The Engineering Times.

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How We Stand in the Steel Competition.

It is an interesting commentary on the tall talk that goes on of successful American competition with England in structural engineering work to learn that many thousands of pounds are annually spent in the Black Country alone by American merchants and commission agents. At this very moment, says the *Westminster Gazette*, large orders of steel for structural purposes are being executed by Midland manufacturers at the instance of American customers, and all branches of the steel and iron trade in various parts of the country report business in a healthy condition. Another significant fact is that mining machinery is still being freely ordered for South Africa, in spite of the Transvaal troubles.

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Report on Dangerous Trades.

The fifth and final report of the Dangerous Trades Committee has been issued. The trades reported on by the Committee include the manufacture and use of grindstones and emery wheels, basic slag works, the manufacture of salt, flour-mill working, the use of metallichrome powder in lithographic works, the use of lead in print and dye works, dyeing with arseniate of soda, and the licking of labels for reels in thread mills. The Committee report generally that the number of deaths caused by dangerous trades is much greater than supposed, the cause of death being seldom inquired into by the coroner. The Committee suggested that in the case of death of a factory hand the inspector of factories for the district should report to the coroner. Thus light may be shed on the way in which diseases are induced in many cases where the matter is now obscure.

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Hints to Emery Wheel Users.

Too great a variety of work should not be expected from one grade of wheel, and if the amount of grinding will warrant it several grades can be profitably employed, each carefully selected for its particular purpose.

Wheels should be kept perfectly true and in balance, and in order that they may not become in the least out of true an emery-wheel dresser should be used to dress up the wheels a little each day, or as often as they require it.

In mounting emery wheels, never crowd them upon the arbor.

Use flanges at least one-third the diameter of the wheel.

Flanges should always be concaved and fitted with rubber washers between flange and wheel.

Have wheels slip easily on the arbor, and screw flanges only tight enough to prevent wheels from slipping.

Machines on which wheels are

mounted should be heavy and strong, and solidly bolted to a firm foundation.

Keep machine well oiled, so that arbor will not become heated ; otherwise there is danger of wheels breaking from expansion of arbor.

Users of wheels are particularly cautioned not to run wheels on shaky machines, or on machines in which the arbors have become loose in the boxes from wear.

See that rests are properly adjusted in relation to the wheel ; otherwise accidents may occur owing to work being drawn between the wheel and the rest.

Never run wheels at a higher speed than the maker recommends.

Don't try to grind malleable iron with a wheel that was made for brass, as no one wheel can be made which will be just right for grinding all kinds of metals.

To obtain the best results, emery and corundum wheels should be run at a surface speed of 5,500ft. per minute. Wheels, if run too fast, will heat the work and glaze, and if run too slowly, will wear away rapidly and do but little work. The same speed should be maintained as the wheel wears down, and the speed of the spindle should be increased correspondingly as the diameter of the wheel is decreased. Where there is a sufficient amount of grinding to warrant the use of more than one machine, this can be accomplished by transferring from the first or larger grinder to smaller ones as the wheels wear down, otherwise by means of cone pulleys.

WILFRID J. LINEHAM, M.INST. C.E., M.I.MECH.E., ETC.

Author of the article "The Education and Training of an Engineer," in this issue.

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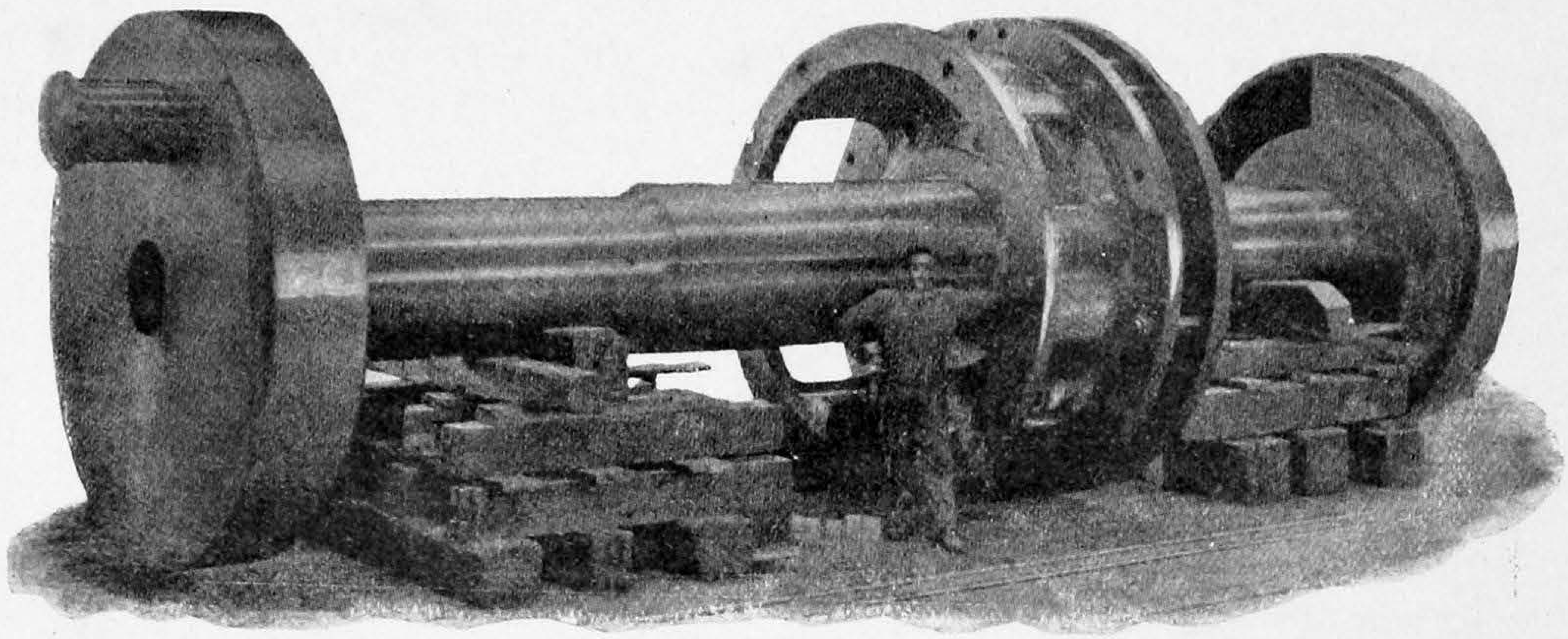
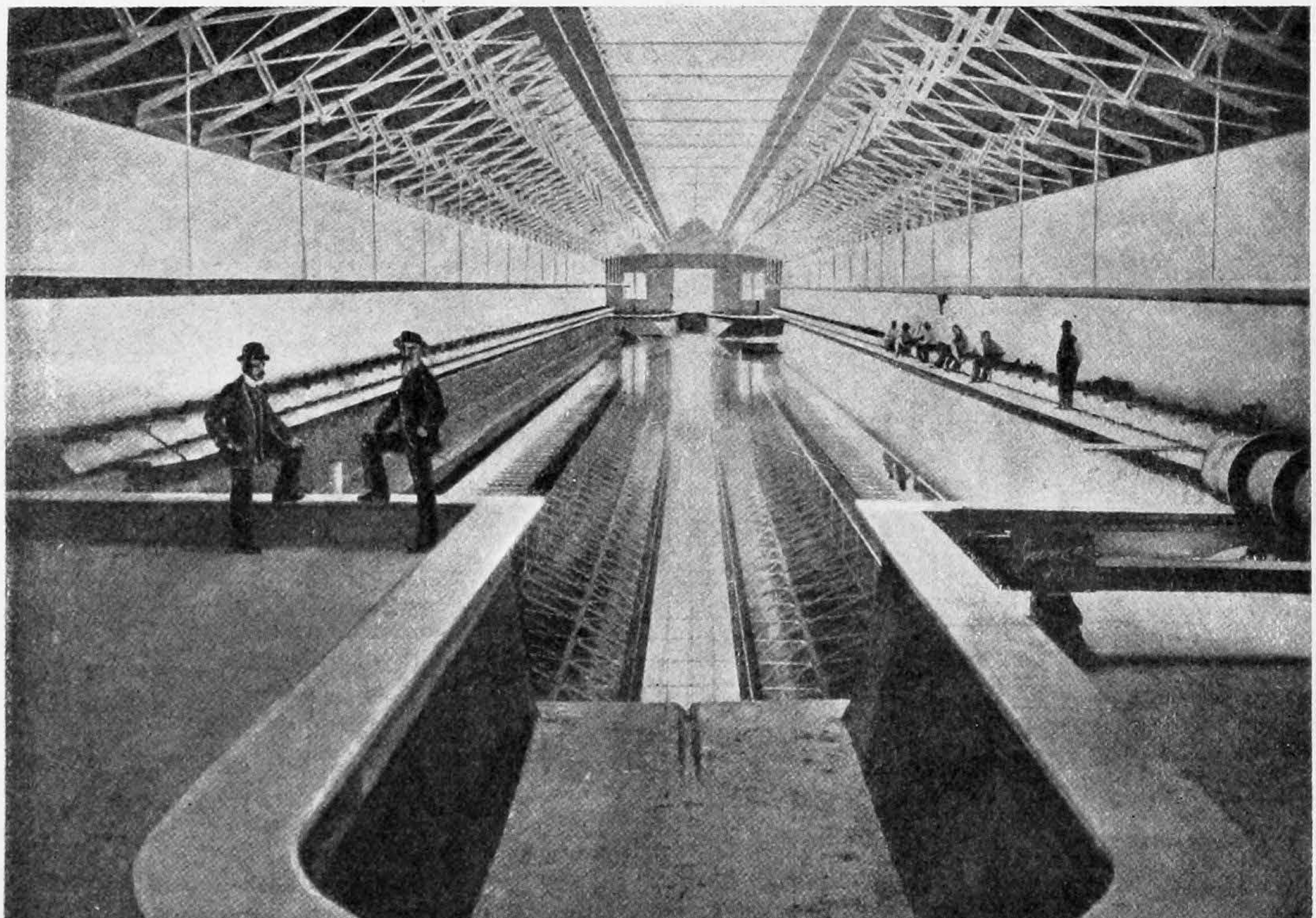
A Large Engine Shaft.

We give an illustration of a very large engine shaft, one of three just built by the Bethlehem Steel Company, of America, for the Boston Elevated Railway. The shaft is for a 8,000 h.-p. engine, and is 27ft. 10in. long; the diameter of the fly-wheel fit, 37in.; diameter of journals, 34in.; diameter of crank disc fit, 32in. The shaft is hollow, the diameter of the axial hole being 17½in. The weight

