author, he found that the pitch between the holes was $2\frac{3}{16}$in. and the width of each segmental cantilever where it joined the pipe body $1\frac{3}{16}$in. The ratio of these figures, $1\frac{3}{16}/2\frac{3}{16}$, was as 54 to 100. As tested with the radial saw cuts each cantilever carried a load of 1.27 tons, but as a solid whole the flange

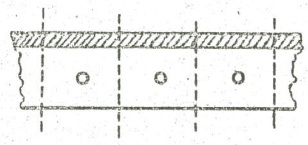


Fig. 1

carried 19.2 tons for the same deflection. Each cantilever, therefore, in the undivided state carried an eighth of this, or 2.4 tons. The ratio of these figures, 1.27/2.4, worked out at as 53 to 100, or practically identical to the other ratio. They thus arrived at the curious result that the flange as a solid

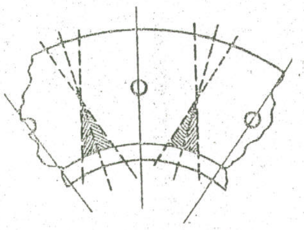


Fig. 2

whole carried a load equal to the sum of the loads carried by the eight cantilevers if these were considered not as having radial, but as having parallel sides—see Fig. 2. Each segment, therefore, it seemed, used more than its proper width to transmit its load to the pipe body. Where the parallel-sided cantilevers overlapped, as indicated by the shading in Fig. 2, there was a compound stress in the metal. In the diagram, reproduced in Fig. 3, there was shown the probable scheme of these imaginery cantilevers for a flange with eight bolts as it might be supposed to work out in actual fact. It was clear from this figure how notches might be cut out of the flange periphery

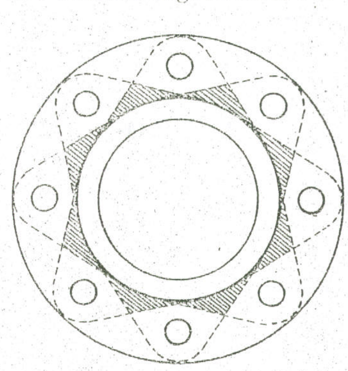


Fig. 3

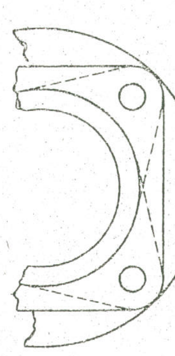


Fig. 4

without loss of strength. The author's tests on this point showed a loss of strength of 11 per cent. This he believed was due to the circumstance that too much had been cut out and would not have occurred had the notches been properly cut. There was great difficulty, he continued, in getting people to believe that four bolts only were necessary for the flange of a 2in. pipe. A drawing of such a flange was exhibited —see Fig. 4—and it certainly looked as if four bolts were too few. But, said Dr. Maw, if we made the flange square without altering the bolt holes this appearance vanished. It would be noticed that nothing of the strength was lost by making the flange square, as in this state the whole of the imaginary cantilevers was left untouched. He would like also to call attention to the case of the 2½in. pipe tested by the author—see Figs. 2 and 3 of the paper. The left-hand flange was bolted to the adjoining cast iron flange with a space between and was distorted under the test. The right-hand flange, however, was bolted up tightly and was not distorted at all, although both flanges were symmetrical.

Mr. W. H. Patchell, referring to Dr. Maw's last point, suggested as an explanation that the outer edge of the tightly bolted flange was prevented from moving to the right under the test, whereas the outer edge of the other was free to move. The worst part of a flange, in his opinion, was the joint in between. He then discussed at some length the qualities of various jointing materials and their behaviour under test. In the course of these remarks he alluded to the author's contention that the packing material should extend over the whole width of the flange. He could not quite agree with this, as to follow it out would entail much trouble in the erection of a range of piping. His concluding remarks related to some tests conducted by the Admiralty on flanges for pipes 12in. and 13in. in diameter. The flanges used were not really thick enough and most of them wept under a pressure of 500 lb., although the best of them could stand up to 600 lb. The expedient was resorted to of cambering the flange faces until the edges were $\frac{1}{32}$in. open. The 12in. pipe was then found to stand 1100 lb. pressure before weeping commenced. This was really making the best of a bad job. He could not recommend the general use of cambered flanges. For one thing, they would be expensive to make.

Mr. E. J. Fox, speaking as a manufacturer, praised the Standards Committee's report for the efficient and economical dimensions adopted. With one exception the dimensions, he said, were very generally adopted by everyone in this country except by the Admiralty—cries of "Shame"—and by marine engineers. The exception referred to lay in the case of the standard dimensions for loose flanges. It was difficult, if not impossible, to follow the rules laid down by the Committee for these flanges, because it stipulated that the bolts should be in number multiples of four, whereas it had been the universal custom to make them multiples of two. He dealt also with the various methods of attaching fixed flanges to steel pipes—screwing, riveting, and welding—and expressed himself as being strongly in favour of welding. Flanges in general, he concluded, were merely the means of joining two lengths of piping together, and if we could do away with them entirely so much the better. The practice of joining two such lengths by welding by the oxy-acetylene process was likely to be considerably extended in the future. It resulted in a joint that was very strong, was as cheap to make as an ordinary red lead joint, and was permanent.

