight of the arm by direct pressure (see fig. 4). The position of the signal arm or the colors shown by lamps after dark, can be indicated by a repeating screen and lamp placed within the signal cabin. In working distant signals a double wire is used. The liquid used for transmission is a mixture of water and glycerine, and is supplied to the plunger through pipes about ½ in. in diameter; power is obtained from a small accumulator that is charged from time to time by means of a hand pump, the liquid being brought back from the discharge reservoir, and the signalman having this work under his charge. About five minutes' pumping is sufficient for accumulating power for fifty manipulations of the levers.

Fig. 5 illustrates the arrangement of the levers in the signal cabin; the handles are arranged with their upper ends in a vertical box that carries a locking bar. The controlling plunger is intended to completely reproduce the movement of the plunger actuating the points, so that if the operation of the switch mechanism is imperfect, the levers in the signal box cannot be moved.

For the description and illustration we are indebted to *Engineering* (London).

Consumption of Coal as Affected by Enginemen.

BY GEORGE H. BAKER.

As the cost of coal forms such a large proportion of the expenses of railroad operating, and as it is well known that but a small fraction of the heat energy contained in the coal is converted into the actual work of pulling cars, fuel economy is generally an important but vexed subject for railroad officers to consider. But no subject of railroad operating is more worthy of careful consideration, for operating expenses can be reduced more by a careful use of coal than by any other line of economy.

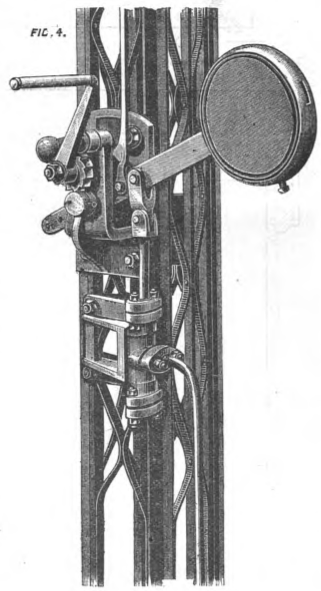
The consumption of fuel by locomotives depends greatly upon the men who have charge of them while they are engaged in doing work, as well as upon the condition and equipment of the engines. The popular error has been in supposing that the consumption of fuel depended mostly, if not entirely, upon the condition and equipment of the engines, and that the enginemen had really but little to do with the amount of coal the engines consumed in doing their work. The contrary is the case. In every kind of work that locomotives can perform the engineer exerts a potent influence on the cost of operating. From the moment he enters the cab at the start, until he leaves it at the terminus of the trip, the economical operating of the engine depends mostly upon his management. As he is careful or careless there may be a saving or waste of fully a ton of coal per day, or trip of 100 miles. This is no exaggeration, and numerous cases can be shown where the difference between careful and careless management, while doing practically the same work, has been 50 per cent. more than this. There are many ways by which an engineer may affect the coal consumption of his engine while it is engaged in pulling trains over the road, and an engineer who may be considered an excellent runner because of the care and judgment he exercises in handling trains, may yet operate his engine in such a manner as to cause an extravagant consumption of coal.

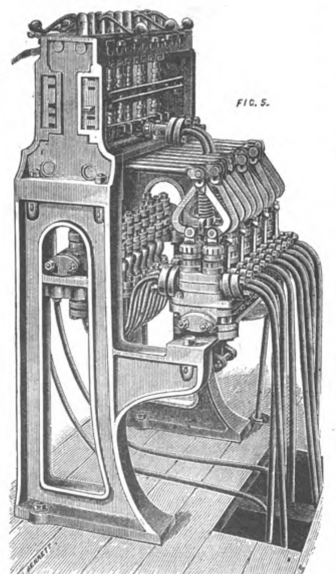
Care for the safety of his engine and train is, of course, an engineer's first duty, and the one to which he is held most strictly. The next requirement is successful running—pulling his train over the road promptly and on time, getting up the hills all right, and making meeting points in time to avoid delays to his own and other trains. At present, upon most railroads, engineers who satisfactorily meet these two requirements, and take proper care of their engines, fill the bill. But the time is fast passing away when this will be the case. Competition is narrowing the margin of earnings until the strictest economy in operating is demanded, and when it is understood to what extent engineers can influence the operating expenses of the engine in their charge, they will be held to strict account for the economical operating of the same.