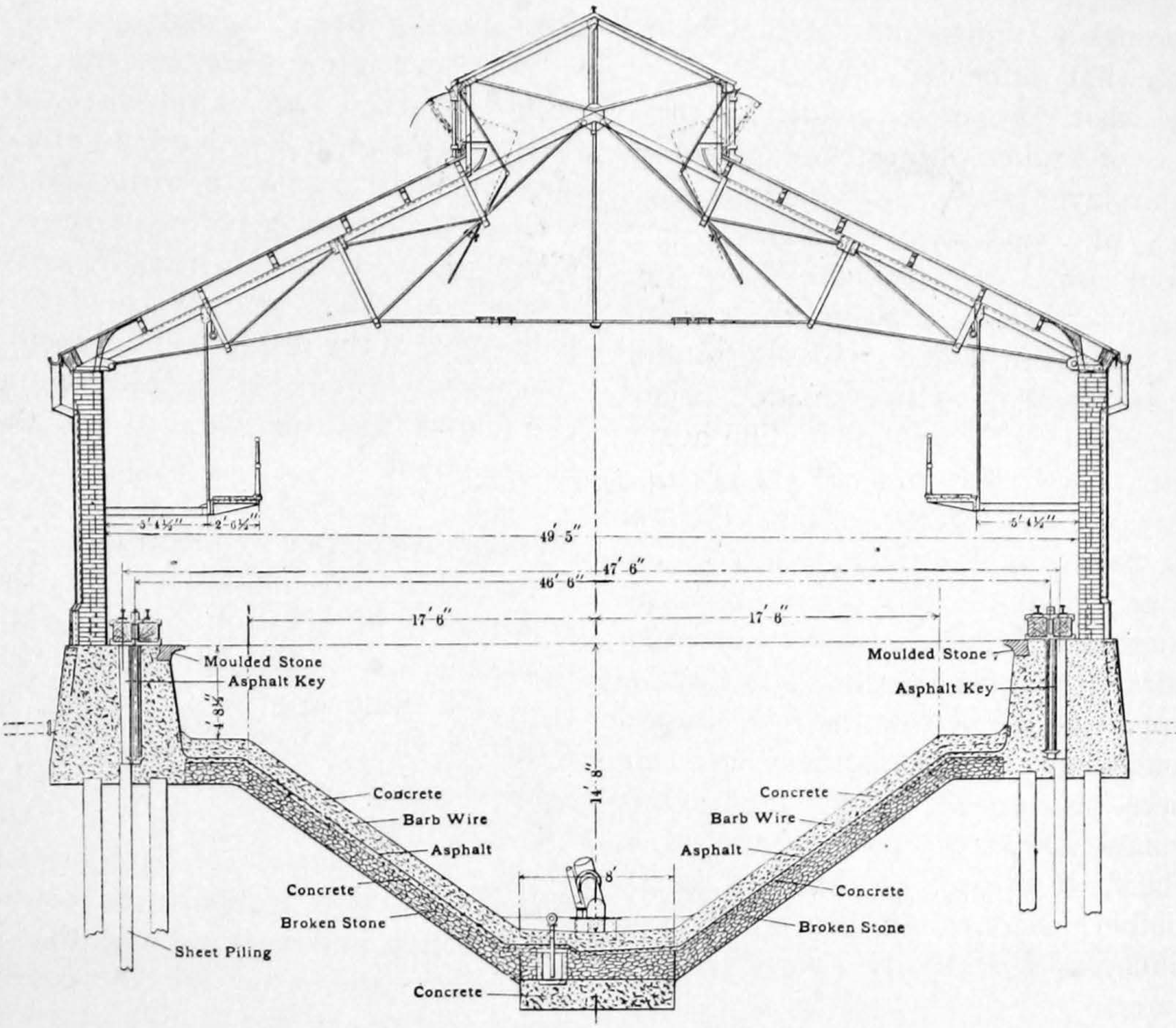


AN ENGINE SHAFT WEIGHING 65,410 LB.

of the shaft is 65,410lb. It was fitted to crank discs 8ft. in diameter, weighing 58,004lb., and to a fly-wheel hub, weighing 46,986lb. The total weight of the shaft, with crank discs and generator fly-wheel hub assembled on it, all finished, complete, is therefore 170,400lb. The shaft is of fluid compressed nickel steel, hydraulically forged on a mandril, oil tempered and annealed. The metal of which the shaft was made showed an elastic limit of 50,000lb. per square inch and an elongation of 18 per cent. in test pieces 1in. in diameter and 10in. long.



AN EXPERIMENTAL MODEL BASIN.



SECTIONAL VIEW OF EXPERIMENTAL MODEL BASIN.

An Experimental Model Basin.

We take the liberty of reproducing from our contemporary the *Marine Review* two illustrations of an experimental model basin, installed last year at the Washington Navy Yard. The value of towing experiments upon models of ships, for the purpose of deducing the resistance of full-sized ships from that of the small model was demonstrated by the late Mr. William Froude, who, at his own expense, started a small tank for such experimental work at Torquay. In about 1870 our Admiralty subsequently recognised the value of his work, and assisted him in it by building at Haslar, near Portsmouth. Other Governments, notably Italy and Russia, have now established model basins largely on the plan of Froude's, and the enterprising firm of shipbuilders, Messrs. Denny Bros. of Dumbarton, have now constructed for their own use. The Washington Basin is fairly well explained in the accompanying illustrations. The building covering it is 500ft. long and about 50ft. wide inside. The water surface of the basin is slightly shorter than the building, being about 470ft. long. The deep portion is about 370ft. long, the south end, from which the runs begin, being shallow. The water surface is 43ft. wide, and the depth from top of coping to the bottom of the basin is 14ft. 8in. The basin is materially larger than any other in existence. The nature of the ground was such as to render the construction of a thoroughly tight and stable basin somewhat difficult. The bottom of the basin proper is made up of a layer of broken stone, upon which is a thin layer of concrete, then a half-inch of Neuchatel asphalte, then about 9in. of concrete in 16ft. lengths ; the key between the various lengths being filled with Bermudez asphalt, and the whole inside surface covered with the asphalt. The heavy side walls are 6ft. thick at the bottom, 6ft. deep, and about 4ft. 6in. thick on the top, not counting the moulded stone coping. They are in 40ft. lengths, with a square key between adjacent lengths filled with Bermudez asphalt. The side walls rest upon a double row of piles, and in addition there is sheet piling completely around the deep part of the tank. The shallow part of the tank at the southern extension is also carried on piling, as it actually overhangs the water.

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Sir W. H. Preece and Wireless Telephony.

Sir W. H. Preece, since his retirement from the post of chief electrician to the Post Office, has taken up his residence at Carnarvon, his native town, where, assisted by a number of officials from the General Post Office, he has made successful experiments with wireless telegraphyon the system identified with the name of Dr. Lodge, of Liverpool. Profiting by the results obtained, Sir William turned his attention to the telephone, and sought within the past few days to establish telephonic communication without wires between the Voryd and Belan Points, about a mile distant from each other, on the shores of the Menai Straits. So far the experiments have been eminently successful, conversations having been carried on daily without interruption between the two points named. The sound was quite distinct, though not so loud as would have been the case with wires. It is now proposed to experiment over a much greater distance—namely, across Carnarvon Bar, and it is firmly believed that the results will be equally successful. The experiments are being conducted in the interests of the Government.

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Mechanical Traction by Electricity.

At the last conference of the Institution of Civil Engineers, Mr. Granville C. Cuningham, M.I.C.E., read the following very interesting paper on the above subject :—In the installation of mechanical traction by electricity on tramway systems the point to be considered is how this form of traction compares in cost of construction and working with that it displaces ; and what are the conditions that make for a high or a low cost of working. It will doubtless be admitted that unless such form of traction were financially superior to other forms it would not be adopted ; but it will be useful to inquire wherein this particular superiority lies, as this indicates the direction in which the skill and resource of the engineer should chiefly be turned. The cost of constructing and equipping an electric tramway system is very much greater than the cost of a horse system. The receipts per car-mile may not be much greater, and with the largely increased mileage run, may possibly be even less ; therefore, unless the expenses per car-mile of the electric system are very much less than the expenses of the horse system, whence can be obtained the large additional net revenue required to pay interest and sinking fund on the greatly increased capital invested? It is accordingly to this lowering of the cost of electrical working that the attention of the engineer should be chiefly directed, and the best results in this respect can be obtained only by care in construction.

In the first place, on what item in working cost may a saving be looked for?

In the matter of wages of men on the car, no saving can be effected; two men would be needed on the electric as on the horse car, and the electric employees may even be expected to require higher wages. The maintenance of car-body—painting, repairs, and so forth—would be practically the same in either case; the maintenance of the electric equipment of the car is an addition to any expense of the horse system; so also is the overhead wire and feeder system; the maintenance of the track would be greater for the electric system, including therein the bonding. In all these items the cost in the total would be greater for the electric than for the horse system. There would be some advantage to the electric system in being able to run at a higher speed, thus distributing the wages of motormen and conductors over a larger mileage in a day, and reducing the amount of that item per car-mile. But this is not a large amount and would not compensate for the increase in the other items mentioned.

The only item remaining to be considered is the power used in the service, and it is in this item alone that the saving can be effected. For this reason the power house on an electric system is the point to which the intelligence and skill of the engineer should be mainly devoted. It is upon this that the financial success of the undertaking depends. If it is carelessly constructed with engines, boilers, and appliances that do not ensure a low cost of working, then it is certain that but a small profit—and perhaps no profit at all—will be realised. It is certain that no great financial success will be secured. Everything that will reduce the cost of producing the electric current should be sought out and applied in the construction of the power house.

The cost of horse traction—and by this is meant the cost of horse-keep, wages of grooms, shoeing, veterinary expenses, but exclusive of drivers' wages—may be taken as varying from 3½d. per car-mile in an easily worked town such as Glasgow, to 5d. per car-mile in a hilly and more difficult town, such as Liverpool. This is the cost of horse traction arrived at from the working of fairly large systems showing 7,000,000 car-miles annually in Glasgow and over 4,000,000 in Liverpool. The cost of electric power for traction on the overhead trolley wire system should, with economical engines, boilers, and heat saving appliances, be under ½d. per car-mile for an easily worked level town, and for a more hilly town with steep gradients, but slightly over ½d. per car-mile. The cost here meant is the cost of all wages, fuel, water, oil, etc., in the power house, together with the cost of maintenance, repairs, and upkeep of the plant. The cars driven by this power are those weighing about 6½ tons when empty, and capable of seating 26 passengers inside. But in order to ensure this low cost of working, every care must be taken in the power house. In choosing its site, it should be placed close to a plentiful supply of water, where all that is requisite for condensing purposes may be had at a nominal charge, or merely for the cost of pumping. A river, canal, pond, or the sea, would afford what is needed. It should be conveniently situated for the supply of coal from railway line, canal, or wharf, so as to save the charges of handling fuel. One shilling per ton saved in cartage would amount to a very considerable sum in a year in a large traction station. But, needless to say, the most important matter is the type of engines, boilers, and heat savers to be used. The writer favours low speed (70 revolutions) compound condensing engines, such as are built by numerous English firms, boilers of the Lancashire or Galloway type, with Green's economisers. A plant of this character was constructed and worked under the writer's charge on the Montreal Electric Street Railway, with the result that the cost of producing current was a little under one farthing per kilowatt-hour, and the cost per car-mile less than a halfpenny in the open months of the year, when coal could be obtained for 9s. per ton. The consumption of coal was 3·48lb. per kilowatt hour, or 2·60lb. per e.h.-p. hour, and this was maintained during months of working. The average for a whole year was only 2·70lb. per e.h.-p. hour. It is not pretended that this is a phenomenally low rate of consumption. On board many of the large ocean-going steamers as low as 1·50lb. of coal per h.-p. hour has been reached with triple expansion engines; but the writer believes that few electrical power houses have been able to show better results than those mentioned. Nor is the result to be attributed to a very large output; precisely similar results can be obtained by using similar appliances on a smaller scale. In the Montreal house there were six 800 h.-p. engines, and the daily output of current averaged 43,000 units. But the author has recently obtained similar results with a small cable plant on the Birmingham cable system. In 1897 this plant consisted of a pair of single cylinder engines running at 53 revolutions of 287 maximum h.-p., with Galloway boilers, and no special heat-saving appliances. It was necessary to increase the engine power to meet increased traffic. The author put in a pair of superposed compound condensing engines of 400 h.-p., running at the same speed as before, and obtained condensing water from a well in conjunction with a tank and cooling tower. The result was that the consumption of fuel was reduced from about 325 tons per month, or 8·9lb. per car-mile, to 6·5lb. per car-mile; and the introduction of Green's economisers has further reduced the consumption to 4·7lb. per car-mile, or to about 3lb. per h.-p. hour. On the Birmingham small cable system, the saving does not amount in money to a large sum, but on a great electric system running, say, 7,000,000 car miles in the year, 4lb. of coal saved per car-mile, at 9s. per ton, amounts to £5,625 per annum; and it is this consideration that gives emphasis to the plea for an economical power house plant.

To return to the previous line of argument. Note what a large saving is effected when a cost of ½d. per car-mile for power is substituted for 5d.; on a car mileage of 7,000,000 it means no less a sum than £131,250 per annum! and indicates the source whence the increase of net earnings may be obtained to pay for the heavy cost of electrical installation. The whole cost of working a large electric system, including working charges of all kinds, should be under 5d. per car-mile; but this can only be obtained with a carefully constructed power house, where the works' cost of the current is cut down to a minimum.

The limits to which this note had to be confined prevent the introduction of any more elaborate figures or statistics than those given; but enough has been said to indicate that, in the writer's judgment, it is to the power house that the chief attention should be directed in order to ensure the financial success of an electric system. Other parts of the system claim attention, but it is on this that success or failure mainly turns. More money can be lost on the one item of power than would pay all the other working charges, and whether the high potential system with transformers, or the multiple unit system be adopted, the successful working ultimately depends upon having engines and boilers that will do their work with a low consumption of fuel.

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Agricultural Machinery in Russia.