Mr. H. F. Rutter, as a user of flanged work, bore testimony to the advantages and convenience of the Standards Committee's work. He urged, however, that it should be extended to larger sizes of pipes. For steam pipe purposes the range of sizes adopted was no doubt sufficient, but for water pipe purposes standard sizes for the flanges of pipes 30in., 33in., 36in., 42in., 48in., and 54in. in diameter were very badly required.

Mr. J. A. Aiton also urged the extension of the standards to larger sizes, not only for water pipe purposes, but for the steam pipes of low-pressure turbines. He strongly urged that columns 7, 8, and 9 of Table II. in the Standards report should be entirely cut out, as in his opinion a body of the dignity and importance of the Engineering Standards Committee should no longer encourage the antiquated practice of using cast iron for steam pipes. Dealing with the question of jointing material, he said he had always favoured the practice of putting the material inside the ring of bolts. To put it all over the flange face did not, in his opinion, strengthen the joint, but weaken it. If the joint "cupped" it became tighter if the material were inside, but if it were outside only it would leak through the bolt holes. As regarded welding up pipe joints in place, he had never practised it and would continue to fight shy of it. He had never yet found a joint welded by the oxy-acetylene or carbon arc process to possess the strength of the unbroken material, although he had to confess that with the new Quasi-arc process it seemed that this could be obtained. As a whole he was disappointed in the paper. Historically it was interesting, but it missed a grand opportunity of raising many unsettled points of importance connected with pipes and the manner of joining them.

Mr. Michael Longridge regretted to hear Mr. Aiton express preference for a joint with the material wholly within the bolt ring. It might result in a tight joint, but with cast iron it was a dangerous practice, in view of the stresses which were thrown upon the material when the bolts were tightened up. As regarded welded flanges, he felt that the welding was apt to be confined to the edge of the flange collar, and preferred in such welded flanges always to have rivets used as an additional safeguard. He could not really see any connection between a cantilever and a pipe flange. A round flange was actually a great deal stronger than the sum of the strengths of the equivalent cantilevers. Were there a true relationship nothing would be gained in strength by adding material to the flange outside the bolt holes. Actually the strength could thus be considerably increased.

Mr. Patchell was induced by the references to welding pipes in place to speak again and to relate his experience with a wrought iron pipe 6ft. 6in. or so in diameter, which had to be so welded up. All was accomplished satisfactorily except for the last joint, which, as the weather had become frosty, could not be completed as intended, because the required temperature could not be attained.

Mr. Fox, speaking again, also dealt with this welding-in-site method of joining pipes, and said that it had been adopted by seventy or eighty gas and water undertakings in this country. At first considerable difficulty had been experienced in completing the joint underneath the pipe, as it was found that before the welding metal could solidify it frequently flowed out of the gap. The method now adopted, as shown

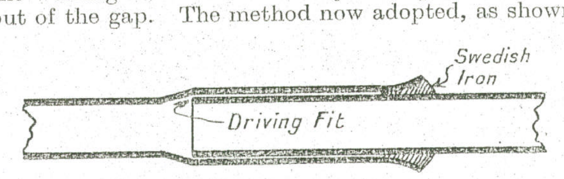


Fig. 5

in Fig. 5, was to form the spigot end with a curve such that the "angle of respose," so to speak, for the small amount of liquid metal was not exceeded The spigot length was about three diameters.

Mr. Longridge, in this connection, remarked that in Liverpool a short time ago he had seen an ingenious process—a German one, he believed—in which the chips to be welded in were held in place in a vertical crack by magnetism until they could be melted and welded.

Mr. Dewrance then briefly replied to the discussion, but added little to the information already given in his paper. He remarked, however, that when the Committee first published its report it was condemned by the pipe makers because it had adopted "excessive" flange thicknesses. Subsequently the makers conducted experiments for themselves—sometimes at great cost—and convinced themselves that the Committee was right, and as a result even begged it to increase the flanges in thickness for certain purposes.

On February 8th Sir Robert Hadfield will deliver a lecture to the graduates on "The History of the Metallurgy of Iron and Steel." All members are invited to be present. The annual general meeting will take place on the 19th.