The best way to economize is to prevent waste, and waste of fuel on locomotives results from enginemen not being sufficiently impressed with the *necessity* of preventing it and of the evils of wasteful practices, of which there are many. The most wasteful practice indulged in is, no doubt, the use of steam with a later cut-off than is necessary to do the work, and then by throttling, reduced in pressure so as to perform only the desired amount of work. The same amount of work could generally be done by cutting off earlier in the stroke and keeping throttle full open, so as to utilize the full boiler pressure, with a great deal less steam. This directly affects the coal pile. Engineers have many prejudices against using steam with full throttle and early cut-off, and it is safe to say that except a small proportion of their number, and upon a few roads where the waste of using throttled steam is not tolerated, locomotives are generally operated with later cut-offs than is necessary, and steam throttled to low pressure. This is wasteful of fuel in several ways: More steam is used than is necessary; back pressure in the cylinders is greater, and the exhaust steam escaping at a much higher pressure than it would with early cut-off and high initial pressure causes a stronger draft on the fire, which hurries the hot gases and products of combustion from the heating surfaces before their heat has been absorbed by the water in the boiler. Engineers should understand these facts, and be disabused of their wrong ideas of the ill effects of running with full throttle and the shortest possible cut-off consistent with the work required.

Next to the manner of using steam, that of feeding water to the boiler affects the coal consumption of a locomotive more than any other cause. A great amount of heat energy can be stored up in a few pounds of water. Take for illustration the water space in the boiler of an ordinary four-wheel coupled engine, the water level of which is indicated by a column of water in the water-glass. The rise or fall of the column of water in the glass one inch indicates an increase or decrease of four cubic feet of water in the boiler. Under 145 pounds steam pressure, each cubic foot of water in a boiler is stored with 18,850 units of heat (from 32 deg.); one inch of water in the glass therefore represents *a store of heat* in the boiler of (4 × 18,850 =) over 75,000 heat units. In practice, the water level, as indicated in the glass, may, with perfect propriety, vary eight inches. That is to say, an engineer can start out with his water glass nearly full of water, indicating the water level in the boiler to be eight inches above a good fair margin for safety—several inches yet above the heating surface. These eight inches represent a store of heat of (8 × 75,000 =) 600,000 units. As the source of a locomotive's power is heat, this represents a capital stock to start with, which may be drawn upon with great advantage in emergencies of hard work, such as starting trains and forcing them into speed.

An engineer understanding this aims to always start with the boiler as full of water as he may and avoid priming, and then assists his engine to economically perform the hard task of forcing the train into speed by leaving his injector off at such times, and drawing upon his store, instead of upon his fire, for a large amount of the heat necessary for the work. In this way, and by adjusting the injector at other times to feed a less amount of water to the boiler than what it is parting with as steam, he draws upon the store of heat represented by the full glass of water as far as it is practicable, possibly to a third or a quarter of a glassful, and thus favors





Bianchi & Servettaz's Hydraulic Interlocking Machine.

his engine all he can while it is performing hard work; and then, while running into the next station, or down the next hill, with steam shut off, he refills his boiler with water and recuperates his store of heat, guarding, while doing so, against changing steam pressure or temperature of boiler. Engineers not understanding these points, and there are many, will of course take no advantage of them, and the coal record of their engines will suffer accordingly.

Wasteful practices in firing also cause serious waste of coal. From the start to the completion of the trip the actions of the fireman noticeably affect the fuel consumption of an engine. He should understand the principles of combustion, and that air is simply *the other part* of the fuel of his fire, and as necessary to it as the coal upon the grates, so that he may appreciate the importance of providing for a sufficient supply of air to his fire, and not allow the grates to become choked with ashes and clinkers, which, by restricting the admission of air, causes much of the coal to burn to carbonic oxide instead of carbonic acid, and thus in burning yield only a third of the heat it is capable of giving out.