According to a recent report from Odessa, with the increased facilities now given by the Government to stimulate the sale of agricultural machines and implements, there are good prospects for trade. The competition of Germany and America is, however, being keenly felt by British manufacturers, whose activity is almost exclusively limited to the supply of portable engines and threshers of a complicated system. The first-named is endeavouring to undersell British firms and to attract purchasers by the introduction of novelties, often of no practical use to the agriculturalist, while the second still retains the monopoly of the trade in binders, reapers, mowers, and horse rakes. The American self-reaper is fast superseding the manual reaper manufactured in Russia. The incorporated report from Kieff states that there was a good demand for steam threshing machinery, and it is pleasing to note that Great Britain still holds the field in this line, although the competition of Germany and Hungary cannot be ignored, and is a factor bound to make itself felt in the future. No direct importation of any agricultural machinery or implements to Nicolaiev was recorded last year. Seven eighths of the demand for smaller implements was supplied by articles manufactured either here, at Odessa, or in Elisavetgrad. Portable engines and threshers were imported through Odessa from England. This is the only class of goods of British origin that finds buyers here, and even they are being ousted from the market by machinery from the works of Lantz at Mannheim, in Germany. On an average German goods are 15 per cent. cheaper than British, and, as has been reported before, the cheaper the article the more easily it is sold, quality being a secondary consideration. It is true that British goods have the highest reputation and are admired, examined, and compared with those of foreign make, but they are not bought. A large number of reapers, self-binders, rakes, etc., have been imported from America (through Odessa) during the last two years, and the trade promises to assume very large proportions, as most American machines sent here have been specially adapted to the local requirements. The "Colonist" plough, made by Messrs. Ransome, Sims, and Jefferies, of Ipswich, is steadily gaining ground, owing to its being specially made for this country.

The Skilled Labour Market in August.

The following is an extract from a memorandum which has been prepared by the Labour Department of the Board of Trade for the *Board of Trade Journal*, and also (with additions) for the *Labour Gazette*. It is based on 2,361 returns, viz.: 1,679 from employers, 542 from trade unions, and 140 from other sources. The general state of employment during August continued good, with little change compared with July. The percentage of unemployed members returned by trade unions was the same as in the two previous months, and lower than at any similar period since 1890. In the 123 trade unions making returns, with an aggregate membership of 502,439, 11,573 (or 2·3 per cent.) were reported as unemployed at the end of August, the same percentage as in June and July, compared with 2·8 per cent. in the 117 unions, with a membership of 466,025, from which returns were received for August, 1898.

IRON AND STEEL MANUFACTURE.

Employment has remained good during August, and is better than a year ago, though it has been interrupted at some of the works by the hot weather, and also by local holidays. At the 223 works from which returns have been received 81,655 workpeople were employed in the week ended August 26th, 80,863 in the week ended July 29th, and 76,587 in the week ended August 27th, 1898. The average number of shifts worked in these three weeks were 5·47, 5·53, and 5·50 respectively.

TIN-PLATE TRADE.

The improvement in employment has been maintained. It continues much better than a year ago. The number of mills working at the end of August was 390, employing an estimated number of 19,683 workpeople, compared with 396 mills employing 19,614 workpeople at the end of July, and 290 mills with 15,414 workpeople at the end of August, 1898.

ENGINEERING.

Employment in the engineering and metal trades has remained good in most branches. The percentage of unemployed union members in this group of trades at the end of August was 2·6, compared with 2·5 in July. The percentage for August, 1898, was 3·0.

SHIPBUILDING.

In the shipbuilding trades employment has continued brisk, the percentage of unemployed union members at the end of August being 1·5, compared with 1·4 in July, and 4·2 per cent. in August, 1898.

A GREAT INDUSTRIAL CRIME.

THE ATTEMPT TO BOYCOTT THE PARIS EXHIBITION.

By BEN. H. MORGAN.

GREAT BRITAIN has been made the laughing stock of the commercial world, a prey to the sensational section of the British press and public, that section which we all know to be ever ready to sacrifice common-sense and commercial interests for notoriety. We regard the attempts that have been made, and which have deservedly met with ignominious failure, to boycott the Paris Exhibition and French goods as a huge industrial crime, an outrage on Commercial England. They were apparently entered on without any consideration as to their probable effect on British trade. The sensational press, and particularly those journals boasting "imperialistic" principles, shouted "Boycott! boycott! boycott!" immediately after the Rennes martyr was condemned. And to the shame of the majority, be it said, claim was made that they represented the general feeling prevailing amongst the 640 British exhibitors. This has proved to be entirely false.

No argument of ours is needed to show that the authors of the boycott movement did not represent the feelings of English exhibitors on this matter. Events have demonstrated this, and the condemnation of their action may be found in the letters from representative British exhibitors which we append to this article. Many of our leading morning journals have already repented of their action, and are doing what they can to excuse themselves in the eyes of manufacturers, and the thinking British public.

That Dreyfus has been unjustly condemned their can be no possible doubt, and every right-thinking person must feel indignation and disgust at such a prostitution of justice in this 19th century. But the injustice of boycotting the Paris Exhibition and French goods and labour is, to our mind, equal if not in excess. Is France to be condemned because five of her judges and a few of her army officers have seen fit to degrade themselves in the eyes of the world? Are thousands of honest Frenchmen to be ruined in consequence of the action of a few dishonourable men? There can be but one reasonable answer to these questions.

Boycott? We had thought that all true Englishmen had long ago spurned this means to any end, however glorious. The principle itself is degrading, and entirely in opposition to the morals and traditions of the people of this country. Justice is never obtained by such sordid means, but by earnest and persistent appeals to the sense of right. In our experience and knowledge we have found that, at least, in commercial transactions, straightforwardness prevails in France to an equal extent to which it does in this country.

What has surprised us beyond measure is, that foremost amongst the advocates for boycott and revenge have been those who occupy the pulpits in our Churches. We are making no mistake on this point. The "leading lights" of Christianity in this country have shouted "revenge" with all their might, and have done more to raise the feelings of the public than any other agency. "An eye for an eye and a tooth for a tooth" has been their predominating cry, and as a means of putting into practice this detestable and antichristian doctrine, they have advocated the "boycott." They have gone beyond their provinces in interfering with the trading matters of the nation, and that they have disclosed a profound ignorance of the subject few manufacturers and traders will deny They have advised the sacrifice of national prosperity to personal sentiment, and we unhesitatingly say that their intemperate oratory will have lasting and ulterior effects on the trade of this country.

The proposed boycott has had little or no real support from the beginning, and certainly totally insufficient to justify the stand taken by some of the daily press in the matter, even if we admit the principle to be good. It is true that a few firms of undoubted repute have withdrawn from the Exhibition, but the majority of the names of firms which have appeared in print as advocates of the boycott are not such as to lend the movement any significance in the eyes of the trading world. And as for being representative, the majority were practically unheard of until they were gratuitously advertised. As to their sincerity in joining the movement, we have nothing to say, but the following from the *Daily Chronicle* may throw some light on the point :—

> There is a strange discrepancy between the number of firms who are known officially to have withdrawn from the Paris Exhibition by way of showing their sympathy for Dreyfus and their love of justice, and the number of firms who have publicly announced their withdrawal. Is the explanation to be found in the fact that firms who never intended to be represented at Paris are making a pretended sacrifice for the sake of —advertisement ?

The sensational press have this time made a record blunder. That our national progress will be affected by their intemperate and unjust denunciation of the foreigner, there can be no doubt, and their action deserves the universal condemnation of all loyal Englishmen. We reproduce samples of the material which some of the "boycott" press have been working on. The following appeared in the correspondence column of the *Daily Mail* :—

> Some little time ago I arranged preliminaries for a cycling tour to Paris for the exhibition. By resolution the party have decided now to go to Germany, including the Rhine route.
>
> I have a circular letter before me to-night from the secretary of my club—the Surrey Wheelers — to the effect that the tour arranged to start this week for Normandy and Brittany has, by common consent, been "declared void."
>
> CHARLES LANE.
>
> 4, *Cicely Road, Hanover Park, S.E.*

> I hereby solemnly swear and declare that, until France regains her lost honour, by releasing and re-instating Dreyfus, I will neither visit that dishonoured country, buy or use any French goods, nor have any dealings whatever with any Frenchman or anything French—so help me God !
>
> WM. S. FREEMAN.
>
> *Otford, Kent.*

What, then, shall we say of this extract from a "leader" in *Commerce*:—

The verdict of five infamous scoundrels, as against two honest men, which found Captain Dreyfus guilty of a crime that the judges, equally with the rest of the civilised world, know him innocent of, has conferred a responsibility upon every man and woman who has either influence, connection or association with French affairs. A people like the French, sunk, as the prosecution and persecution of Dreyfus have demonstrated they are, into the infamous depths of class and race hatred, to the extent of subverting the claims of ordinary justice and humanity, placing them on a level with the lowest and meanest of the brutes of creation, are not the concern, neither they nor their affairs, of civilised people. The only natural resource open to honest and justice-loving humankind, after having failed to make any impression upon this degraded nation, is to bring home to this maniac conglomeration of imbeciles the responsibility of wrong-doing and its traditional reward. We appeal to the great manufacturing corporations in this country, the United States, and all civilised Europe to apply their power in no uncertain manner by holding aloof from any concourse with such a scum-ruled faction as the French nation now is.

Has anything more extravagant and unreasonable ever been written?

We are surprised to find our esteemed contemporaries, the *Standard Daily Graphic* and *Globe*, countenancing this movement. The former has remarked that "the boycott of the exhibition by British and American exhibitors, even without the assistance of those of the leading Continental States, would go far to ensure the failure of the enterprise." Now, we venture to say that this is a mistake. On this point we reproduce an extract from a letter by Mr. J. C. Connoly to the Editor of the *Pall Mall Gazette*:—

1889 was a first-class exhibition. The total number of visitors was about 28,000,000. On one day, August 15th, 500,000 visitors attended. The total number of British visitors to Paris from May 1st to October 31st, 1889, did not reach 400,000. As regards America, about 100,000 visited France in 1889. So that England and America combined sent about one fifty-sixth of the total visitors. We may, therefore, safely surmise that a big exhibition could get on nicely without such a fractional assistance. And it is certain that Boulanger made a considerable pow-wow before the 1889 show.

Mr. Connoly, in our opinion, does not put the matter in its proper light, but we believe that he is substantially correct in his figures. Even if England and America withdrew from the Exhibition, we do not think it would necessarily make it a failure. But America has already declared that she will take no part in the boycott, and so have Germany and Austria-Hungary. After all our Government are only contributing a very small amount for the representation of British interests — indeed scarcely more than a quarter of that voted by Germany; and if British exhibitors absented themselves, it is quite certain that individual engineers and manufacturers of this country and all progressive Englishmen would keep abreast of the times by attending the show and seeing all that is up-to-date in foreign manufacture.

The following words of Dr. Barclay, president of the British Chamber of Commerce in Paris, expresses the feeling of the majority of British exhibitors on the matter. He says that if "the Dreyfus agitation should degenerate into a boycott of the Exhibition, it would be an impulsive act of injustice fully equal to that perpetuated by the five judges at Rennes."

The action just taken by the British Assistant Commissioner in Paris is gratifying, and it tends to show that our Government are fully alive to the interests of British trade. He has called upon the Commissioner General of the Exhibition, and assured him that the Government never for a moment thought of withdrawing its participation, and that if some exhibitors had decided or threatened to take no part in the Exhibition, they were only isolated cases to which no attention should be paid. This is indeed insignificant, and should tend to mitigate the evil which the boycott movement has undoubtedly wrought, and which we stigmatise as an industrial crime.

The writer has received a large number of letters on this subject from representative exhibiting firms, but the reproduction of a few only are necessary to indicate the general feeling on the subject.

Whilst sympathising fully with the general indignation against the result of the "Dreyfus" trial, we have no intention ourselves of withdrawing from the Paris Exhibition, considering that a boycott would serve no useful purpose, and that it would probably do an incalculable amount of harm.

MATTHEWS AND YATES, LIMITED.

We quite agree with you that it is somewhat absurd that in consequence of the verdict against Dreyfus that England should start a boycott against the Exhibition to be held at Paris. We think it is most absurd. Further than that, we think that the very object which all British people would like to accomplish is likely to be rendered more difficult by the strong feelings and language expressed in some of our newspapers and attempt to boycott the Exhibition by them. It is our intention, as far as lies in our power, to keep to the promise we have made and exhibit at the forthcoming Exhibition, unless something occurs in the meantime to compel us to alter this decision.