ELECTRIFICATION ON THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

MORE electric railway systems have been tested in America than in any other country. Besides lines working with high and low-tension direct-current, there are railways employing the single-phase and split-phase systems, and on the electrified lines of the New York, New Haven, and Hartford Railway tests are being made with a locomotive that collects single-phase current and uses direct-current on the motors. In all recent experiments the object aimed at has been to work trains from a high-tension overhead wire. If single-phase current is used, it is, of course, quite practicable to operate trains at 15,000 volts, but it is common knowledge that some engineers prefer direct-current.

The American General Electric Company has succeeded in building direct-current equipments for 3000 volts, and has recently secured the contract for electrifying with this system the Puget Sound lines of the Chicago, Milwaukee, and St. Paul Railway. The electrification of the 113 miles of main line between Three Forks and Deer Lodge is the first step towards electrifying the four engine divisions, extending from Harlowton, Montana, to Avery, Idaho, a total distance of approximately 440 miles, the track miles including yards and sidings aggregating about 650. All the locomotives, sub-stations, equipment, and line material is to be supplied by the General Electric Company, of Schenectady, New York, and the Montana Power Company is constructing the transmission lines and overhead trolley system.

If the results obtained from the electrification of these lines meet expectations, electric working will be adopted on the lines from Harlowton to the coast, a distance of 850 miles. Plans for the electrification of this section are at present being prepared. Fig. 1 is a map of the Chicago, Milwaukee and St. Paul Railway connections from Avery (Idaho) to Harlowton (Mont.), from which it will be gathered that the line passes through mountainous districts. Electrification is being adopted purely on economic grounds, and it is expected that the saving which will result from the use of electric locomotives will effect a reduction in the present cost of steam operation sufficient to return an attractive percentage on the large investment which the scheme necessitates.

Arrangements have been made with the Montana Power Company for the supply of power to operate the trains on the 440 miles of main line that are to be electrified at the outset, and special precautions are being taken to ensure continuity of the supply. The network and transmission lines of the Montana Power Company extend over a great part of Montana and Idaho, and they are fed from a number of stations, mostly water-power stations. The capacities of the principal plants are given in the table below :—

	Kilowatts.
Madison River	11,000
Canyon Ferry	7,500
Houser Lake	14,000
Big Hole	3,000
Butte (steam turbine)	5,000
Rainbow Falls	21,000
Small powers, aggregating	7,390
	68,890

Other stations are also to be constructed, and work on some of the following is now in hand :—

	Kilowatts.
Great Falls	85,000
Holter	30,000
Thompson Falls	30,000
Snake River	20,000
Missoula River	10,000
Total	175,000

It will be seen that, when all these new stations have been built, the power company will be in a position to supply about 244,000 kilowatts. In the case of the earlier installations the transmission lines are supported on wooden poles, and operated at 50,000 volts, but the lines erected more recently are worked at 100,000 volts, and are supported on steel poles. Ample water is stored to meet demands under all conditions. Altogether the reservoir capacity is 418,000 acre-feet. The main reservoir, which is known as the Hebgen Reservoir, has a capacity of 300,000 acre-feet, and is situated at the head waters of the Madison River so that it can supply in turn the several plants on the Madison and Missouri Rivers. In this way the same storage water is used a number of times, and it will be seen that with the large amount of storage available, there is little fear of the railway being put out of action owing to shortage of water.

From the foregoing it will be gathered that the lines to be electrified are very favourably situated as regards the supply of power, and owing to the low cost of construction it has been possible for the power company to offer current at the low rate of .00536 dols. (.268d.) per kilowatt-hour, based on a 60 per cent. load factor, and it is expected that under these conditions the cost of current used by the locomotives will be considerably less than the cost of coal consumed by the steam locomotives. The agreement entered into between the power company and railway company has been drawn upon the assumption that the electrification of the lines between Harlowton and Avery, comprising four engine divisions, will be in operation in January 1st, 1918.

In order to connect the sub-stations with the several feeding-points of the Montana power transmission line, a "tie-in" transmission line is being erected by the railway company, which will enable each sub-station to be fed from two directions and from two or more power sources. This transmission line is to be erected on wooden poles and is to be operated at 100,000 volts. A great portion of the line will follow the route of the railway, but where possible, and especially in mountainous districts, where the course of the railway is winding, a more direct path will be taken.

For the first 113 miles of track to be dealt with four sub-stations will be necessary, which will contain step-down transformers and motor generator sets for converting the 100,000 three-phase 60-cycle current into 3000-volt direct-current. This is the first railway in America to use such a high pressure as 3000 volts on a direct-current system. The 2400-volt direct-current installation of the Butte, Anaconda and Pacific Railway is in the immediate vicinity of the Milwaukee and St. Paul Railway, and it is owing, we are told, to the satisfactory operation of the high-tension direct-current equipment on the former line that the Milwaukee and St. Paul Company is using this system.

