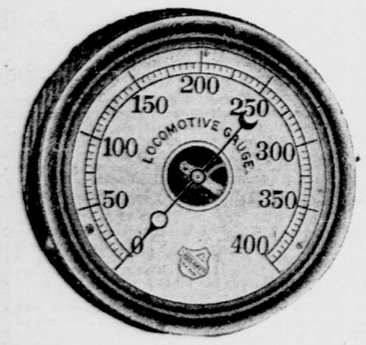
FOR SECURITY and EFFICIENCY in RAILROAD OPERATION

SAFETY DEVICES. STATE OF THE ART. WHAT RESTRICTS USE. CAUSES OF THE RARE FAILURES.

In all the recent discussion of the conduct of transportation affairs, and of the operation of the railroads themselves, which has, for months past, filled the columns of the daily press, and overflowed into the pages of the magazines and periodicals, there has been too little of that which has had an educational value for the community, and far too much that has caused undue alarm, has impaired confidence, has aroused violent passion, and has bred bitter prejudice. While there is no doubt that the subject of transportation, in all its phases, has needed agitating—for the vastly changed and still changing economic conditions, in which it is such an imposing factor, have brought about a situation the continuance of which is incompatible with the progress and welfare of the country—the satisfactory solution of this difficult problem can only be found through sane and temperate deliberations. Instead, ignorance, demagogy and malice have stepped in to confuse counsels, with the result that the public mind, already distraught over the epidemic of railway disasters, has been reduced to a state in which it has been utterly, and almost hopelessly, unable to discover and heed the small measure of sober and sound reasoning, that has sought to stay the wild flood of hasty and ill-advised legislation—largely attributable to the frantic desire of politicians to "make good"—of explanation that did not explain, of baseless and foolish charges, and of malignant invective, and has, instead, yielded itself up entirely to that peculiar, inexplicable, and, in this case, baneful influence to which, in commenting thereon, The Tribune has given the name "crowd psychology."

In truth, so befogged, by the miasmatic exhalations of class hatred, foul mists that too often rise to distort the aspect of the great economic questions that present themselves, and by the dense clouds of misrepresented and misconstrued facts, misconceived arguments and illogical conclusions, have been the real issues, that the public must have been, and most probably is yet, quite bewildered. For which reason, it is thought, it will the more readily, now that a certain measure of calm has succeeded the storm, welcome this contribution toward the data and evidence upon which it must ultimately build up the opinion, and pass the judgment, which are the law in free America. That the said contribution may—to the fullest extent—serve its purpose, it may be well, at the very start, to present that which will aid the reader to the attainment of that impartial attitude which, only, will enable him to justly weigh its components. He has taken a long step in this direction when he has reminded himself that railroad men—whether those who construct, who supervise, who operate, or who in any capacity serve the railroads—are, in the average, made of the same clay as he, are subject to the same human limitations, cherish the same ideals of civic duty, of patriotism, and of personal and business morality, and have the same appreciation of responsibility for interests intrusted to them, and the same honest pride in work well done; and when he has learned that, as a well informed official of a company of world-wide repute, the business of which is so intimately connected with the railroads as to give him an unobstructed view of the workings of all of their departments—and whose experience and professional education have well fitted him to avail himself to the utmost of this advantage—has put it, "While a certain



ASHCROFT AUXILIARY SPRING LOCOMOTIVE GAUGE.

class of speculators have gotten hold of the financial affairs of some few of the roads, and deserve the severest censure, the people who manage their operation are honest and intelligent, and have a keen sense of obligation to the public"; for he has thus fitted himself to judge their acts—and consequently, the situation which has partly resulted therefrom—without bias, and, therefore, the more intelligently.

For another reason, the importance of digesting and assimilating this, and thoroughly, may not be underestimated. They who obtain the elements of the nation's wealth from the soil, or dig them from depths beneath it; they who manufacture them; they who trade in them; they who furnish the ways and means for handling them, and they who transport them—agriculturists, miners, manufacturers, merchants, financiers and transportation men—all these are indissolubly bound together, their interests interdependent; and one may not receive injury, and the others go unscathed. For these interests to attempt to do anything hurtful to any one of their co-partners is simply to attempt self-injury. Now, there could be no greater hurt inflicted upon the railroads than the weakening of their credit at this particular time, when most they need the help of money lenders to enable them to respond to the many and extraordinary demands that are being made upon them—demands for extension of all kinds and descriptions, such as new terminal facilities, new tracks, new equipment, etc. And there is a well grounded fear that that hurt has already been inflicted, for, while it may not be well to accept, in toto, the extreme view that no railroad can, to-day, for any purpose, increase its indebtedness, the policy of severe retrenchment, which has recently been adopted by even the strongest companies—and at a time, too, when the utmost possible expansion of railroad facilities is so imperatively demanded—must be accepted as showing inability to raise money on any save prohibitive terms; for it cannot be supposed that a course so generally followed is prompted by anything so unbusinesslike as a spirit of retaliation.

EFFECT ON RAILWAY DEVELOPMENT.