THE CAMPBELL GAS ENGINE COMPANY, LIMITED.

We do not think that the boycotting of the Paris Exhibition will do Captain Dreyfus any good, or his enemies much harm, and we do not intend to join such a combination.

We agree with most people as to the cruelty and injustice of the verdict, but we think that the friends Captain Dreyfus has among his own countrymen, are determined, and will be better able to fight his battle without our interference than with it.

THE HARDY PATENT PICK CO., LIMITED.

As intending exhibitors at the Paris Exhibition we are much concerned at the result of Rennes trial, and the manifest injustice which has been committed.

We cannot think that the French people as a whole will lend themselves to the perpetuation of this crime, and we think that before any decision to boycott the Exhibition is arrived at the French Government should have an opportunity of showing its intention in the matter, and this we are pleased to see they are about to do.

Naturally, if the present state of unrest continues, the Exhibition will be bound to suffer, as both exhibitors and intending visitors will be affected thereby.

We hope, however, that the decision of the ministry to "pardon" Dreyfus will be accepted by all parties as a settlement of the affair, and that better feeling will prevail all round.

It is in the interest of France and everybody else that the Exhibition should go on and be a success.

GEO. RICHARDS AND CO., LIMITED.

We have not the slightest intention of withdrawing from the Paris Exhibition.

THE FRICTIONLESS ENGINE PACKING COMPANY, LIMITED.

We beg to state that we have no intention whatever of withdrawing from the Paris Exhibition.

THE ROSSENDALE BELTING COMPANY.

We have not decided to withdraw from the Exhibition and our arrangements are proceeding. At the same time, if there is any disturbance in France, we should then have to consider the question.

LUMBY, SON AND WOOD, LIMITED.

We feel as much disgusted with French judicial procedure as any one could be, but we intend exhibiting at Paris all the same.

THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED.

In conclusion we give the following extract from a letter written by a well-known engineering firm to a "boycott" journal:—

We share at least in your indignation, but ours is directed against the officers of the court-martial and the military chiefs—not against France.

If you were dealing some telling blow *at the right people* we would join you, but we dislike the principle of an organised boycott. It is unjust in its action, and seems a strange weapon to use in the name of Justice.

Again, our proposed exhibit would be just a six months' advertisement.

Now, we deal with many countries in which Justice is but indifferently administered, and have never considered pushing our trade there the less on that account; indeed, such a course would defeat its own object, for British ideals will best be spread by British trade.

There is another aspect. The highest Court in the land has pronounced for Justice, and for the moment a Military Court has defied it, and we now await the next move.

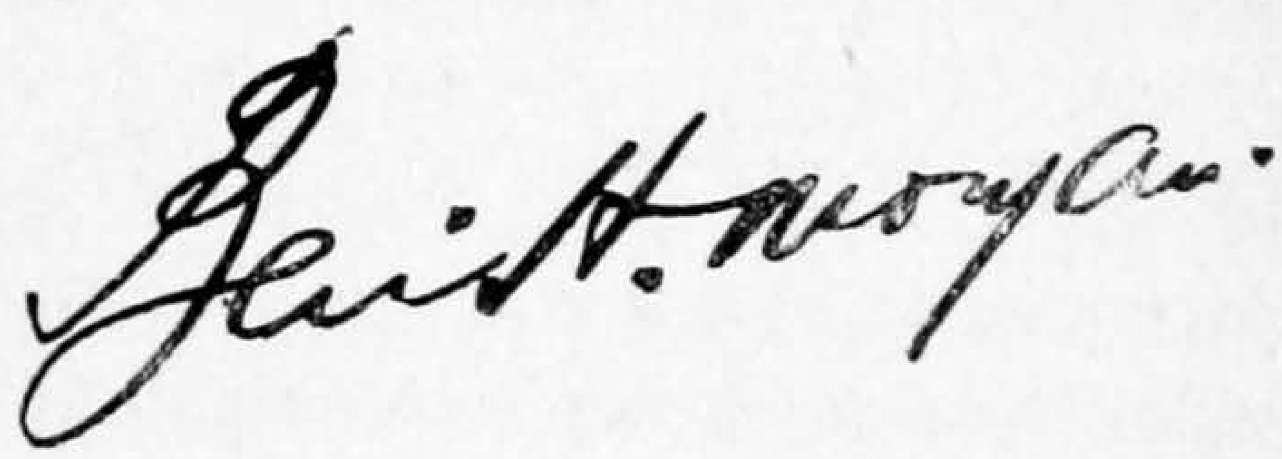
There is no finality in the present situation, and it seems too soon to say that France refuses justice.

The present situation in France needs as much light and as little heat as possible.

We can think of few things so likely to cause warm resentment and an unyielding temper in France, as a blow struck from abroad at the commercial and industrial classes, to avenge a signal failure in duty on the part of officers of the army.

If the shameful attitude of the army chief brings about a state of unrest, in which property is not safe, and visitors will not come in large numbers, then of course quite another question will be raised.

B. AND S. MASSEY.



THE EDUCATION AND TRAINING OF AN ENGINEER.

By WILFRID J. LINEHAM, M.Inst.C.E., M.I. Mech. E.,

Head of the Engineering Department at the Goldsmiths' Company's Technical Institute, New Cross, S.E.

As one who has spent a large portion of his life in the endeavour to combine the theory and practice of engineering in their correct proportions, both as regards himself and others, and who is being constantly asked by parents how it is to be done, I may, perhaps, be permitted to say a few words on this all-important subject.

There are few differences of opinion regarding the fact that theory and practice in engineering matters should be correctly combined, and the difficulties only seem to occur when one commences to discuss the various roads towards this all-important goal. There are, again, as is well known, some educationists who advise that a certain number only of would-be engineers shall be trained as captains or generals for directing purposes, while the rest shall not be specially assisted to rise beyond the rank of private. Surely this policy is a selfish one, for it will be readily apparent that we may possibly thus be training as privates those who should be trained as generals, and perhaps even *vice versâ.* The proposed method takes no cognisance of such peculiarities: hence it is that I say, let the marshal's baton be possible to every private's knapsack, and only let him remain a private if he should himself prefer to do so. At any rate, give him the opportunity of advancing, for there need never be any fear of our not having a sufficient supply of the rank and file.

In the methods of engineering education that have been pursued in the past, some have erred on the side of too much practice, and some on the side of too much theory. There can be little doubt that the former would be the least objectionable, commercially; but it would prevent, or tend to prevent, great progress on new lines. The latter, however, would have its revolutionary advantages greatly handicapped by lack of knowledge of detail or of processes. These one-sided methods are not by any means entirely gone, for even now we have advocates of the one or the other of them respectively. Those who support practice with all but no reference to theory may yet be called legion, while in many of the higher colleges there is often a general notion that practice may be easily acquired in later life, and that theory only should be fundamental.

I need not say that I give my support to neither method, but have on the contrary a strong belief in the necessity of a *simultaneous* grounding in theory and practice; "practice" being defined as the best experience obtainable in a large and important engineering works. How then are these things to be achieved? for we know that the past has bristled with difficulties, while the future holds enough of them to discourage all but the most ardent believer in the laws of perfect evolution. We have had in the past (and even yet possess) some four ways of obtaining an engineering education. Firstly, there were those candidates who had to take to shop practice as a means of livelihood, some remaining as hewers and drawers, and others prosecuting such evening study as enabled them to rise to important positions in shop or office, due to inherent "grit." Secondly, there were others who paid a high premium, only possible to a few, in order to "go through shops and office," ultimately to be "pitch-forked" into a berth of importance. These gentlemen sometimes picked up theory, and sometimes, perhaps more often, did not; but they had a manifest advantage in the acquirement of practical knowledge, for they were permitted to see and learn all the processes carried on in the works where they were apprenticed. Thirdly, there were those who "got engineering" at some university, by a course of Natural Philosophy or the like, adding letters to their names. Excellent work was often done, but it was not engineering practice. Such students usually became teachers. Fourthly, premiums were paid, generally high, in order that candidates might be taught the profession of a civil engineer. Theory here did not come off so badly, because much calculation had to be done in most "civil" drawing offices, especially in those of constructional engineers. Practice, however, was rarely obtained by the handling of tools and materials, but only by the viewing of work erection.

It is now, I think, pretty well conceded that if one is to become a true engineer, he must, in some way, make himself acquainted with all the practice and theory covering the special branch of the profession which he may have chosen. Taking this for granted, I will now proceed to draw my own conclusions as to how this should not and how it should be done. In the first place, it cannot be done by allowing a boy to remain at a public school till late in his teens, and then placing him in a University College till he be twenty-one or more. There is no room for practice in such an arrangement. I know that University Colleges have hoped that employers would assist them by taking students as "premiums" during the summer vacation, but this is only a weak method, and begs the question considerably. I will, therefore, during the remainder of this article, endeavour to formulate what I believe to be the happy medium of a combined theory and practice in engineering education and training.

Assuming a boy of intelligence, not much troubled by illness, he ought to have imbibed, at the age of thirteen, all that a primary school can give him. Let him, up to that time, learn nothing that is not elementary education: none of your smatterings of science. Object lessons on common things he may have, mixed with his more serious work; but above all let him have good English grammar; history, both English and comparative; geography, and good mathematics. He should easily have done some three or four books of Euclid and simultaneous equations; and should also be taught how to make proportionate sketches from still life. At thirteen he should join one of those secondary schools, known as "Organised Science Schools" or "Technical Day Schools," and if he remain there from thirteen to sixteen he will acquire chemistry, physics, fairly high mathematics, mechanics, machine drawing, and perhaps two modern languages. Who will say that this equipment has no value for the youth who now, at the age of sixteen, passes into the engineering workshop? This knowledge, I say, will make all the difference in the boy's future like or dislike of engineering, for I have known many who, having had to become engineers for bread-and-butter's sake, never acquired a real taste for the profession till many years afterward, for very lack of that previous study which should point out the beauties of the mechanic arts. At sixteen, then, the boy becomes an apprentice fitter, but not a bound one. The workshop of the technical school has already taught him the use of his tools, so that the employer is only too glad to set him on, in preference to those who are not so prepared; and if he makes himself agreeable, there may be little difficulty in his doing some machine work as well. Here the advantage of first apprenticeship at a small establishment becomes most apparent, for in such a place the boy is changed about rather more often than in large works. To get a little pattern-making or smithing may be more difficult, but if these cannot be obtained in the actual works, they can be learnt at the evening technical school. This brings me to say that all the time the youth is pursuing his practice he should still continue evening study in all the well-known engineering subjects, by attending lectures, laboratory, drawing practice and workshops, and here, probably, the first difficulty will occur, unless we have the hearty co-operation of the employers. The solution, however, suggests itself. There are always many of the rank and file who do not wish to rise above the level of "private," and these may continue the old tradition of the 6.0 a.m. commencement of the daily work; but is it too much to ask that striplings of sixteen to nineteen might be permitted to begin at a later hour, say eight or nine, if they can satisfactorily show that they are doing serious study every evening from seven to ten? I think not. I am willing to call such permission an act of generosity, but it is scarcely so much as a robbing of Peter to pay Paul, for the money lost on the morning hours will be more than repaid to the country by the increased value of our best young engineers. It is a *national* question.

By the age of nineteen the student will have acquired a considerable mastery over both theory and practice, and his knowledge of design will be so important that his firm may be very glad indeed to admit him into their drawing office. If they cannot, he must apply elsewhere, for to the office he must go; and he will thus be able to put in two years of real office design before he is twenty-one. Presuming he has continued his study satisfactorily at the evening technical school, he will by this time have acquired a knowledge equal to, or better, than that of a Whitworth Exhibitioner, and will certainly have entered the Institution of Civil Engineers as a student, the examination having no fears for him. The mention of this last "matriculation" (may I call it?) reminds us that his apprenticeship or technical study—preferably both—should have been served under a corporate member of the

Institution to permit him to take the examination.

I have thus drawn up what I believe to be the best training for a mechanical engineer; but, however he may finally specialise, the youth must *always commence* on mechanical engineering. If he proposes to become an electrical engineer, he should make the change at about the age of nineteen, when he leaves the mechanical shops, and he must also arrange his evening study to suit. If, on the other hand, he wishes to be a civil or constructive engineer, he should similarly change, and enter the office of a gentleman or firm prosecuting the kind of engineering he desires, who will only be too pleased to have a draughtsman of such valuable practical experience. The problems of erecting large work would, of course, come on at a later period, and would have to be largely left to individual observation.