The equipment for the 2400-volt line, it will be remembered, was also supplied by the General Electric Company, this company, as is well known, being a strong advocate of the high-tension direct-current system. A comparison based on six months' steam and electrical working on the Butte, Anaconda and Pacific Railway shows that electrical working results in a net saving of more than 20 per cent. on the investment or total cost of the electrification. The comparison also shows that the tonnage per train has also been increased by 35 per cent., whilst the number of trains has decreased by 25 per cent., there being a saving of 27 per cent. in the time required per trip.

A profile of the line from Avery to Harlowton is shown in Fig. 2, from which it will be gathered that the gradients to be negotiated are by no means light. The average distance between the sub-stations on the Chicago, Milwaukee and St. Paul Railway is approximately 35 miles, notwithstanding that the first section embraces 20.8 miles of 2 per cent. gradient westbound and 10.4 miles of 1.66 per cent. gradient eastbound over the main range of the Rocky Mountains. The engineers of the General Electric Company point out that the long distances between the sub-stations and the small amount of copper in the feeders are advantages which have been secured by the use of 3000 volts on the overhead wire. The sub-stations will be of the indoor type; that is to say, the equipment will be erected in buildings. For reducing the 100,000-volt three-phase current to the secondary pressure, viz., 2300 volts, oil-cooled transformers will be used. The motor generators, which will work at the above-mentioned pressure, will be composed of a 60-cycle synchronous motor driving two 1500-volt direct-current generators, permanently connected in series, small direct-current generators connected directly to the ends of the motor generator shaft providing the exciting current for the synchronous motor and the generator. To maintain the direct-current pressure constant up to 150 per cent. of the normal rating, the direct-current side of each motor generator will be compounded, and to ensure good commutation at heavy overloads, which may with safety reach three times the normal load, commutating poles and distributed compensating windings are to be fitted. In addition to driving the direct-current generators, the synchronous motors are also to be called upon to act as rotary condensers, and it is estimated that it will in this way be possible to regulate the transmission voltage and so eliminate the effect of the fluctuating load of the railway. The positions and capacities of the sub-stations are shown in the following table:—

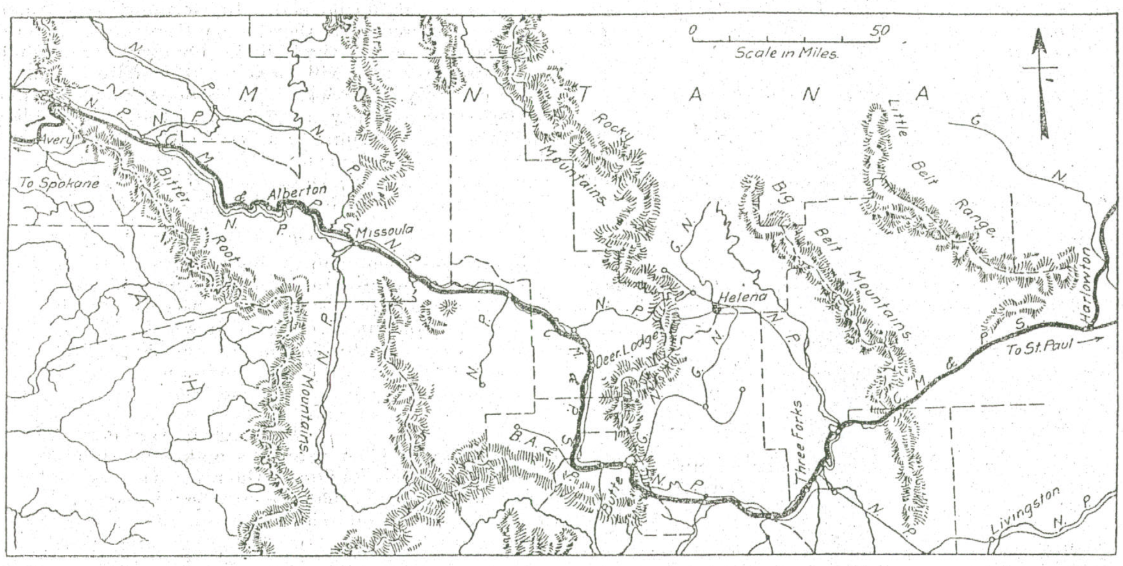
Station.	Miles from Deer Lodge.	Number of units.	Kilowatts per unit.	Total kilo-watts.
Morel	17.1	2	2000	4000
Janey	50.5	3	1500	4500
Piedmont	77.9	3	1500	4500
Eustis	120.6	2	2000	4000

Owing to the heavy currents that will have to be collected, a special catenary system is to be employed. Wooden bracket poles will be used on straight portions of the line and cross supports on sharp curves and in yards where the number of tracks to be spanned is large, steel poles will be used. At the time of writing the poles have been placed in position along 30 miles of track, and the work, it is estimated, will be completed in the summer of this year, and will be ready for operation in the autumn, when the first locomotives are to be delivered. From the brackets or cross supports a steel catenary cable is to be suspended, and this in turn will support two 4/0 copper wires by means of hangers alternately connected to each conductor. This form of construction is claimed to be very suitable for the collection of heavy currents, for, apart from the fact that two conductors naturally give twice the contact surface of a single conductor, the method of suspending the two wires gives great flexibility. On the first section of the railway to be electrified, that is, the section between Deer Lodge and Three Forks, there are, including sidings, cross-overs, and yard tracks, 168 miles of track to be equipped.