The pertinence of all this is to be found in the fact that this sudden and very serious lessening of the railroad's ability to borrow—except on terms which, to say the least, are not reassuring—will, in like degree, lessen their ability to equip themselves, as speedily as could be desired, with the safety appliances and devices wherewith to afford that better protection to life and limb for which the public, through its mouthpiece, the press, has been making a perfectly legitimate, if sometimes too vociferous, demand, and to increase facilities for handling the enormous, and constantly growing, volume of freight traffic. Something more than mere property qualifications are needed to enable a company to borrow money—its management, and the sources, volume and certainty of its income are also taken into consideration by the lender. Wholesale, extravagant and unwarranted charges of overcapitalization and of incompetent or dishonest management are hardly calculated to inspire with confidence, in American railroad securities, the money markets of the world.

Perhaps the best way in which to attempt the rescue of the truth from the enormous mass of discussion—or, rather, what has masqueraded as such—under which it lies buried, is to examine fairly the charges, the complaints, the explanations and the suggestions that appear worthy of consideration, and to try to discover in how far they answer the tests of recorded history, of experience, of mechanics, of economics, of the expert railroad practice of the day, or of those standards in the other fields they may enter by which they must be measured.

As to the charge that railroad managements are in the business of robbing stockholders, it may be answered that the indictment is too general; that, even amidst all the heated discussion, specific charges of that character have been made against but few officials. While to that that they rob the general public through passenger rates, and the business public through freight charges and discriminations, the pleas may be entered that both our railroad freight and passenger rates are the cheapest in the world; that many experts are disposed to credit the claim of railroad managements that passenger rates in general are unremunerative; that the roads cannot afford any further reduction of charges—which would mean a dangerous lessening of income, even if apparently trifling—because of the great increase in the costs of labor and supplies, costs which are further enhanced by the roads having to do four times the business their construction and equipment were planned to handle; that, as one expert has expressed it, "It is not possible to make a standard for rates, as these are a commercial proposition, which must be governed by the law of supply and demand"; and that there are two sides to the rebate story, for the railroads' customers have been as deep in the mud as they have been in the mire, and lastly that this matter has now been definitely disposed of by the Congress.

While on this subject of passenger and freight rates, it may be well to introduce the following figures, which were taken from census reports. Consideration of them should tend to dissipate certain of the mistaken theories—the dissemination of which has had so much to do with the arousing of public sentiment against the railroads—for they show that, despite the fact that everything which they have to pay for has steadily and greatly advanced in cost, these rates have as steadily and as markedly declined: "The net decline in passenger rates in the thirty-four years, 1870 to 1904, was 16.14 per cent, while that in freight in the same period was 58.71 per cent." These figures have been estimated to mean about two billion dollars less in the treasuries of the roads, and, consequently, that much more in the pockets of their patrons. The comparison between American rates and those of Continental Europe is equally favorable to our railroads' contention as to relative cheapness; for "they carry freight at rates that average but 57.14 per cent of the average charged in France, 62.30 per cent of that in Germany, 60.32 per cent of that in Austria, 61.27 per cent of that in Hungary, about 50 per cent of that in Italy, and about 90 per cent of that in European Russia. Since 1890 American rates have declined 19.15 per cent, French rates 13.64 per cent, German rates 8.96 per cent, Austrian 6.35 per cent and Hungarian 10.14 per cent."

THE RAILROADS' STUPENDOUS TASK.

The revived charge that their "speculative projectors ran them everywhere and nowhere" may be considered at greater length. One trouble with this contention is that those who have made it have been taking European railroad building as a standard of comparison, whereas Europe—an old, a long inhabited and a densely settled portion of the globe—has built railroads to answer more or less existing demands, while here the roads have built up the country to create business for themselves; the instances of roads which have started for "nowhere," originally, and which now have flourishing terminals—and prosperous communities lying between—are too numerous to warrant, and too well known to need, recapitulation here. Perhaps a more forceful expression of this idea is to be found in a recent statement of an authority on transportation matters: "The great fact to bear in mind always, is speaking of American railroad practice, is that the building of our railroads was the most prodigious real estate enterprise ever imagined; but none like it will ever again be undertaken. We built railroads in advance of population, covering enormous areas of unoccupied or thinly settled territory. We did it in order that the nation might be built, or at least we did it in order to promote the building of the nation, so that we could make money—if you choose to put it that way. At any rate, the result was the same."

The charge that railroad managements have endangered the travelling public through wilful neglect to provide adequate safeguards, through over-fast train schedules, and through neglect to enforce discipline, will have to be discussed at greater length. A recent statement to the writer of this article by the authority just quoted, however, answers this in a way: "To make it possible," said he, "to build our great railroad mileage through long stretches of thinly settled country, we have had to do things that would not have been done, and perhaps would not have been justified, in England. I have often said that civilization walked across this continent on the legs of the wooden trestle. You will remember what a rare thing an iron railroad bridge was when you were a boy; and you know how, for a couple of generations, the railroads of the United States served the people pretty well running over wooden bridges and pile trestles. Precisely the same thing is true of the use of cast iron car wheels. We never in the world would have had the rapid development that we did have if we had been obliged to pay four times as much for our car wheels as we did pay. The same thing is true of the American method of laying a flattened rail on a tie and nailing it down with a spike. So, for the Lord's sake, don't abuse the methods and materials that have made the growth of the United States possible."