He, too, should prepare beforehand for emergencies of hard work, by having his fire in such condition and sufficiently supplied with coal before the hard task of work is commenced, that the fire-door may remain closed as much as possible while the draft of the exhaust is strong, and thus prevent the inrush of the immense volumes of cold air into the fire-box, that always enters at such times and absorb the heat of the fire and cool the temperature of furnace and flues. Many firemen are careless about this point, and much waste of fuel and injury to fire-boxes and flues are the results. Surplus steam blowing off at safety-valves, or "popping," is noticeable and general upon all railroads, but the waste of coal resulting is little appreciated.

Some months since I traveled from Chicago to New York over a railroad noted for the strict economy exercised in its operation, especially as regards the use of coal. I was somewhat surprised, therefore, to hear the engines frequently popping, sometimes for minutes together, while stopping at stations. Change of engines did not alter the frequency with which the safety-valves relieved the boilers of surplus steam. At a divisional point, where two fresh engines were taken on to climb a mountain, there were a number of engines standing around, and I counted eight that were popping. Shortly after, my interest in a famous bit of scenery was somewhat lessened by mentally criticising the carelessness of enginemen who would allow two engines to blow off continuously during the several minutes used in passing the place. On my return, although in the rear car of a long train before the start, the scream of escaping steam, continuing without abatement, caused me to seek the cause. I found it in the engine attached to the train I was on. The black smoke issuing from the stack indicated a heavy charge of coal on the fire, although it was several minutes of leaving time. The fire-door stood wide open, presumably to check the generation of surplus steam, by admitting cold air to the furnace to counteract the heat of the fire; but as both dampers were wide open, and the blower on quite strong, surplus steam was formed as fast as it could blow away. The popping continued without intermission for five minutes until the train started.

The fireman was certainly careless, or ignorant of the waste attending the escape of steam, and of the principles of combustion, which required him, if he wished to check the generation of surplus steam, to shut off the blower, which only stimulated his fire to a greater heat, and to close the dampers, and thus cut off from the fire the other part of its fuel—the air. The engineer in charge was equally careless, or ignorant of the advantages of a store of heat to start with. Judging from reliable data, no less than 8 cubic ft. or 447 lbs. of water were converted into steam and blown away during the five minutes the blowing off continued. So, aside from the waste of heat (coal) that went to convert this amount of water into steam*, the boiler was deprived of a store of 150,000 heat units to start with, and the engine robbed of the economical advantage of the same, which was nearly as great a loss as the original. That such wasteful practices are indulged in and permitted upon a railroad noted for the economy of its management is evidence that there is wide room for the improvement of locomotive enginemen generally as regards the use of fuel. Education in regard to the proper use of fuel, the principles of combustion and the evils of wasteful practices, is what is needed to improve the service and decrease the consumption of coal, but what has until recently been considered quite unnecessary. Only in the June number of the *Master Mechanic* a correspondent sneeringly remarks that too much "high science" is being advocated in the operating of locomotives. The trouble is, and always has been, that the coal consumption of locomotives, and through it the profits of railroad operating, is suffering from the lack of this very "high science" that many very "practical" men regard as superfluous.

The science of steam engineering is knowledge and conception of its general principles, but the "higher" it is, the greater the knowledge and the clearer the conception, the greater the skill of the engineer, and with due care, the greater the economy of his engine.

In locomotive operating, greater than in any other line of steam engineering, because of the nature of locomotives' work, the consumption of coal depends upon the care of engineers and firemen, and upon their knowledge of the influences at work during the process of the production of heat, and the conversion of its force into useful work; and their cooperating with each other in the proper management of their engines.

A practical illustration of what has been said above will be found in the following record comparing the average monthly performances of several engines with those of engines under the charge of H., running on the same divisions and in the same service.

July, 1886.

All six-wheel coupled engines; level road.

	Average miles run.	Average tons of coal.	Average miles run per ton.
Twelve engines	2,354	93	25.3
Engine A	2,578	73	35.3
Difference	224	20	10.0

A saving of 22.4 lbs. of coal per mile run by engine A; amounting to 28.8 tons, or $43.20, in month's service.†

* Computing six lbs. of water converted into steam per lb. of coal burnt, a fair average, about 75 lbs. of coal were consumed to furnish the heat.

† Cost of coal on tender, $1.50 per ton.