From Harlowton to the coast the Chicago, Milwaukee and St. Paul Railway crosses four mountain ranges:—The Butte Mountains, at an elevation of 5768ft., the Rocky Mountains at 6350ft., the Bitter Root Mountains at 4200ft., and the Cascade Mountains at 3010ft. The section of the line between Three Forks and Deer Lodge calls for locomotive operation over 20.8 miles of 2 per cent. gradient between Piedmont and Donald, at the crest of the main Rocky Mountain divide.

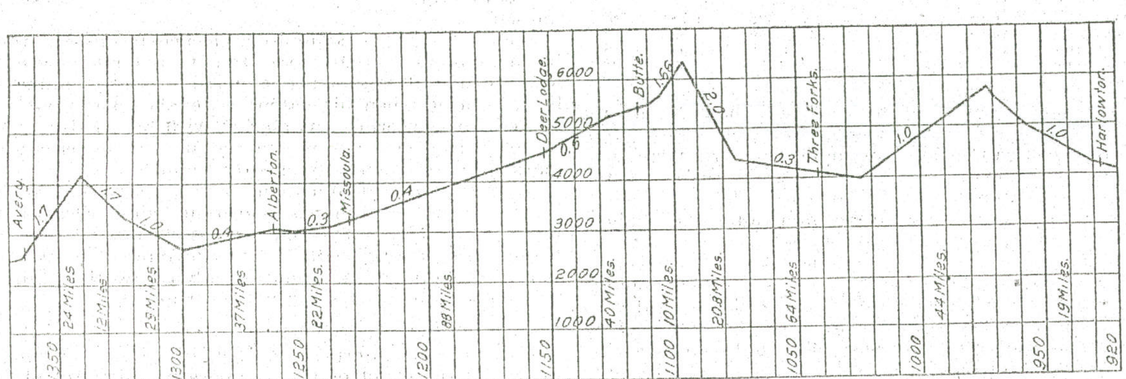
The locomotives, which, as already stated, are being built by the General Electric Company, are exceptional in more than one respect. In the first place, they are the first direct-current engines to be built for a pressure of 3000 volts; secondly, they will have a capacity greater than that of any steam or electric locomotive so far constructed; and thirdly, they are to be designed for regenerating when travelling down gradients. There is, of course, nothing remarkable about this latter feature, but the makers point out that regeneration has never before been attempted on such a large scale. An outline drawing of one of these engines is given in Fig. 3, and the general characteristics are set forth in the table on the next page.

The first order is for nine goods and three passenger locomotives with characteristics as set forth in the table below, the only difference between the goods



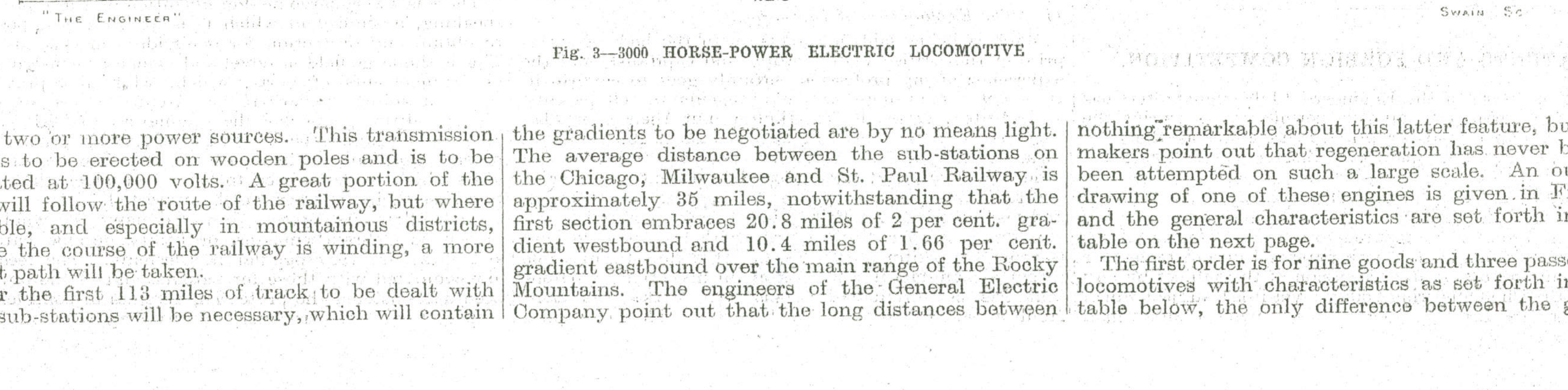
"THE ENGINEER" SWAIN Sc

Fig. 1—CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY—AVERY TO HARLOWTON