Perhaps it would be well to take up specifically the several items of this indictment. (It may be interpolated here that, as a means of imparting more exact information concerning the more important safeguards under discussion, there will be presented, in the proper places, descriptions of the products of the exponents of the "state of the art" in these various fields. No thorough understanding of their character, and of the conditions governing them, can be obtained from the brief explanations which, only, are to be desired at this stage.) "Adequate safeguards," it is evident, from the innumerable references to them in the press, are meant to include more particularly steel cars, air-brakes, automatic couplers, safety car heating and lighting, rails that won't break or spread, wheels that will not flatten, axles without flaws, spikes that will not pull out or shear off, ties that will not rot or split, locomotive boilers that will not explode, auto train stops, and up-to-date signal systems.

As regards the train-brake systems and the automatic couplers, it may be explained that their use has been compelled by law since January 1st, 1898. Safety car heating is in general use on all American railways, and that use is also compelled by law. No way has yet been discovered of determining the integrity of steel rails; the one which caused the wreck at Tivoli was of 100 pounds weight, and was rolled in 1904, at the Carnegie Works. It broke because of a concealed flaw, something that cannot be discovered by any test except actual wear; it was relaid at the same spot and a wrecking train sent over it, when it broke again, proving that it was brittle. Concerning the flattening of car wheels, this results from wear, something that human ingenuity has not yet discovered a way to prevent; nor is it possible to determine when the danger point has been reached. The axle is subject to the same weakness as the rail—the concealed flaw. Much has been claimed for the screw spike, and it is said to be in general use in Europe; here it is only under trial. While American experts are inclined to think it more secure than the ordinary spike for fastening rails, they are not at all certain that the results from its adoption would be sufficiently advantageous to justify the greater expenditure it would entail. The tie is a vexed question; its liability to decay, and thus release the spike, but more particularly the growing scarcity of suitable timber, have led to experiments with concrete and steel ties, for both of which much is claimed, though the value of neither has as yet been determined. Boiler explosions, perhaps, present the greatest difficulty experts have to encounter in determining the causes against which to guard, for things are generally so torn up, in such disasters, that all clues are usually destroyed. The suggestion—or perhaps 'twould be more faithfully described as demand—that the railroads discard the "flimsy wooden cars," and promptly equip themselves with all steel cars, is founded in ignorance of the "state of the art," in this branch of passenger car building, which is yet in its infancy; it would be quite beyond this young industry to comply with an immediate demand from all the roads. How young it is can be figured from the fact that when it was decided to use steel cars in the Subway, it was found that, so little progress had been made in this direction, designs had to be improvised; and it is well known that the results so obtained have not been all that could be desired.

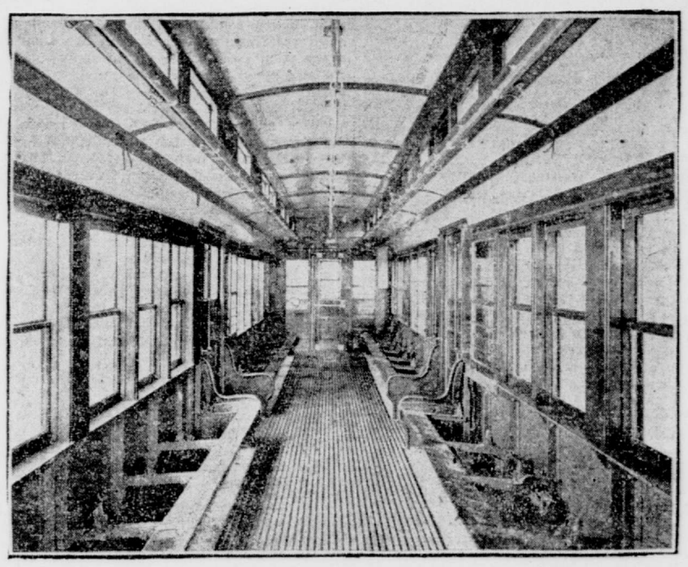
THE STEEL PASSENGER CAR.

Indeed, it was only a year ago that the Pressed Steel Car Company, the first concern to make an all-steel freight car commercially successful, ten years ago—it introduced later the equally successful steel underframe car—inspired by the belief that the next important step toward improving the vehicles of railroad traffic, and thus preventing the great loss of life occasioned by passenger train wrecks, would be the steel passenger cars, installed a plant for their construction, after having its best engineers give long and exhaustive investigation to the subject of this fireproof equipment. A number of important orders have been filled, among the best known being those for the Philadelphia Rapid Transit and the Boston Electric Railway. It would appear from the reports of the company that this portion of its business has thus far been unprofitable; and this would seem singular, in view of the fact that the public, startled almost daily by reports of disastrous accidents, is making such an imperious demand for steel cars, had not inquiry developed the causes; the hesitation of the railroads to get them because of their effect upon the wooden equipment, in accidents, and the consequent increased expense of repairs to the latter, and their further reason that the general effect of "investigations, reduction of rates, and restriction of traffic, in the different states," has not been such as to offer them any encouragement to buy a more expensive class of equipment—it is estimated that the "fireproof (steel) cars" cost from 30 per cent to 40 per cent more than wooden ones of the same capacity.