In closing, I may draw together the previously-detailed proposals as follows:—

Proposed Course of Education and Training for a young Engineer, up to the Age of Twenty-one.

AGE.		OCCUPATION.
Up to 13	..	At a primary school, with, preferably, some private tuition.
13 to 16	..	At a technical day school, studying sciences, pure and applied, and the use of tools.
16 to 19	..	In the mechanical workshops of a large firm, learning fitting, machining, etc.; evenings to be spent at a technical school, learning the advanced stages of applied engineering science.
19 to 21	..	In the drawing office of a mechanical, electrical, or civil engineering firm; continuing also his evening study into the highest stages of the subjects.

Finally, let those who wish to follow Law, Medicine, or the Church, go to the University or high school till a late age; but the engineer must be an engineer above all things, and his school is the school of experience.

Wilfrid J. Linehan

THE HISTORY AND DEVELOPMENT OF MOTOR CARS.

By W. FLETCHER, M. Inst. Mech. E.

Author of "Steam on Common Roads," &c.

III.—SOME HISTORICAL MOTOR CARS.—(Continued.)

IN the present article we purpose to describe several small and light motor cars. Few engineers have taken so deep an interest in the history and construction of motor cars as the late Mr. I. W. Boulton, of Fairfield, Manchester. During the last few years the writer has received numerous letters from the above-named concerning the motor cars made at his works at Ashton-under-Lyne. We will refer to one of these, illustrated by Fig. 14, reproduced from a photograph. From the engraving, it will be seen that the carriage was mounted on three wheels, the two hind wheels were the drivers, and the single wheel in front was used for steering. The carriage ran very smoothly at eight to ten miles an hour, due, in a great measure, to the laminated springs, which received most of the weight, and to the employment of wood wheels of large diameter. The leading wheel was also fitted with a

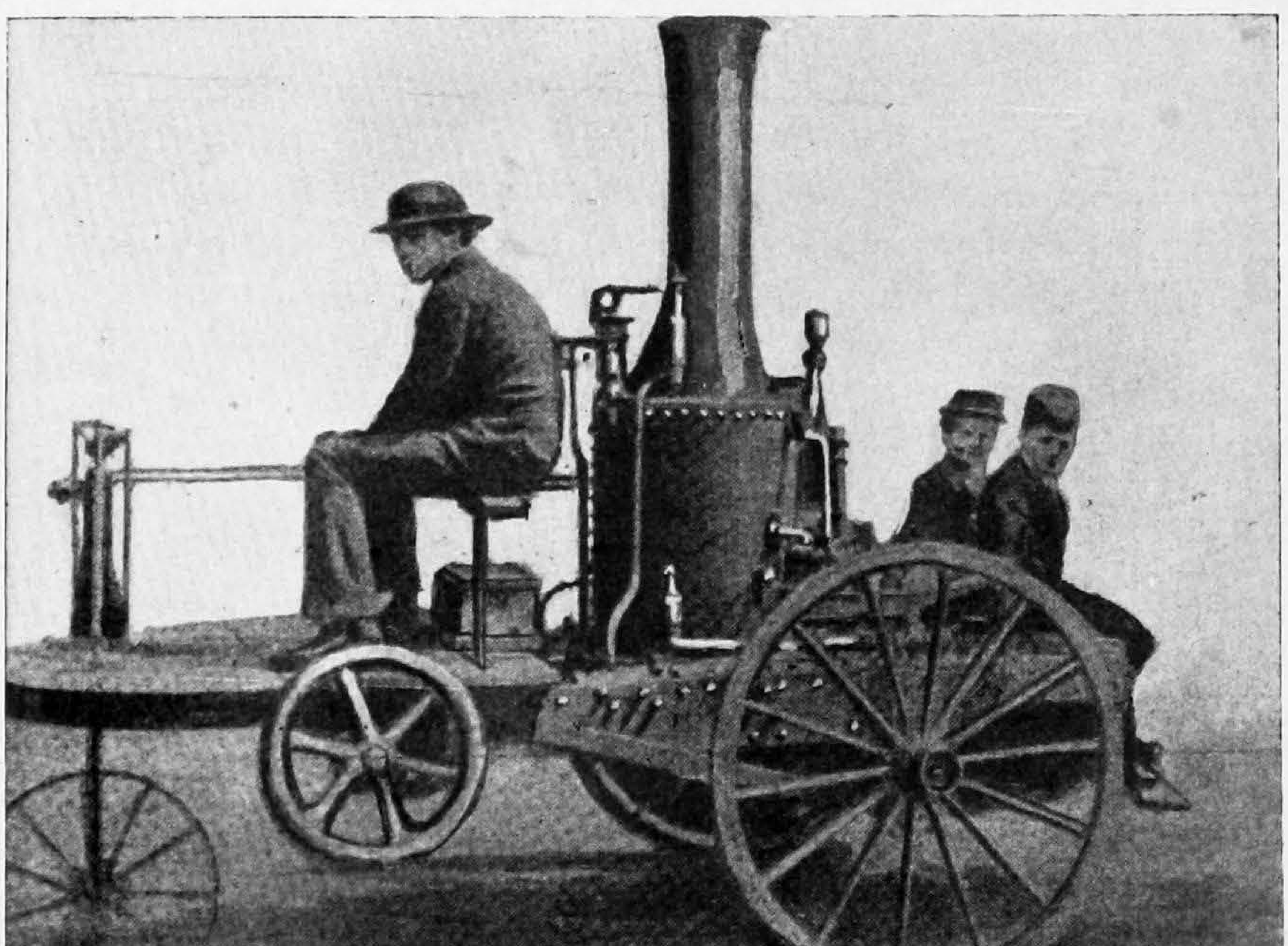


FIG. 14.—BOULTON'S MOTOR CARRIAGE.

spring. Two cylinders were bolted to the side frames near the boiler. Steam was conducted to the cylinders by two separate steam-pipes as shown. A pitch driving-chair communicated the motion from the crank-shaft to the driving axle. In order to reduce the number of working parts, the engine was not provided with link motion reversing gear. It was urged that the little vehicle could be quickly stopped and turned round. The boiler was 20in. diameter, and 36in. high, of the vertical tubular type, the working pressure was 60lb. per sq. inch, and the weight of the carriage was under 20 cwt.

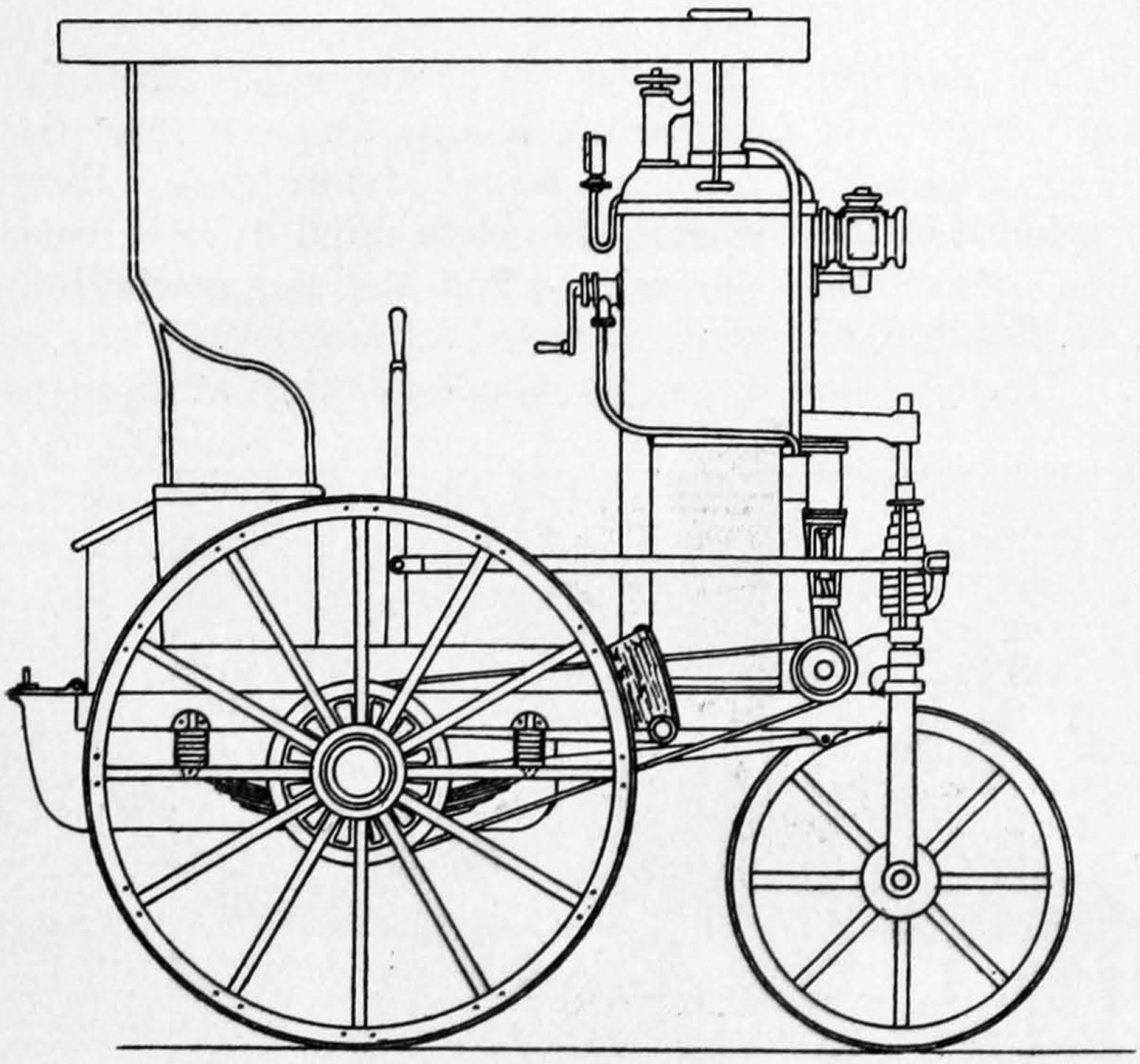


FIG. 15.—TODD'S STEAM CARRIAGE.

An interesting little motor car was made by Mr. L. J. Todd, in 1869. Fig. 15 shews a side elevation of the carriage. The driving-wheels were 4ft. in diameter, made of wrought iron; on the boss of each driving-wheel was fixed a grooved driving-pulley. On each end of the crank-shaft was fixed a friction cone carrying a grooved pulley 6in. diameter, and from this pulley motion was communicated to the driving-wheel by a gut cord $\frac{1}{2}$in. diameter, thus allowing the engine to turn with facility. The leading wheel was carried in a fork with a volute spring and rubber washer. The main bearing-springs were of great length, and fitted with rubber washers, as shown. The steam cylinders were $2\frac{1}{2}$in. diameter and 4in. stroke. No reversing gear was provided. A good brake acted on both the tyres of the driving-wheels. The water-tank was placed beneath the floor. The motor car was built to carry two persons, and Mr. Todd guaranteed to run 100 miles in ten hours over any high road in England. We may add that the little motor car was a practical success, and many would have been made but for the Road Locomotive Acts, which strangled many a useful vehicle in its infancy.

A neat motor car was made by Messrs. Catley and Ayres, of York, in 1871. Fig. 16* shows the waggonette, which deserves a fuller description than we can accord to it. It was driven by a horizontal engine placed under the floor of the carriage.