"THE ENGINEER" SWAIN Sc

Fig. 2—PROFILE OF LINE BETWEEN AVERY AND HARLOWTON



"THE ENGINEER" SWAIN Sc

Fig. 3—3000 HORSE-POWER ELECTRIC LOCOMOTIVE and passenger engines being that the gears of the latter will permit of the 800-ton trailing trains travelling at a high speed, viz., 60 miles per hour. The passenger engines, moreover, will be fitted with an oil-fired steam heating equipment for heating the trailing cars. The electrical and mechanical parts of the goods and passenger locomotives are to be interchangeable. From Fig. 3 it will be seen that the cab consists of two similar sections extending practically the full length of the locomotive, each section being about 52ft. long. Owing to the unusual height of the overhead conductor, viz., 25ft. above the rails, the bases of the current collectors are to be mounted 5ft. above the roof.

Total weight	260 tons
Weight on drivers	200 tons
Weight on each guiding truck	30 tons
Number of driving axles	8
,, motors	8
,, guiding trucks	2
,, axles per guiding truck ..	2
Total length of locomotive	112ft.
Rigid wheelbase	10ft.
Voltage of locomotive	3000
Voltage per motor	1500
One-hour rating of each motor	430 horse-power
Continuous rating of each motor	375 horse-power
One-hour rating of locomotive	3440 horse-power
Continuous rating of locomotive	3000 horse-power
Tractive load capacity on 2 per cent. gradient	1250 tons
Tractive load capacity on 1 per cent. gradient	2500 tons
Approximate speed at these loads and gradients	16 m.p.h.

Each motor, as shown in the above table, will be rated at 430 horse-power on the one-hour basis, and the continuous rating will be 375 horse-power. With a 30 per cent. coefficient of adhesion the draw-bar pull available for starting will be 120,000 lb. Each motor will be coupled to its driving axle by twin gearing in the same manner as the motors on the Butte, Anaconda and Pacific, the Detroit River Tunnel, and the Baltimore and Ohio locomotives. The motors are to be fitted with commutating poles and ventilated by a motor-driven blower placed in the cab. On all the gradients up to 1 per cent. the goods locomotives are to be capable of hauling a 2500-ton load at approximately 16 miles per hour, and with the aid of a second locomotive at the rear this load will be carried over the 1.66 and 2 per cent. ruling gradients on the west and east slopes of the Rocky Mountain divide.

Arrangements are being made on the track at Donald to enable the second locomotive to run round the train and be coupled to the front end so that electrical braking can be obtained on the down gradient. The two locomotives at the front of the train will return current to the line, and the braking will be under the control of the motorman in the cab of the leading locomotive. Naturally, in mountainous parts such as those through which this railway passes regenerative braking is very advantageous, for the trains that are on down gradients supply current to those that are ascending gradients, and the load on the generating station is considerably reduced in consequence. The air brakes will only be applied in cases of emergency and when the trains are brought to a standstill.

With the completion of the remaining engine divisions it will be possible, owing to the use of electric locomotives, to combine the present four steam engine divisions into two divisions, approximately 220 miles long, but the train staff will be changed at the present division points. As the electric locomotives only need inspection after a run of approximately 2000 miles, and as it is unnecessary to stop for taking on coal and water, it is expected that it will be possible to make a considerable change in the present method of handling the trains. The electrification of the line is being carried out under the direction of Mr. C. A. Goodnow, assistant to the president in charge of construction, and the overhead construction work is being supervised by Mr. R. Beouwkes, the electrical engineer of the railway. On page 112 several views of the railway are given. Fig. 4 shows a mountain which the line skirts, along the Jefferson Valley between Three Forks and Piedmont; Fig. 5 a section of the line at the Bitter Root Mountains; Fig. 6 the great falls on the Missouri River, where a 60,000-kilowatt hydro-electric station is to be built, and part of the power will be utilised for working the railway. Fig. 7 shows a goods train ascending the 2 per cent. gradient between Piedmont and Donald; Fig. 8 the station at Avery, Idaho; and Fig. 9 the station at Piedmont, where a sub-station is to be erected. We are indebted to the British Thomson-Houston Company for these particulars.

PATENTS AND FOREIGN COMPETITION.

THE secretary of the Engineers' Club, Manchester, has been good enough to give us permission to reprint the following paper read for private discussion at the Club on Wednesday, 20th inst., by a chartered patent agent.

The subject of our debate this evening is one which I am exceedingly glad to find a representative body of engineers are at last prepared to discuss. During all my experience in connection with patents I do not remember seeing any report of any discussion of the subject by any of our British engineering bodies; yet it is a subject which more or less directly touches every engineer and which should periodically be ventilated and discussed to ascertain if the law cannot be made of more assistance to British trade.