While there are in use, of this company's make, some 200,000 all-steel and steel underframe freight, it has thus far only constructed a few hundred steel and steel underframe passenger cars. The first steel passenger car made by it was No. 2256 of the Broadway surface line, on which it is still in service.

The weight of the steel car, of the same size and strength as the wooden passenger coach, will not exceed the latter by more than 10 per cent, and the cost by more than 20 per cent. But this company's engineers say the roads go too far in their anxiety to get cars that shall not only not splinter or burn, but shall not be destroyed in collision, for they mistakenly furnish specifications which greatly increase both cost and weight. "A moving body when brought to rest," the engineers explain, "is destroyed by a force which equals the weight of said body, multiplied by the velocity at which it is travelling. Increased weight produces increased momentum, and destroys the body in like proportion."

The steel cars are susceptible to decorative treatment in the same degree as are the wooden ones—in fact, the interiors cannot be told from those of the wooden coaches. By way of floor they have a monolithic pavement over a steel base. Some of



VIEW SHOWING THE INTERIOR CONSTRUCTION OF CAR (WITHOUT SEATS) BUILT FOR THE BOSTON ELEVATED BY PRESSED STEEL CAR COMPANY.

the roads specify that the inside sheets shall be covered with non-conducting material—seats, of course, will have the temperature of the car, as they are not in contact with outside air, and will not be uncomfortable, therefore, to the touch. But this is really unnecessary, it is claimed, as the air spaces between the outside and inside plates provide insulation and effect the desired result. For sanitary reasons the steel car should be plain and elegant, with no overtrim to catch dust and thus harbor germs. The framing of the steel car has been so designed as to reduce to a minimum the danger of pinning passengers tightly between loose parts, and injury by fire is, of course, eliminated by its entirely fireproof construction. Another important advantage is its great resisting strength, both in "butting" and "side" collisions. As regards endurance, it is practically not to be destroyed by time, wear and corrosion being easily prevented by the occasional application of a little paint to the parts not exposed to view, such as the underside of the body.

The performance of these cars, under the severest possible conditions, is shown in the fact that, in one of the numerous railroad accidents, one of them hung over a bridge for half its length, was

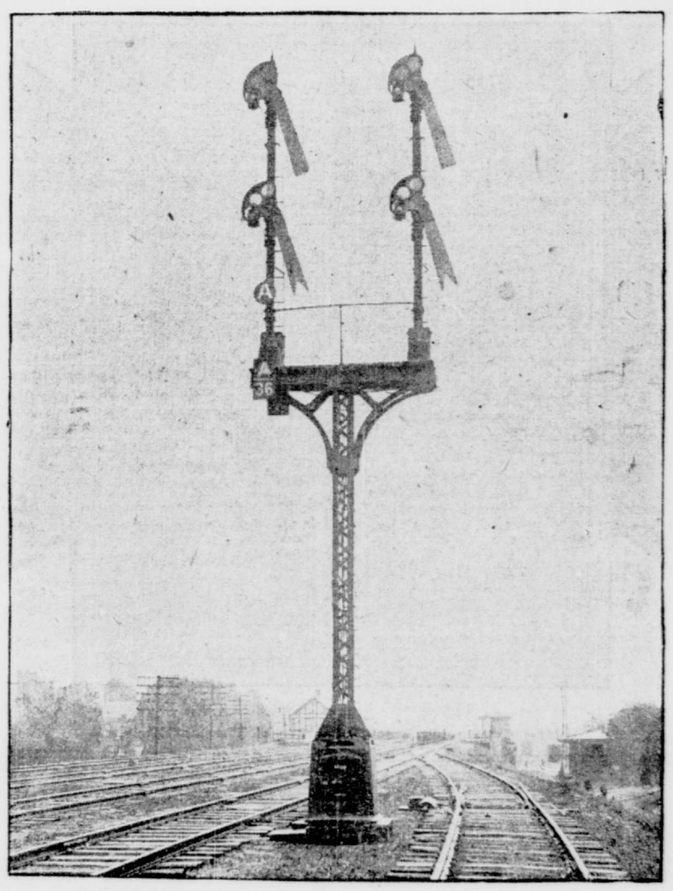


FIG. 1—"ELECTRO-PNEUMATIC SIGNALS."

pulled back onto the track and went on its way with its passengers rejoicing at their escape from a situation that might have cost many of them their lives, or serious injury, had it been constructed of wood, for in that case it would certainly have broken in two. Would it not be the part of wisdom for the travelling public to show appreciation of this description of service by exhibiting its readiness to pay passenger rates that will enable the railroads to offer more encouragement to the manufacture of these fireproof and practically non-destructible coaches?