Power was transmitted from the crankshaft to the main axle by a pair of small spur wheels. In order to

* I am indebted to *The Engineer* for this illustration.

reduce the number of parts, only one travelling speed was provided, but the travelling pace on the road could be regulated by the stop valve. The motor car was well-mounted on springs. Wood driving-wheels were adopted, with wrought iron tyres and light wrought iron spokes. The front steering-wheel was made in the same manner. A special superheater was

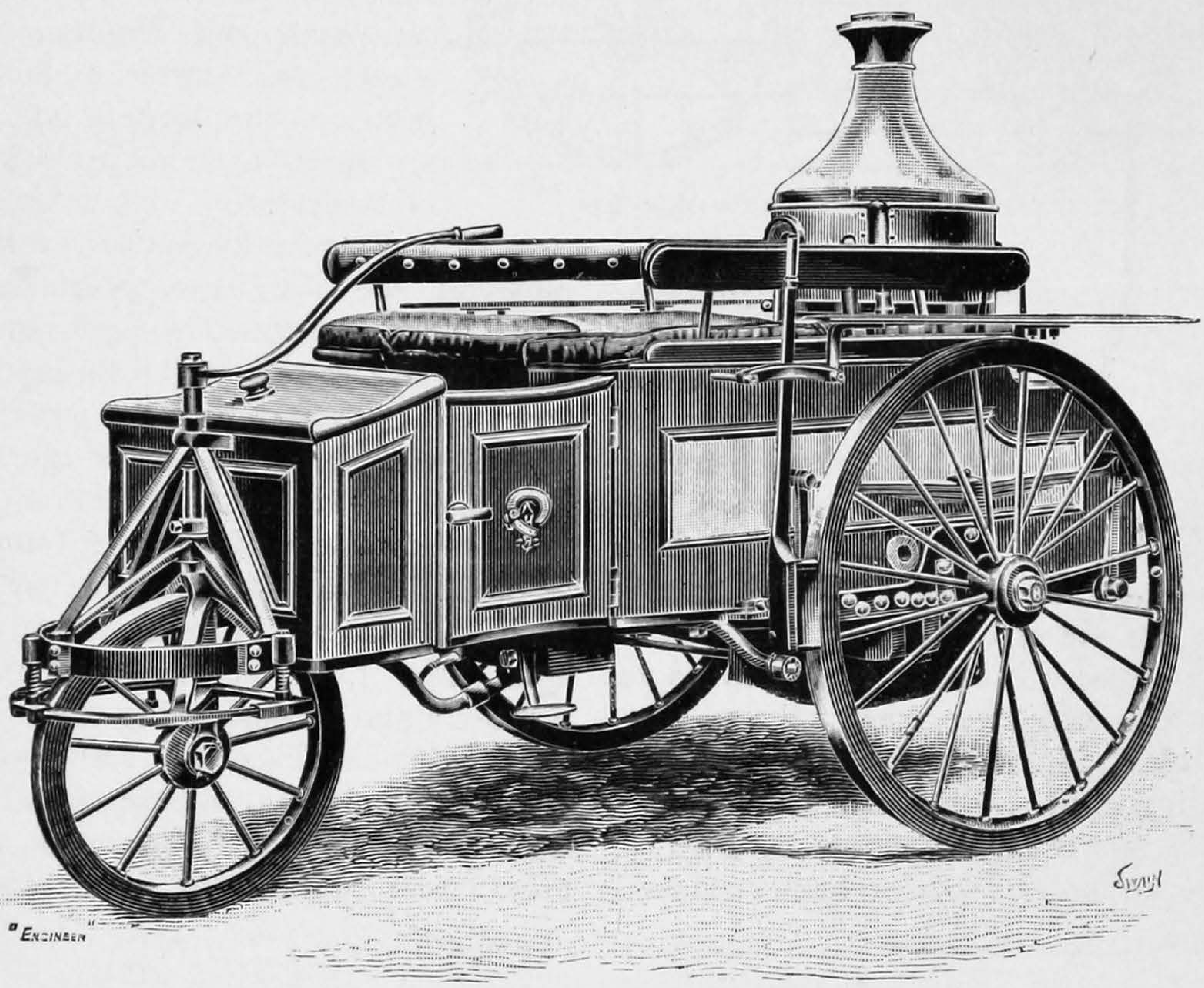


FIG. 16.—MESSRS. CATLEY AND AYRES' STEAM WAGGONETTE.

fitted in the base of the chimney, which thoroughly dried the steam before it was conducted to the cylinders. The carriage made very little noise when travelling, and no vibration was experienced by the riders. An important feature of Messrs. Catley and Ayres' waggonette was its very moderate weight. When the boiler, tanks and coal bunkers were full ready for the road, the total weight was only 19 cwt. Among the objections urged against steam for the propulsion of motor cars, the *supposed* great weight is always dwelt upon.

Messrs. Lough and Messenger constructed a tiny motor car in 1858, as illustrated in Fig. 17. It was fitted with a double cylinder engine, and a vertical boiler working at 120lb. pressure. When the boiler and tanks were full, the machine only weighed 8 cwt., and run fifteen miles an hour on the level road, and six miles an hour up inclines of one in twenty.*

By Fig. 18, we illustrate a motor car made by Mr. G. H. Goodman. This vehicle it will be seen, was propelled by a pair of direct-acting engines, and the boiler worked at a high pressure. The dog-cart pos-

*A detailed description is given of this carriage in "Steam on Common Roads." E. and F. N. Spon.

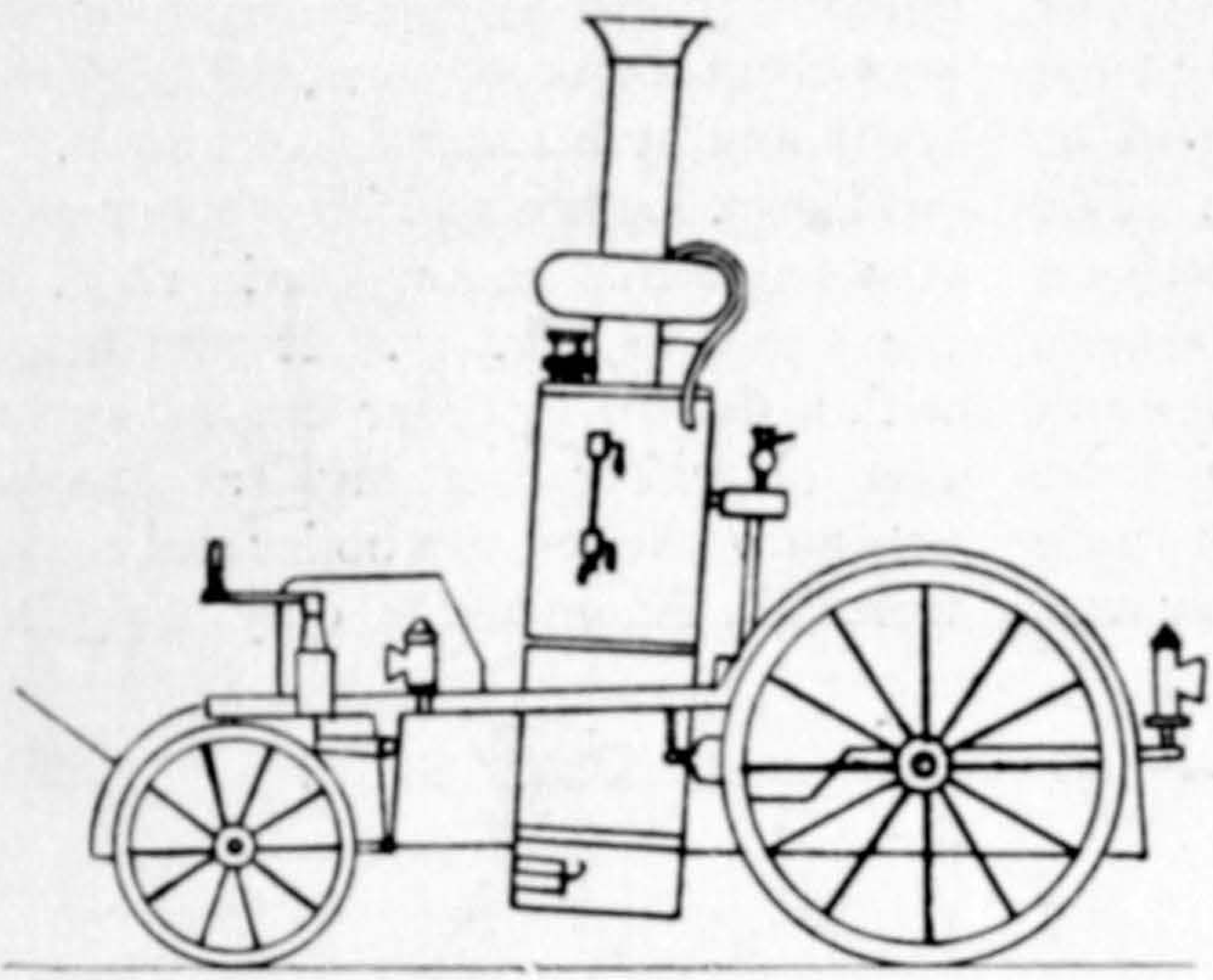


FIG. 17.—LOUGH AND MESSENGER'S STEAM CAR.

in practice. The two cylinders were fitted with trunks, so as to do away with slide bars. One end of the vibrating lever was driven by the piston rod, and the opposite end actuated a crank on the axle by means of a coupling rod. The boiler worked at 100lb. pressure, and, when the vehicle was ready for the road, the weight was small, while the travelling speed was twelve miles an hour on the level road, and six miles an hour up inclines of 1 in 20.

sesses a number of commendable features. One only can be mentioned, and that is, the manner in which the front-wheel fork was relieved from the injurious strains, which had a tendency to break the fork at the neck. When fully equipped, the weight of the motor car was about 12 cwt., and the travelling speed was ten to twelve miles an hour on ordinary roads. Some time in 1868, Mr. Armstrong (an English engineer in India) constructed the little motor car, as shown by Fig. 19. The method of driving answered well

From information we have received, we are in a position to state that the various light motor cars, as illustrated and described in this article, were well built by English mechanics, and were efficient vehicles and successful runners; but they were not allowed to travel at more than a crawling pace by the police regulations in force some years ago. Mr. J. C. Merryweather has written as under respecting the motor cars made in England some years ago:—"Inventors of motor cars would do well to look back a few years, and take some hints from previous ex-

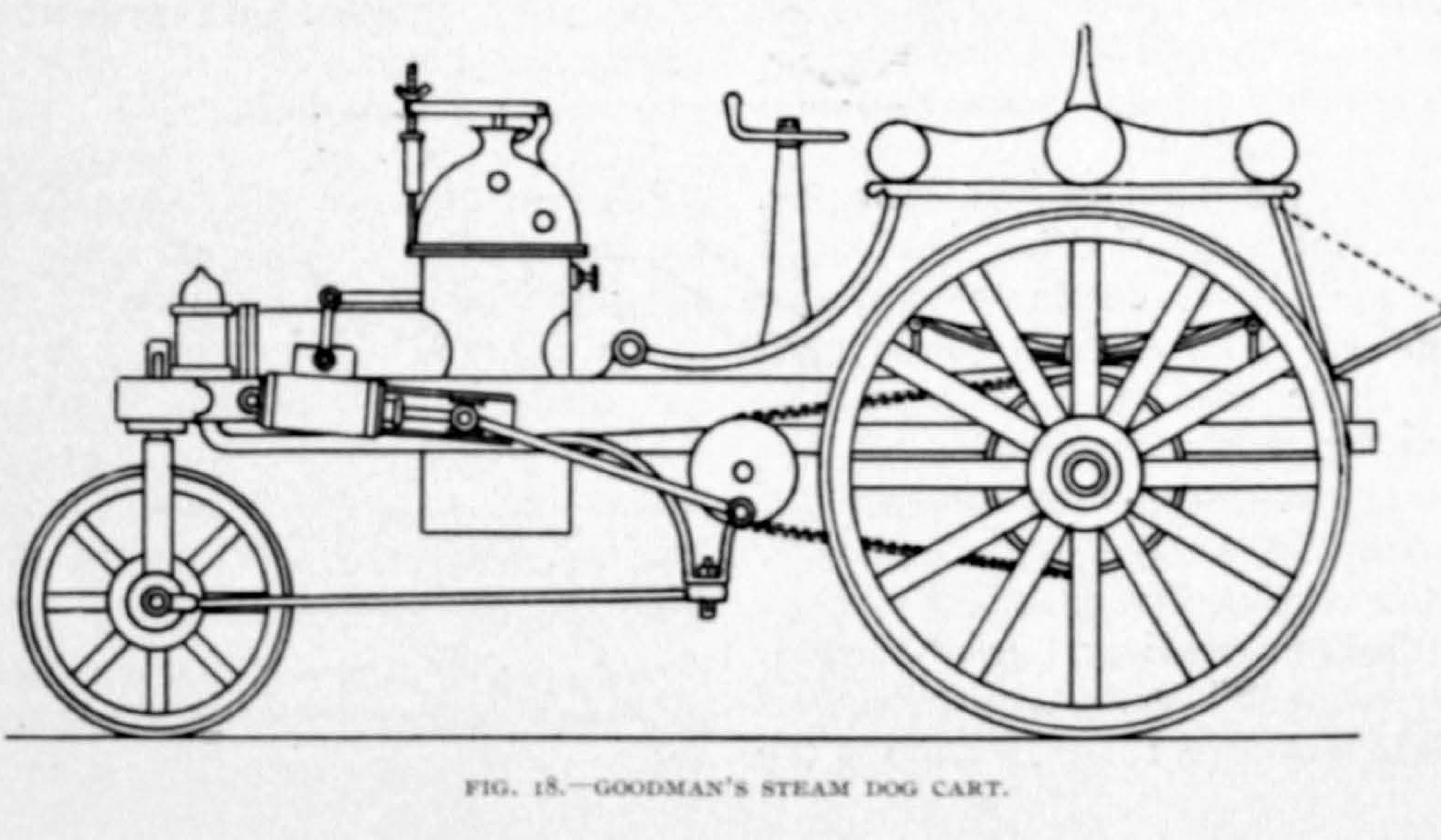


FIG. 18.—GOODMAN'S STEAM DOG CART.