Chambers of Commerce have tackled some points in connection with it, but they are unsatisfactory bodies to deal with the matter, as the proportion of their members interested in patents is small, and therefore it is not difficult for a few people with strong opinions to impose their views on a large, uninterested majority who never think about the subject.

I do not propose to read a connected paper to-night, but to put before you a few more or less disconnected facts and considerations, which I hope may provoke a useful debate and possibly result in one or more practical propositions for improvement of the law.

Let me first put before you some comparative figures :—

I.—Some Figures.

In the United States the annual number of applications for patents has steadily grown. In 1874 it was 21,602, in 1884 it was 35,600, and since then it has doubled, being in 1913, 70,367. Of these applications, an average of 50 per cent. to 60 per cent. have been allowed, and patents have been granted on them. It is interesting in considering these figures to know the number of applications originating from foreign countries. In 1874 352 applications originated in Great Britain, 74 in France, and 101 in other countries, Germany not being classified. At later dates the figures were as follows :—

	1884.	1894.	1903.	1913.
United States.. ..	19,013 ..	18,637 ..	27,819 ..	31,382
Great Britain.. ..	463 ..	743 ..	1,199 ..	998
France	161 ..	196 ..	321 ..	340
Germany	253 ..	582 ..	1,053 ..	1,433

The applications for patents filed in Germany in 1878—the first complete year under her Patent Act—numbered 5949. In 1884 they numbered 8607 and in 1913 they reached the enormous total of 49,532. In only one year in all that time was there a reduction on the number of applications of the preceding year. Whilst in the States, therefore, the number of applications for patents has doubled in the last thirty years, more or less following the increase in population, in Germany the applications have increased more than fivefold. Can it be doubted that this is largely due to her system of technical education?

The origin of most of these applications at various dates is instructive.

The numbers of applications from foreign countries filed in Germany are again instructive :—

	1894.		1904.		1913.	
	App'ns.	Gr'ted.	App'ns.	Gr'ted.	App'ns.	Gr'ted.
Germany.. ..	No list of applications published.	4,214	21,009	5,904	38,282	9,047
France		294	1,239	474	1,962	754
Austria-Hungary		327	1,079	393	1,781	563
Switzerland ..		113	602	206	1,325	462
United States..		444	1,644	1,012	1,988	1,128
Great Britain ..		530	1,141	574	1,376	619

In passing it may be pointed out that the figures entirely disprove the statement so often heard from patentees that in Germany an application by a German is favoured as against a foreigner. Not one-quarter of the applications entered by Germans are allowed, whereas in the last ten years rather more than half of the applications entered by Englishmen have been.

Now let us consider the English figures. The average number of applications entered per year in this country is about 29,000 or 30,000, and this figure has varied very little since 1896, when it first reached 30,000. In 1883 the number was, roughly, 6000; but in 1884, under the new Act which came into force that year, it rose to more than 17,000.

Of these applications an average of rather more than 50 per cent. have been completed and sealed. At the end of four years renewal fees are paid on about 35 per cent. of the patents granted, or on about 18 per cent. or 20 per cent. of the original applications, and only an average of about 2 per cent. of the cases originally filed are maintained for the full duration possible. The origin of some of the applications is as follows :—

	1884.	1894.	1904.		1913.	
			App'ns.	Gr'ted.	App'ns.	Gr'ted.
Great Britain..	12,511	19,180	20,030	7,638	20,426	8,336
France	788	799	1,096	778	1,143	1,068
Germany.. ..	890	1,945	2,809	2,140	3,167	2,582
United States..	1,181	2,017	3,596	3,051	2,646	2,488

The essential thing to be noted from all these figures is the gradual advance of the United States and the tremendous advance of Germany, whilst England and France have remained practically stationary. It is also to be noted that there are far more applications for patents by Germans and Americans in this country than there are by Englishmen in Germany and America, and that in this country the Germans are getting well ahead of the Americans. Omitting uncompleted provisional applications—which can hardly count in the comparison—there are more than three times as many applications for patents filed in Germany as in this country, and the proportion is speedily increasing, and there are between four and five times as many applications filed in the United States, and the proportion is increasing here also, but not so speedily.

II.—The Exploitation of Inventions.

Much is being said nowadays as to the lack of enterprise of the British manufacturer and capitalist, and the experience of my profession certainly goes to confirm it. It is not the business of patent agents to sell patents, as patentees often like to think; but their every-day work does give them an insight into what is going on with regard to the sale and exploitation of patents in this and other countries, and it can be said without any fear of contradiction that the conservatism, lack of enterprise, and fear of risk of the British industrialist, capitalist, and banker, as compared at any rate with his American and German competitors, are colossal. It is almost impossible to get a manufacturer to look at an invention or patent that has not originated in his own works. As Lord Moulton said recently in Manchester, "holders of capital in England have little sympathy with any knowledge they do not themselves possess." If the basal cause of this was ascertained I believe it would be found to lie between pride, laziness, and fear; pride in our belief in our own supremacy, laziness in the desire to avoid trouble, and fear—no matter what the future may bring—of risking an immediate outlay.