FIREPROOFING THE CARS.

It cannot have escaped the reader's notice that the figures given in the foregoing as to car production show that the "steel underframe" vastly outnumber the "steel" coaches. This and the further fact that it will be a very long time before either or both will replace the wooden passenger coach on all the roads, on two accounts—first, that the railway managements do not feel authorized, under existing conditions, to make the outlay, and, second, that the industry as yet lacks capacity to fill such a tremendous order—would seem to demand the use of some non-inflammable material as a factor in, and protection to, present passenger car equipment. In fact, there is already in use (for head linings and roofs) on the New York Central's steel electric cars; on the Oneida (trolley) Railway of the Andrews Syndicate of Cleveland; by the Public Service Corporation of Jersey City; on the Atlantic Coast Line; on the Seaboard Air Line; on the Ontario & Western, and on a number of other roads, just such a material. The qualities it has been proven to possess should cause its more general use, however. It will smoulder, but it cannot flame, and therefore it's an excellent fire retardent; it is germ proof and therefore highly sanitary; it takes paint and decorative treatment quite as well as any other material; unlike wood, it cannot splinter; and, manufactured in dimensions as great as seven feet by eleven feet six inches, it can yet be made to readily follow any contours of the structure it is required to protect.

These (so-called) boards are the product of the Indestructible Fibre Company, and are of three kinds, which are designated as follows: "Fibrite"

PINTSCH GAS TANKS, AFTER TRAIN WRECK.

—This is less susceptible to moisture than wood, and will take as handsome a finish at no greater cost.

"Durite"—This is slow burning, is very hard, and has the tensile strength of oak; it takes a higher decorative finish than either of the other boards, owing to its homogeneous structure.

"Kantlite"—This is "fireproof," being chemically treated twice—to give it that quality; first the pulp in its raw state, and, second, the individual sheets during the process of manufacture. It has, approximately, 80 per cent of the strength and 85 to 90 per cent of the weight of oak; and it will retain its fire retardent qualities, it is said, for practically an indefinite period. Durite and Kantlite will absorb moisture, but to no greater extent than will kiln dried wood.

As regards the cost of these boards, comparing them with hardwood veneer, which they substitute: Fibrite is about the same in price; Durite and Kantlite about 12½ per cent more.

The latter has been on the market but a few months. The Barney & Smith Engineering Company, of Dayton, Ohio, are about to apply it to an experimental steel car which it has in course of construction, and thus its merits will soon be satisfactorily tested.

The Sherwin-Williams Company is getting up for their makers, it is reported, specifications through which the cost of finishing and painting these boards will be standardized.

The various boards are utilized at present, on steam and electric roads, only for roofs, ceilings and panels of cars; but, if encouraged by the railway companies in such production, there is no reason why the makers should not turn out, also, car partitions, inside trim and possibly floors. Indeed, the fact that such varied and widely differing uses have been found for it—as, for example, in show cases, incubators, mirror backings, concealed parts of furniture generally, and steamboat superstructures—according to the manufacturer's report, would seem to indicate an adaptability that peculiarly fits it for such purposes. And certainly its use, wherever—in the steel car—the human anatomy is likely to come in contact with the metal, especially in regions of extreme heat or cold, is to be commended. Naval experience has, as a matter of fact, demonstrated such protection to be a necessity, in the steel ship.

THE LIGHTING OF CARS.

While on the subject of that most dreaded result of train wrecking accidents, fire, with its ghastly immolation of human beings, the horror and piteousness of which are intensified by the sight of the charred and grotesquely distorted remains, and by the impossibility of their identification by those who are left to mourn their awful fate, it may be well to reassure those in whom misinformation—as to what starts it on such occasions, for it's always the result and very rarely the cause of accident—gives birth to fears that keep them in a flutter from the beginning to the end of a journey by rail; such persons' minds are usually storehouses for all kinds of theories, concerning this, which have little or no solid foundation upon which to rest.

For example, they have been in a wreck—or some friend has, and has related a similar experience—where the debris has been set on fire, and they have smelled the gas with which the train has been illuminated—proof positive that "the gas did it!" Whereas the real cause was, sometimes, the dining car cooking range, or, in an overwhelming number of cases, the thousands of pounds of coal, at white heat, in the firebox of the locomotive, suddenly dumped into the chaotic and combustible mass of splintered wooden cars, with their even more inflammable draperies and furnishings.

The gas used as an illuminant on nearly all railway passenger trains—the Pintsch—is non-explosive. Indeed, the very nature of the gas itself, and the design and application of its equipment on cars, are such that even the bare possibility of danger from them is eliminated. The former is carried, in limited quantities at moderate pressure, in tanks of amply strong construction, outside of the cars, these tanks being suspended under the floors, while all pipes containing gas under a pressure which materially exceeds that of the atmosphere are at the middle, and, together with the small pipes conveying it to the lamps, outside of the cars—with the single exception of a one-half inch pipe passing from floor to roof. It is many times safer than city gas, if for no other reason than that there is such a very small quantity on a car at any time.

