houses of different types, as there are so many variable factors. However, the author's experience of a considerable number of estimates indicates that up to a capacity of, say, 1,000 kw., there is generally little difference between the gross capital expenditure required, whether steam, gas or Diesel engines be adopted.

Having now dealt with what may be termed the commercial aspect, it may be well to study briefly the constructional features desirable in engines for dynamo driving. For speeds which are not slow, engines of the multi-crank type

Table II.—Average Works Cost Per B.T.U Sold on Steam Stations of Different Sizes.

Capacity of station not exceeding.	Fuel.	Lubricating oil, waste, water and stores.	Wages.	Repairs and maintenance.	Total.	Load factor.
kw	d.	d.	d.	d.	d.	
250	.63	.09	.35	.36	1.43	13.2
500	.56	.06	.27	.29	1.18	13.3
750	.43	.05	.23	.24	.95	15.4
1,000	.40	.05	.23	.21	.89	16.8
1,500	.42	.04	.17	.18	.81	16.9
2,000	.37	.04	.16	.21	.78	17.7
3,000	.33	.04	.15	.17	.69	17.4
4,000	.40	.03	.14	.20	.77	18.8
5,000	.34	.03	.11	.16	.64	18.7
7,000	.36	.04	.13	.20	.73	17.9
10,000	.26	.03	.09	.13	.51	22.6
20,000	.30	.03	.11	.16	.60	19.6
50,000	.23	.02	.10	.11	.46	20.56

become desirable, otherwise serious vibration is likely to be caused. For the same reason it is important that the distance between the centre lines of the cylinders of an engine be reduced as much as possible, and on this account the vertical construction is much more suitable than the horizontal, and gives much better accessibility. The vertical design is also better from the point of view of piston wear.

Very complete enclosing, combined with forced lubrication, is in the author's opinion an absolute essential for high-speed engines, whether steam, gas or oil. With the first few oil engines to which forced lubrication was applied, a portion of the lubricating oil got drawn up into the cylinders. Improvements in construction have, however, completely overcome this, and now the oil consumption is quite as low with the forced lubrication as with the ordinary systems. For moderate speeds of revolution, ring lubricating bearings are thoroughly satisfactory, combined with centrifugal lubrication to crank pins. With such an arrangement less complete enclosing meets all requirements of cleanliness.

There is another point in regard to the multi-cylinder design of engine which should be mentioned, viz., that with this design a smaller diameter of cylinder is required for a given power than with a single-cylinder engine. With internal combustion engines this is of great importance, as, after a certain size, every enlargement of cylinder diameter brings with it increased constructional difficulties, and a greater liability to breakdown.

Turning now to the particular features of the Diesel engine itself, Carnot enunciated the conditions required for a perfect heat engine, and Diesel propounded a scheme which to a certain degree met the Carnot conditions. The original cycle has become modified to that now adopted, which may therefore be claimed to be the nearest to the Carnot cycle which present day practical limits admit.

The heat efficiency of the Diesel engine, though far from perfect, is still much better than that of any other heat engine, as is readily seen from the fuel consumption, which is 0.44 lb. of fuel oil per B.H.P. per hour. The fuel consumption is also low at partial loads, viz.: ¾ load 0.45 lb., ½ load 0.47 lb., and ¼ load 0.62 lb. per B.H.P.-hour.

These are not records, but everyday figures, and are for engines of quite moderate size. With larger engines the fuel consumption per h.p. is rather lower, but increase of size does not give anything like the improvement in fuel consumption that occurs with steam engines. This is a point to be remembered when fixing the size of engine to be adopted in a station. With steam plants the size of engine should be kept up, whilst with internal combustion engines the size within certain limits can with advantage be kept down.

Owing to the high economy at light loads it is often found distinctly advantageous to run a Diesel engine in preference to using a storage battery.

The oil generally used is residual petroleum, i. e., the residue left from petroleum after the lighter oils have been distilled off. The increased demand for petrol will certainly tend to increase the further supply of residue, whilst the opening up of new oil wells in various parts of the world is steadily increasing the oil supplies. Not only is residual petroleum used for Diesel engines, but residue shale oil and gas works tar oil are now much used.

The fuel oil used can be almost any of the fuel oils which are used for boiler firing, and a wide variety of oils can be used with no alteration of the engine, this being probably explained by the fact that a pulverizer which will sufficiently pulverize a thick, viscous oil can easily pulverize the thinner oils. The use of oil fuel carries with it certain advantages in the way of ease of handling and of cleanliness. With coal it is difficult to avoid dust, and this must be particularly objectionable in the case of steam plant where the engines are carried on the boilers, thus placing a considerable quantity of moving machinery in the neighborhood of the coal. With oil there are no ashes to cart away, and thus handling of gritty materials is entirely eliminated. Usually the oil is pumped from an outside storage tank to the small tanks near the engines.

The question may naturally be asked whether Diesel engines are suitable for long periods of continuous running. In reply to this, the following instance may be quoted:

At the Birkdale electricity works a Mirrlees-Diesel was put down a little over four years ago. The station engineer recently made a return, which showed that the engine had on the average worked 23¾ hours out of every 24 hours throughout the four years, or an average stoppage of about 1¼ hours each Sunday.

Numerous cases could be given of large savings effected, but the figures already given substantially prove this, and are, perhaps, more appropriate for a paper of this kind.

Diesel engines of the Mirrlees make have been fitted on board many warships and first-class cruisers, for driving dynamos; also some have been used for boat propulsion. It might be of interest to mention that the first Diesel engine made in Great Britain was a Mirrlees-Diesel engine, and was made over 14 years ago, consequently the present Mirrlees-Diesel engines represent quite a long experience; and the present appreciation of this engine is not a temporary boom, but is based on substantial experience.

CORRECTION.

In our issue of September 21, we published an article on German Accident Statistics, and we neglected to credit the Electric Railway Journal, from whose columns the article was taken. We take pleasure now in correcting this oversight.