A patent agent is always hearing of the difficulty inventors have in getting their inventions taken up and the discouraging reception they meet with from manufacturers, even when the invention is a really meritorious one; and he knows, too, how exceedingly often their efforts only fail in the end. In Germany and America it is very different. If there is anything in an invention at all there is comparatively little difficulty there in finding a manufacturer who will at any rate test it, and in both countries many firms have special departments regularly on the watch for new inventions as they are published which they can take up. If we are to regain the supremacy which we have lost, or even our fair place, in the world's engineering trade, we shall have to do the same thing. This leads me to my third section :—

III.—Compulsory Working v. Compulsory License.

Most Englishmen seem to think that because a patented invention originates abroad it is something to be condemned. Generally the reverse is the case, as it is only the more important inventions on which a foreigner will pay the fees for patenting in this country. But submit such an invention to an English manufacturer and he positively will not look at it. The invention, however, is taken up, say, in Germany, and becomes a success, and the goods are imported to the English market. Then the English manufacturer wants to make the thing. Under the present Act he applies for the revocation of the English patent on the ground that the invention is mainly or wholly worked abroad, and wins his case. He then starts to manufacture, but only to find that the market is flooded against him, for, in getting the patent revoked, he has destroyed any protection he might under other circumstances have been able to get under it, and he has freed the market for anyone else to make it. Not only so, but he still has to face the competition of the German maker, for revoking his patent does not close the English market to him. In fact, it only tempts him with his, by that time, greater experience and facility in manufacture, to cut prices.

If, on the other hand, the English manufacturer could, by a process as simple and inexpensive as the present revocation process, obtain a compulsory licence under the patent, he would get protection against competitors in this country, and if the licence was made an exclusive one—which it should be—also against importation from abroad by the patentee himself, and though he might have to pay a small royalty to the foreigner—and thus be saved the odium of robbery—he would have the market to himself.

Such a system of compulsory licence I consider would be more punitive than revocation to a foreign patentee who endeavoured to use his patent to prevent manufacture here, because when his patent is revoked he is not prevented from entering this market with his goods; but if an exclusive licence were granted under the patent the market would be entirely closed to him.

Another practical objection to the present law is that it is causing other countries to introduce similar legislation. It is, for instance, proposed to pass a similar law in the United States, admittedly by way of reprisal to our law. It is also making other countries administer their present laws on working more strictly against us.

IV.—Alien Enemy Patents.

The lack of enterprise of English manufacturers is shown by the effect of the Temporary Rules Act of last year, by which it is possible for English manufacturers to secure the avoidance or suspension of alien enemy patents in their favour.

We have already seen the very large number of English patents that are held by Germans. Yet from the beginning of the war up to last week only 235 applications have been made by British manufacturers in connection with such alien enemy patents, and many of these applications have been in groups, and in several cases a number of applications have been made in connection with one patent.

In connection with 17 of these cases licences have been granted, 13 of the applications have been withdrawn, 19 have been refused, and the remainder, 186, are still *sub judice*. The court hearing the applications consists of the present and the past Comptrollers of the Patent-office, and the procedure is very simple and inexpensive.

It has been officially notified that licences will as a general rule be granted :—

(1) Where there is no manufacture in this country under the patent, and also

(2) Where what manufacture there is is carried on by a company or firm on behalf of alien enemies resident abroad, and there is any reason to doubt that the manufacture will continue to be carried on, or where it is in the interests of the country that some other manufacture should be started in the British interests, licences will be granted for the full term of the patent.

So far as can be ascertained—I understand no cases will be reported—the royalties so far fixed are low, usually 5 per cent. and not more than 10 per cent. on sale price; but after the war the patentee has the right to apply to the Board of Trade to revise the amount of the royalty.

V.—Petty Patents.

There is a very large field of invention or, more properly speaking, ingenuity in which it is at present impossible to obtain any protection for one's ideas in this country. This is the large field of novel and ingenious constructions or arrangements of parts, which, while not providing sufficient subject matter to be patentable, yet are sufficiently advantageous for the originators to desire some protection against the copying of them by others. All patent agents are familiar with the large number of such ideas which are submitted to them and which they have to advise their clients cannot be protected.

Such ideas are protected in Germany by what are known as Gebrauchsmuster, or utility designs patents, and these are very popular in Germany. The fees are low compared with those for patents, and as the law has been administered the protection given is of considerable scope. It is very customary to enter applications for a