The exceedingly volatile gas that the passenger smells when, in the case of wreck, the tank is pierced and the gas is released into the surrounding atmosphere, has wholly escaped from confinement before his or her olfactory nerves have conveyed the impression to the brain, and the latter has had time to determine the nature of the odor. No doubt this is horribly impressive, for a small fraction of 1 per cent of Pintsch will, when mixed with ordinary atmospheric air, greatly leaven it and will produce a very high power odor—one that really cannot be said to resemble those from "Araby, the blest"; still, if all the gas contained in the tanks underneath was liberated in a tightly closed car it could not cause an explosion. Under ordinary conditions, it would not even vitiate the atmosphere, for its method of pipe installation offers the avenues of escape of which its extraordinary volatility would cause it to instantaneously avail itself. It is remarked that this method of installation is in itself a valuable ventilation factor, and at all times, whether the lamps are lit or not.

Of one thing it is reasonably possible to be sure: Those responsible for its very general adoption—it is the standard means of lighting on hundreds of railroads, and is advertised as in use on 30,000 cars in the United States, and on 160,000 cars in the world at large—would scarcely have afforded it such tremendous indorsement had they been able to discover in it even the remotest particle of an element of danger, or had its history and development given any hint that such was to be discovered. It is not a thing of yesterday, but a thoroughly tried-out system which, for over fifteen years, has been furnishing the most reliable and generally satisfactory light for railway cars; and the mere fact that it has, in that period, been used for all classes of railroad service, in which, too, it has been operated by all classes of railroad servants—good, bad, and indifferent—without disclosing any objectionable, or dangerous, feature whatever is ample warrant of the sagacity which prompted that indorsement.

The light is the result of attempts made, at the request of the Prussian State Railway, so well known for its enlightened efforts at improvement of land transportation, to find a cheaper illuminant than oil, and yet one that would be absolutely safe in use on railroads. To properly estimate the economic result one needs only to be told that it costs about half as much as lighting cars with oil; but the comparison with other illuminants, in use for the same purpose, discloses the fact that it is cheapest of all. The cost per hour for electricity is one cent for 12 candle power; for acetylene, one and one-quarter cents for 30 candle power, and for Pintsch gas, four-tenths of one cent for 25 candle power—with the gas mantle the latter quite equals the acetylene in light giving power, and has six times the brilliancy of city gas. It will be observed that, while the Pintsch gives 25 candle power per burner, electricity—on cars—only furnishes 12 candle power; the reason is that the latter has to depend on storage batteries; these are bulky, and naturally room is at a premium there. These batteries have to be charged, even at that candle power, every six or eight hours; and yet, where electricity is used, they are preferred to the axle system, which is too unreliable to be popular, it is said.

The Pintsch gas has been adopted for American railway service, the conditions of which differ greatly from the foreign, in that a great deal more light is demanded, and that the interchange of railroad traffic existing here makes necessary a uniform system of lighting "from Maine to California, and from the Gulf to the Great Lakes," to use a familiar figure. One means employed in the adaptation was the establishment of Pintsch compressing plants all over the country, so that the roads might use either a small or a large number of cars equipped with it, and not have to obligate themselves to the system—which would be the case if each had to have its own installation. There are now eighty-two of these plants, located at intervals throughout the country. All the details were so admirably planned in the very beginning, it has never been necessary, it is said, to attempt improvement of any description, save in the matter of illumination—such as the adoption of the gas mantle—though the gas is now of a better quality than originally generated. It is said thirty thousand of the forty-five thousand cars in use in this country—and those the most modern—are equipped with the Pintsch, and the annual consumption of the gas is estimated at over seven hundred and twenty million feet.

Something further should perhaps be said of the performance of the Pintsch gas in the presence of disaster to trains on which it is installed. The number of holes punched into the Pintsch cylinder shown in the accompanying illustration would seem to demonstrate the fact that no explosion resulted from their rough usage, as they were otherwise intact. These cylinders were taken out of the wreck of passenger train No. 11, on the Fitchburg division of the Boston & Maine Railroad, near West Deerfield, on January 29, 1907. A similar accident occurring to an acetylene cylinder would have permitted air to mix with the gas, in itself an explosive, and then—well, everything in its neighborhood, animate and inanimate, would probably have been scattered over the surrounding country. But so far as is known—and the company's experts are always instantly on the scenes of the accidents, to find out—the Pintsch has never caused trouble in a wreck. Yet it never fails to have the opportunity to do so offered to it; for, in every kind of railway collision, brakes, as will be more fully explained later on in this article, "set" and cause the trucks to break loose and to collide with the gas tank, which is suspended, as has already been described, midway of and underneath the floor of the car—as a consequence these tanks have been hurled in every direction, and without doing any damage other than their impact may have caused. The gas is not explosive in itself, and there is not enough contained in a tank to make an explosive mixture with the air; still, the quantity carried, and under a moderate pressure, is enough to keep it well filled, and so preclude any chance of air getting to it. Indeed, these tanks, filled with compressed gas, are no more dangerous than if filled with air at the same moderate pressure. They have been found in the fires started by the locomotive firebox among the debris of wrecks, intact, but with, of course, their contents dissipated into the atmosphere.