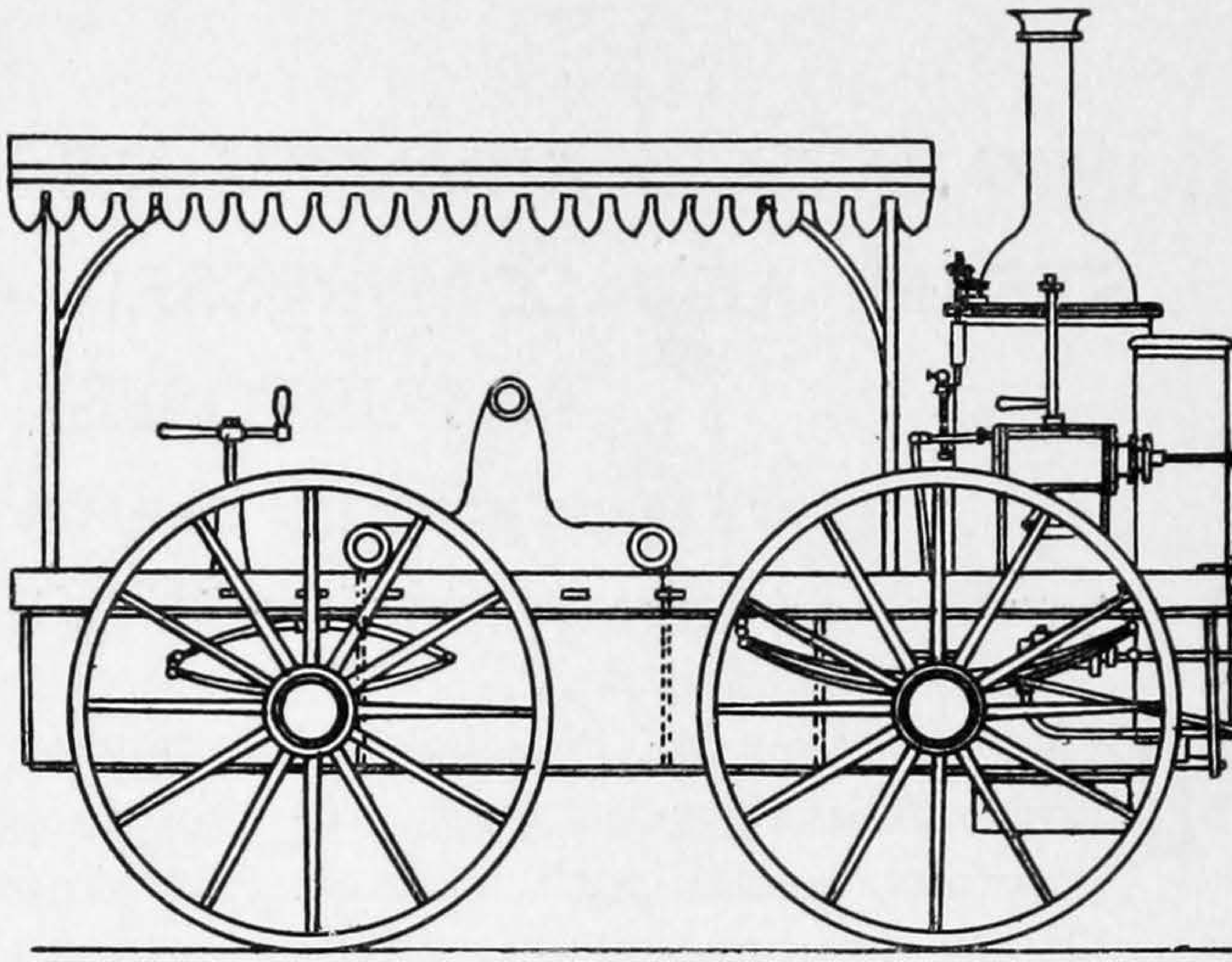


FIG. 19.—ARMSTRONG'S STEAM CAR.

periences." We believe that something may be learnt from the small carriages illustrated in the present issue. The writer goes on to refer to a most successful steam carriage built for Mr. George Salt, of Sir Titus Salt and Sons. "This was presented by the owner to Mr. F. Hodges, the Lambeth distiller, and with him I had many journeys to Barnet, Streatham, Margate, and other places, in the night time. This motor car had a horizontal steam boiler, a double-cylinder engine, and seats for eight persons. It could run fifteen miles an hour on the level, and ten miles an hour up hill. It made no noise, no smell, no exhaust, and was only stopped running by the law which prohibited a speed of over four miles an hour."

The vehicle was made by Messrs. Garrett Marshall and Co. It is illustrated and described in "Steam Locomotion on Common Roads." We may supplement Mr. Merryweather's reminiscences by quoting a few lines from the above work. Mr. Hodges christened the car the Fly-by-night, and it did fly through the Kentish villages when most honest people were in their beds. Its enterprising owner was repeatedly pulled up and fined, and to this day his exploits are remembered against him. Hodges ran the carriage 800 miles; he had six summonses in six weeks, and one was for running thirty miles an hour. After which the carriage was supplied with a fire hose and the paraphernalia of a fire engine, the facetious passengers wore helmets of brass, and thus escaped legal interruptions for some months; but in the end the Fly-by-night was made to crawl at four miles an hour, in spite of the brass-helmeted passengers and the fraudulent hose pipe, etc.

(*To be continued.*)

W. Fletcher.

COMPARATIVE ADVANTAGES OF ELECTRICITY, STEAM, AND COMPRESSED AIR FOR MINING PURPOSES.

By WILLIAM EDWARD GARFORTH, M. Inst. C.E.

(A Paper read before The Institution of Civil Engineers.)

THE question of mechanical power for underground requirements connected with haulage, coal cutting, pumping, etc., is at the present time occupying the attention of mining men perhaps more than any other subject. High-pressure dry steam is the most economical power for use on the surface. Electricity is the most economical and convenient for transmission of power. Compressed air is the safest underground. A combination of the foregoing will probably prove to give the best results.

Whilst high-pressure dry steam is the most economical when generated on the surface in boilers of modern type, and supplied within a limited distance from the winding, pumping, dynamo, hauling, and other engines, yet this remark does not apply when the boilers, engines, etc., are placed underground. The expense of maintaining boiler flues, the danger of setting fire to the surrounding strata, the difficulty of dealing with the exhaust steam, and of obtaining suitable feed water, etc., makes this system unsuitable for use in this pit. Besides, there is also a serious interference in maintaining strict discipline amongst the workmen, and since the introduction of the Compensation Act insurance companies have refused to undertake extra risks without increased premiums. These objections, amongst others, will in future prevent the erection of boilers underground.

Many instances can be given of the successful working of underground haulage by engines placed on the surface and ropes carried down the shaft and for long distances into the workings. Provided local conditions are suitable, and proper attention has been given to the drums, pulleys (of large diameter), ropes, and accessories, this system of haulage is probably the most economical that can be adopted, besides giving, as regards fire damp, the additional advantage of safety.

The statement that compressed air is the safest power conveys to those in charge of coal mines, which naturally and sometimes suddenly give off large quantities of fire damp, an impression of advantages which compensate to a great extent for the loss of economy. The latter can be ascertained, but it is almost impossible to estimate the loss sustained by the stoppage for some months of a large colliery consequent on an explosion. Even the most modern compressed-air plant, designed either on the wet or dry principle, single or double stage compression, water jacketed, driven by engines and boilers of the most modern type, pipes of large diameter, numerous air receivers, etc., show that the losses by heating, leakage, etc., are such that, from an economical point of view, compressed air cannot compare with electricity.

Before referring to the advantages to be gained by the use of electricity, it may be pointed out that there are in a coal mine sufficient natural dangers (fire-damp, etc.) without introducing artificial ones. As an instance of this, several collieries formerly forced artificial gas from the surface by means of a steam jet down the pit to light the roads near the bottom of the shaft, and where the traffic was greatest. So long as everything connected with the underground workings appeared satisfactory, no complaint was entertained, but when an explosion occurred it was suggested the cause of the accident was an accumulation of artificial gas above the roadway timbers, due to leakage from the pipes. In the same way electricity is, by some engineers, being recommended for use at the coal face in all mines on account of its greater economy as compared with compressed air. The danger connected therewith may not be fully realised in the case of certain deep mines until an accident takes place, attended with serious loss of life. Then, judging by other accidents, economy is forgotten in regretting the loss of life, and afterwards in considering the claims made by the relatives of the men who have been killed or injured. At the same time, there are many mines in which it will be perfectly safe to use electricity, provided the cables, motors, and accessories combine the latest improvements.

By the use of electricity not only can high efficiency be obtained, but both generating and transmitting machines are exceedingly compact and require only a limited area, the cables are easily and quickly laid, occupy small space, and, being flexible, are not affected by the lifting floors of the mine.

The cables do not require rigidly fastening underground ; it is, in fact, preferable to suspend them by means of a cord from the props supporting the roof, so that in case of a fall of stone, etc., the suspension breaks readily, allowing the cable to drop, thus saving it from injury.

With regard to the two systems—polyphase and continuous currents—each has its advantages and drawbacks.

The chief points of the three-phased current system are :

1. Absence of commutators in both generators and motors, with consequent saving in wear, reduction of repairs and renewals, and less need of constant skilled attendance.

2. Complete immunity from sparking.

3. No starting resistance required for motors up to 10 b.h.-p., unless exceptionally large starting torque is required.

4. Generators of inductor type have all windings fixed. The rotor windings of motors have low potential difference, and are not liable to burn out. High pressure can therefore be transmitted without risk to generator or motor, and copper is saved in the line.

With respect to the continuous-current system, the following may be mentioned :

1. A single pair of conductors is required, as against three conductors.

2. Greater starting torque can be obtained with the motors.

3. Accurate measurements can be more readily taken.

From a pitwork point of view, the complete absence of sparking at the motor would at first sight seem a consideration in favour of the three-phase current. The best continuous-current motors for this work are, however, now usually boxed in, and for all practical purposes are gas-tight. Thus the danger attending the underground use of electric motors, fitted with the latest improvements, is reduced to a minimum. At the same time, before adopting electricity, every possible danger should be considered and guarded against, especially in the line of cables. A fall of roof, or other accident, may at any moment produce a short circuit, or sever the cable, and result in serious sparking. Should this take place on the outskirts of an unventilated goaf, consequent on the method of driving, straight work, and working back the pillars, with a weighting roof and an atmosphere clouded with fine coal dust, due to the coal face being cut by a machine, then the production of an electric arc gives all the factors for a serious accident.

The greatest care should consequently be bestowed on this portion of the electrical installation, and the system involving the simplest arrangement and least number of cables should be preferred.

The safety of a mine is only equal to the most unsafe lamps or appliances used in it, in the same way that the strength of a chain is only equal to the weakest link.

With regard to the best form of cable for continuous current in mining work, concentric conductors seem to be the simplest and safest.

The adoption of an earthed circuit is open to many objections. Safety is the predominant factor in planning all underground work, and a tight system is on this account to be preferred. Security from shocks is claimed for the earthed system, but in practice this has not always been found to be the case.