To the advantages of economy and safety the Pintsch adds that of the cleanliness so desirable in a vehicle where a number of persons are more or less "cooped up together"—no matter how relatively commodious it may be—and for long distances; besides which the extreme simplicity of all apparatus on the cars, and its already mentioned characteristic of furnishing aids to ventilation, particularly recommend it to railroad managements.

THE HEATING OF CARS.

An allied activity—and a no less important one—is the heating system, which is more or less familiar to the travelling public through enjoyment of its warmth and comfort in the Pullman cars, though perhaps not otherwise known to it.

Fires have never been caused by this hot water indirect system—at least, none have been reported—and yet it has been installed in no less than five thousand cars. In this system a Baker heater is carried in one corner of the car, and to this heater, which is made of boiler steel and is fireproof, no fires have been traced. It should be explained that the Baker heater is only used when steam from the locomotive is not available, when, for example, a train is not coupled up to the latter, or when a Pullman or a private car is "lying over"—for these cannot afford to have their very expensive equipment of pipes, etc., frozen up. These are simply furnished steam heating appliances for the "Baker system," which appliances have been used to equip 19,000 of the 35,000 cars that have modern heating systems installed.

The lay reader may require some slight explanation as to the points of difference between the two systems mentioned. As the expert description is quite simply worded, and, therefore, is free from technicalities, it is here repeated:

"The Baker Heater System consists in the main of a stove, supplied with a coil of pipe within the firepot, an expansion tank or drum, on the roof above the stove, and connecting with the upper end of the coil; and a system of pipes, all connected in a series of bent, or straight, radiators, under the seats, or along the truss planks, of the car. This series of pipes extends in an unbroken circuit from the expansion drum down to the floor, and along the side of the car on which the heater is located; thence across the car and, in a similar way, along the other side; thence back again to the first side, and along that, one or more times, to the inlet of the stove coil; and through the stove coil and pipes above to the expansion drum again. This circuit of pipes is filled with water, salt or fresh, up to the overflow of the expansion drum, which is then closed tightly."

"In the 'indirect,' or, as it is called, 'Standard Heating System,' the aim is to replace the heat of the fire with the heat of steam (the supply of the latter being drawn from the locomotive), leaving the Baker Heater System in such condition that a fire can be started at any time, if needed. To accomplish this, steam jackets are used, one located near the heater, on the pipe leading to the bottom of the coil, and the others on the pipes leading to and from the radiating pipes, on the side of the car opposite the heater side, and known as the "crossovers" (or connected into the circulation near the middle of the car in the case of a double circulation car).

Steam from the engine is conducted from car to car by means of suitable flexible couplings and pipes beneath the floor, the latter being designated as "train pipes." In all jackets the water contained within the outer pipes is heated by the passing steam, thus aiding in the circulation and also reducing to from one-third to one-sixth the time required to cause complete circulation of hot water in all parts of the system. While the steam, at the pressures used, is far below the temperature of fire, its application in this way at various points of the circulation, instead of at one point (the heater coil), results in a more uniform heating and higher average temperature of the pipes throughout the car."

ENERGY IN CONDENSED FORM.

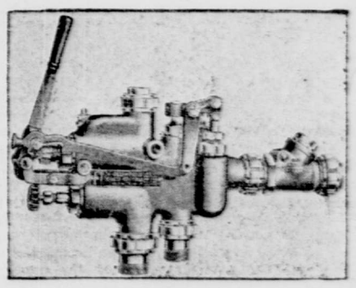
Earlier in this article allusion has been made to locomotive boiler explosions, and the difficulty of tracing their causes; and later, the "iron horse" has been accused of being, in wrecking incidents, the most frequent cause of the holocausts that so often follow in the wake of derailments and collisions. As it is desired to reassure the timid traveller—not to add to the feeling of apprehension and insecurity with which he has already been more than sufficiently inspired by the horrific pictures the sensational word painters have limned on his too sensitive mental retina—it may be well to go into this branch of the subject more fully.

To begin with, it must be pointed out to him that the number of train miles, in the trips by rail that suffer such interruption, to the 1,000,000,000 that the locomotives of America travel annually, is as a drop of water to the mighty Atlantic.

He has just been told that, although there has been discovered no way of preventing a firebox from discharging its deadly contents into the debris of a wreck, this can be rendered innocuous through steel cars and fireproofing processes. And he should be informed that even the statement, made earlier, that "boiler explosions present the great difficulty experts have to encounter in which to determine the causes against which to guard, etc., etc., because in such disasters all clues are usually destroyed," needs considerable qualification; for the chief, the most fertile sources of this class of accidents have been scientifically demonstrated, and, as is evidenced by their comparative rarity, subjected to control.

In an earlier day neither the material nor the workmanship could, anywhere near so well as now, withstand the tremendous energy men sought to confine, and to make take the place of man power, or horsepower—an energy, an explosive power "compared to which," to quote an expert, "a Whitehead torpedo, such as blew up the battleship Retvizan, in the famous naval battle in the Sea of Japan, is a toy." Even the effects of wear and corrosion are estimated with a remarkable approach to accuracy, and, to a considerable extent, guarded against. In fact, almost all the elements of danger have revealed their secrets under the searching eye of modern science, and have been largely neutralized.

Here, however, as in all other fields of endeavor, the chief difficulty science and invention have experienced has been to devise means to protect the



THE HANCOCK INSPIRATOR.

public against the crass ignorance, the lazy negligence, or the criminal recklessness of human agencies. Automata are fast eliminating this human equation, but no way has yet been found to get along without the engine driver, or his fireman—his occasional fellow sinner. Where it has been impossible to take out of the hands of the—fortunately very few—incompetent or unfaithful engineers and firemen the power to do mischief, they have been robbed of all excuse for doing it innocently, at least; and, to a degree, even their recklessness may not be indulged in thoughtlessly—its consequences must be precipitated by wilful disregard for them. It is in the throwing of these safeguards about its boiler, as much as in the building of the boiler itself, and in the planning of its other and even more wonderful features, that this "machine nation" shows its possession of mechanical and inventive genius of the highest order, and its title to supremacy. "The steam locomotive used on the American railroads," said a close student of the art, "is the most compact and efficient form in which steam power has ever been applied. The useful force to which this enormous steam power is daily put can be seen everywhere on this continent in the tremendous freight and passenger trains that are drawn over its network of railroads."

LOCOMOTIVE BOILER SAFEGUARDS.

As the steam power of the locomotive increased coincidently with the improvement of mechanical devices, and the strengthening of materials, that enabled the engineers to use higher steam pressures, the destructive force contained in the boiler grew greater and greater. Every now and then reminders are given of what may happen when man loses command of the agency which he has so skilfully harnessed for the purposes of civilization—when a locomotive explodes and is hurled into a thousand twisted fragments over acres of ground. This potential destruction travelling at the head of every passenger and freight train must be regulated and controlled by devices that are absolute in their action and constantly efficient. When one looks over a locomotive waiting at a railroad station one is scarcely apt to pay much attention to the steam gauge and the spring loaded safety valve, so unobtrusive are they. Yet upon these two devices depends the life of every one in or around the locomotive; and, indeed, to them is due the very possibility of such a tremendous power existing, without so endangering the lives of all that civilization would demand its abolition. Without the safety valve and the steam gauge, we would have as much right to permit steam locomotives to travel on the tracks of our railroads as we would have to permit large quantities of high explosives to be deposited everywhere throughout our cities.

The largest and oldest manufacturers of steam gauges and safety valves in the world are the Ashcroft Manufacturing Company and the Consolidated Safety Valve Company, whose plants are located at Bridgeport, Conn., where they employ upward of a thousand men. The first was established in 1851 and the second a few years later. They are both now located in Bridgeport, although formerly established in Boston. The manufacturing plant of the last mentioned concern is fully equal to that of the first, which is said to be one of the finest factories, for the peculiarly high grade work required on such mechanisms as safety valves and steam gauges, in the United States.

The gauge is the silent monitor that warns the engineer when the steam in the boiler has reached the danger point; and the safety valve interposes, when he has disregarded that warning, to protect the lives and property his unfaithfulness has jeopardized. Without these two devices—and a third described later—it is doubtful if the modern locomotive could perform its duties under the varied conditions it has to encounter.

THE WATCHFUL STEAM GAUGE.

The first of these—the steam gauge—indicates, as said, the steam pressure in locomotive boilers; and, to appreciate its importance, it must be understood that, without the use of this instrument, the engineer would have no means of determining this. In 1851 E. H. Ashcroft, of Boston, began the manufacture of steam gauges, and was the first in this country to adopt what is known as the "Bourdon Tube Pressure Gauge"; to-day it is used universally. The Bourdon type of gauge is simple in itself. The tube is flattened and bent, thus forming the arc of a circle; and, when a pressure is exerted on this tube, the tendency is to straighten it and cause it to resume its natural position, a straight line. Advantage was taken of this fact by a simple mechanism which connects a link, at the end of the tube, to an operating segment, which engages a pinion. It is possible to have a pointer, or hand, on this pinion, to indicate upon a dial the correct pressures. The Ashcroft Manufacturing Company has so improved the pressure gauges that they now overcome the difficulties found to exist; these were due to the liability of the tubes to "set," and also to the great vibration of a locomotive. The "Ashcroft Improved Locomotive Gauge," with its auxiliary spring, shows the simple methods effectively employed to produce the desired results. That the gauge may be sufficiently sensitive and accurate, it is necessary to employ a long "Bourdon tube," or spring, and it is easily