For the cable which requires to be vertically suspended down the shaft vulcanised rubber is the best class of dielectric. The very best qualities of rubber, such as are used for high-class underground street mains, are too soft for this, and a good insulating rubber containing more pigment and of increased thickness should be employed.

The core should be lapped with tape and compounded and sheathed with galvanised iron wires of about No. 16 S.W.G. compounded, and coated with compounded jute.

Lead-covered cables should not be used for pit work. All cables should be sheathed. As a prime source, steam, when used under the conditions previously described, possesses the greatest advantages. For the transmission of power to a distance electricity is the most economical, efficient, and handiest. In the presence, or with the possible occurrence of gas, compressed air is the only one which can be absolutely relied upon. For the distribution of power to distant parts of the mine the writer has on many occasions suggested and advocated the employment of a combination of the foregoing,—*i.e.*, generating the electricity on the surface, and by a cable down the shaft and along the main roads conveying the same to an electric motor, coupled by gearing or ropes to an air compressor, fixed in a well-ventilated position at a safe distance from the coal face ; then through pipes of suitable diameters conveying the compressed air to pumps, hauling engines, or coal cutters as desired. As the coal face advances, the motor and compressors are moved. By this arrangement the surface engine house and foundations are saved, and the motor, etc., can with a little extra work be fixed in a disused road. By a careful consideration of the circumstances and requirements, this combination of the best characteristics of each system should overcome all objections to the low efficiency of compressed air and the danger of electricity, and lead to a consummation of an economical and safe system for the distribution of power underground.

THE MODERN STEAM PLANT.*

By IVORY M. HANSON.

At the present time, when the tendency is to reduce the cost of production, you may be sure any appliance that will help along this line will be favourably received.

In the matter of steam power production the first place to look for a saving is at the coal pile, as the larger the steam plant the greater will be the expense of running and a larger amount of coal is used, so there are chances of making larger savings.

The first step in this direction should be to determine what fuel will evaporate the larger amount of water per unit of cost under the best conditions, with the combustion in the furnace as nearly perfect as possible, providing the appliances used to make it so do not cost more than it would to allow the combustion to be imperfect. For example, it would not pay to instal a mechanical stoker if the interest on its cost and the cost of repairs would amount to more than the saving in fuel and labour.

We should find the amount of heat in a given fuel by a calorimeter test and next find the amount of heat absorbed by the water, which can be found from the number of pounds of water evaporated per pound of fuel; after finding these results it is an easy matter to determine if you are getting good results. If you do not account for more than half of the heat in the fuel you may conclude that something is wrong; either there is imperfect combustion or the gases are passing up the chimney at a higher temperature than they should, and there is large amount of radiation and loss by thin walls and cracks in the boiler settings.

Ideal results are obtained when the temperature of flue gases is of nearly the same temperature as the steam. These temperatures may easily be found by the use of the pyrometer or a protected thermometer introduced in the flue and a thermometer inserted in the steam pipe of the boilers.

It is evident that it would not do to reduce the temperature of the flue gases below the temperature of the steam. The flue gases may be reduced below the temperature of the steam, after having passed through the boiler, by the use of an economiser, which is the only practicable way that more heat can be taken from the gases.

* Read before Mass. No. 17, Lowell.

The effectiveness of the steam plant in the way of economy depends upon the boilers and their appliances, such as well-designed furnaces with grates having proper air space, mechanical stokers, feed water heaters, flue economisers, and mechanical or natural draught.

The boiler, whether of the water tube or the fire tube type, should be of the best design. It is still a question which of the two types gives the best economy; the water tube type has several advantages over the fire tube type, they being quick steamers, and easily forced beyond their normal rating. Another point claimed for them is their safety from disastrous explosions. But they have their disadvantages—higher cost, and generally the flue gases leave the boiler at very high temperature, which necessitates the use of economisers.

At the present time, all things considered, there are no better boilers than a well-designed horizontal tubular when good economy is desired above other considerations. It will be understood that this type of boiler should have the best appliances to enable it to compare favourably with other types.

Boilers, in a large number of cases, do not give good results because they are not properly cared for. For instance, you may instal a first-class boiler plant, but if the boilers are not properly fired and kept clean, both inside and outside, the results obtained will not be good. One cannot say if you instal a certain type of boiler, or feed water heater, or mechanical stoker, or feed pump and other appliances that are said to be first-class, that the results will be the best, for the reason that the different appliances require different treatment. You would not put in fire tube boilers to furnish a large amount of steam if you had a very limited floor space, or you would not put in an exhaust feed water heater if you had water at 212 deg. without it, as there would be nothing gained; you will find instances of this sort all through the steam plant that would apply to this point.

Every steam plant has its own peculiar conditions to be met with, and the engineer should be familiar with the conditions.

Complete burning of the coal means perfect combustion. When a chimney discharges large quantities of smoke you may be sure that the fuel is not completely burned. In some cases this may be remedied by introducing more air into the furnace, or by a combustion chamber, or by changing the mode of firing, as by charging of the furnaces one at a time, or by caking in front and pushing the fire back.

If a hot fire is entirely covered by fresh coal the heat of the furnace is lowered so that the gases that are liberated from the fresh coal are not consumed, as they pass up the chimney in the form of smoke. A change in the method of firing will sometimes effect a large saving.

It is practically impossible to obtain perfect combustion, even with the best designed furnaces and the best mechanical stokers as applied to boilers. A good fireman can easily save more than his wages, a poor one will waste considerably more than should be permitted. For this reason you can see why mechanical stoking is so alluring to some managers of large steam plants. Another point in favour of mechanical stokers is that they reduce the cost of labour. The installation of the mechanical stoker in a large steam plant would improve the combustion and reduce the cost of labour, but the cost and maintenance may overbalance the saving.

Mechanical stokers may be installed with profit where coal is cheap and where there are conveniences for handling coal by machinery, as it reduces the amount of labour required.

Where mechanical stoking has been a success those plants are equipped with conveniences for handling the coal, from the coal dump to storage bins, over the boilers, and carry the ashes from the ash pits to some convenient location where they may be drawn off into carts or cars and carried away.

This sort of an arrangement would only apply to large steam plants of 1,000 h.-p. or over, and even then the large cost for repairs and interest on first cost would perhaps overbalance the saving.

We will now take up the matter of waste heat with a non-condensing plant, where the exhaust steam is allowed to flow to the atmosphere, and where the conditions are such that the flue gases are not much hotter than the steam. It is almost useless to introduce an economiser into the flue when, as you are letting large quantities of latent heat go to waste in the exhaust steam which can be recovered by the use of a properly constructed exhaust feed water heater. The same point applies to the condensing plant, where you can place a heater in the pipe that leads to the condenser.

In a plant that uses the exhaust steam for boiling water, heating coils, and for warming the departments, and where a back pressure is employed and the exhaust steam is allowed to go to waste only at short periods, the problem becomes more difficult, for in this case you have only the drips or return, the exhaust steam to use at intervals and the flue gases. It would be best to utilise all the exhaust steam for heating or other purposes, if possible, in place of steam from the boilers than collect the drips, filter them if possible, or use a grease extractor, which is the next best thing to do, and then pass them, with the additional water required, through an economiser to the boilers. This arrangement would be an ideal one, and in most cases would be impossible to carry out.

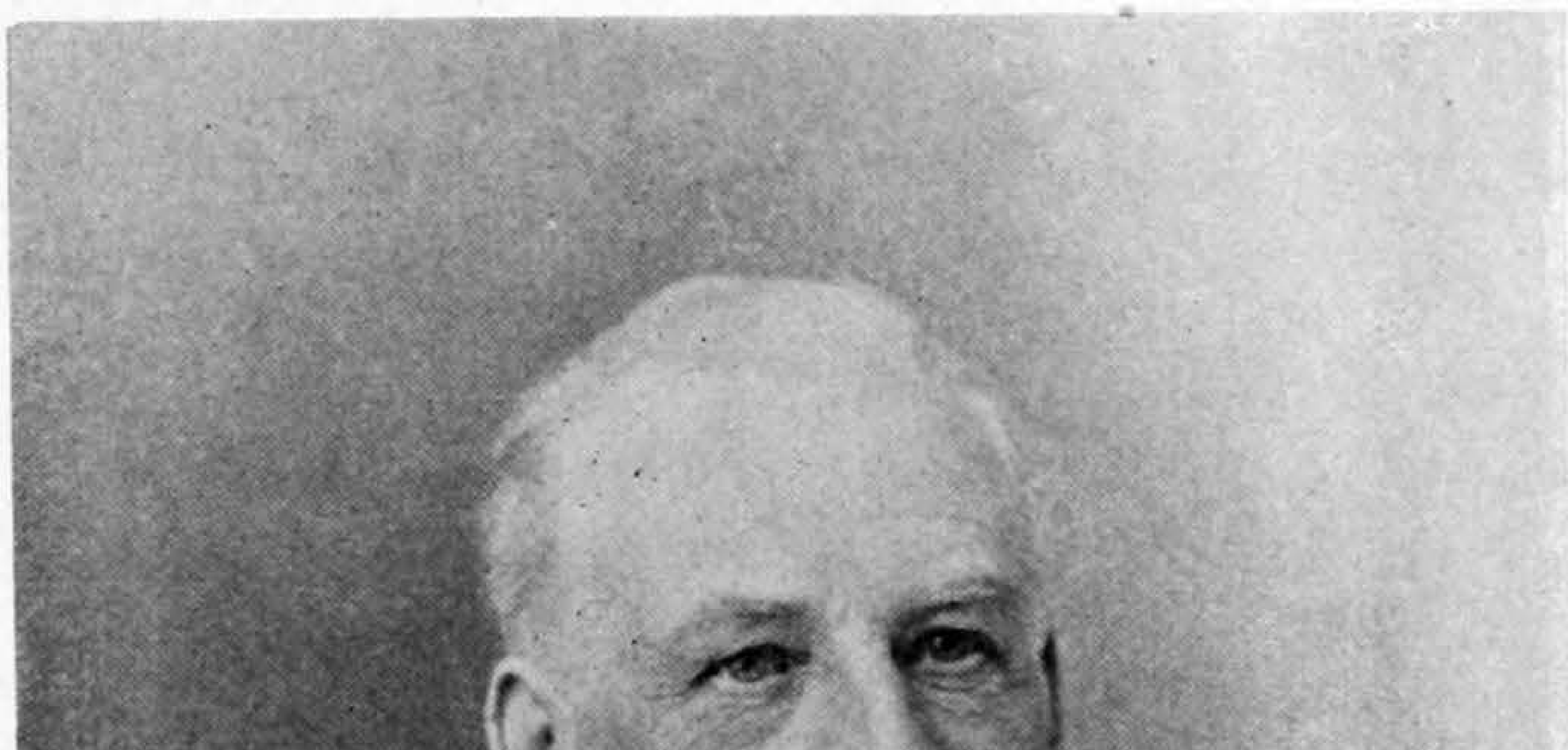
We come to the question of feed water heaters, of which there are two kinds—the open and the closed. An open heater is one in which the water comes in direct contact with the exhaust steam. In the closed heater the heat of the steam is transmitted to the water by convection, the water being on one side of a metal sheet or tube and the steam on the other.

The advantages of the open heater are that most of the impurities can be precipitated at or below 212 deg. to a point where they can be removed. Some of the disadvantages are that the feed pump has to handle hot water, and causes trouble with the pump, also the feed water contains oil, which is brought in with the exhaust steam, even where the best of oil separators are used in the exhaust pipe.

The advantages of the closed heaters are that the feed pump has to handle only cold water, and no oil can get into the feed water. This style of heater is liable to lose its efficiency in a short while on account of a deposit forming on the tubes.

An open heater, properly constructed and properly handled, gives a more satisfactory result than a closed one; its efficiency never becomes impaired and its cost and maintenance is much less. A common way to make heaters is to erect them so that all the exhaust steam from non-condensing engines will pass through them. This is unnecessary, as only about a fifth part of the exhaust steam is condensed.

It is a cardinal principle that steam cannot be cooled down without reducing the pressure, unless the steam is superheated. One writer says: "Allow the steam to escape from the engine superheated, then introduce a heater especially adapted to utilise the gases to escape at a high temperature, then instal an economiser to save that waste. Exhaust feed water heaters should have by-pass valves, so that the plant could be operated should anything happen to the heater."



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