er; 100 × 20 feet. The water supply will be furnished by the rivers Irwell and Mersey.

It is expected that vessels will navigate this canal at the rate of five miles per hour and that the locks can be operated in fifteen minutes each. It is estimated that cargoes will arrive at destination in eight hours less time than it takes to tranship at Liverpool and forward by rail. The rates are fixed by the act at one-half existing railway and canal rates and at one-half the dock and town dues charged at Liverpool. Notwithstanding these limitations the net income is estimated at £709,000, after deducting £104,000 for maintenance and operating expenses, on an estimated traffic of only 3,000,000 tons. This traffic is estimated at over 9,000,000 tons in seven years after the opening of the canal.

Unquestionably the days of small canals are past. This fact is strikingly illustrated in France where now an expenditure of over $270,000,000 is contemplated in order to develop more fully the possibilities of its waterway system. It needs but few instances like the Manchester ship canal project to convince the general public that water carriage is cheapest in thickly settled countries or with large traffic. In saying this we have most fully in mind some peculiar evidence set forth by a well-known engineer in recent lectures, in promoting the Tehuantepec ship railway.

Some of our readers will remember that last year Capt. James B. Eads gave evidence before the Parliamentary committee as to this same Manchester ship canal, and that the project as now set forth received his general approval. Although the ostensible purpose of his presence in England, as believed in this country, was to raise funds for his ship railway, very strangely he did not propose its use from Liverpool to Manchester, although it would seem that there could be no better or favorable application for a ship railway than in this instance.

Here we are about to see invested in a canal and accessories very nearly the amount required by the last estimates for the Tehuantepec ship railway, some four times as long and for about the same estimated traffic. It would seem as if all the chief arguments advanced for a ship railway at Tehuantepec would apply with greater force to the route from Liverpool to Manchester and show a large money saving over the canal and may we not infer from some of these same arguments (notably in the suggestion of a ship-railway as more economical than an enlarged Erie canal) that goods could be carried cheaper by the ship-railway. It would seem as if Capt. Eads, as a man of disinterested public spirit, had failed in a great duty to the English people, a failure which his countrymen will hardly attribute to excess of modesty.

If, however, we accept the Manchester ship canal scheme as a valid one, — that the canal can be navigated with reasonable speed, the locks quickly operated without danger, the cost of operating and maintenance comparatively small and water-borne transport in ample channels as cheaper than any other — what shall we say of the statements which have been made by the Tehuantepec promoters in regard to the Nicaragua canal and of their claims for the ship-railway. After we eleminate the advantages of extra distance and fictitious trade winds what have we to commend it?

We would say, only this! If the Tehuantepec promoters succeed this winter in obtaining from Congress (we believe it is not long since they disclaimed the need of it) a guarantee on bonds to go with their Mexican guarantees, an investment in Tehuantepec ship-railway securities may be a good thing even though the railway itself never becomes a commercial success. If Congress does not make a guarantee the ship-railway is not likely to be built. After all, " the De Lesseps of America " may be able sometime to join hands with the De Lesseps of France in the two colossal failures of the age.

— *American Engineer.*

ELECTRIC MOTOR ON THE NEW YORK ELEVATED RAILROAD.

Preliminary trials of a Daft electric motor, the Ben Franklin, have been in progress for some time past on a portion of the Ninth Avenue Elevated Railroad of this city, extending from 14th to 52d Streets. The dimensions of the principal parts of this moter are as follows :

Driving wheels, 48 in. diameter ; trail wheels, 36 in. diameter ; length over all, 14 ft. 6 in.; spread of wheel, 5 ft. 6 in.; diameter of armature, 25 in.; weight of armature, complete with shaft, 850 lbs. Total weight of motor, 8¾ tons. Ratio of armature revolutions to drivers, 1 : 5·5. Ratio of peripheral speeds of armature and drivers, 1 : 2·8.+ The reversing arrangements consist of four brushes attached with compound levers, and so connected that the direction of rotation must necessarily be that best suited to the proper contact and wear of the brushes. There is also abundant provision made for varying the points of contact in proportion to the load, speed, etc. The regulating switch consists of a sliding plate having metallic contacts arranged on its surface in such a manner that a number of spring contacts effect changes in the internal resistance of the machine, so as to regulate the speed without the use of idle resistances, none of which are employed ; the highest economy is therefore obtained with light as with heavy loads. The electric brakes are of the pendulum type, which were first used on the Mt. McGregor motor in 1883, and are connected with a switch conveniently arranged to vary their power by variation of internal resistances. The mechanical baker consists of a compound lever attachment operated by a screw shaft through a thoggle mounted nut.

Contact with the third rail, placed between the main rails, is effected by means of a phosphor-bronze wheel attached to a movable frame-work which can be raised and lowered as occasion requires, by means of the lever shown in the side elevation, Fig. 3.

Upon each end of the armature shaft is a small wheel, formed with corrugations on its face which fit in corresponding corrugations on the face of a larger wheel mounted at each end of the driving wheel axle. As will be seen by reference to the drawings, Figs 3 and 4, the electro-dynamic machine is pivoted at one end in resilient bearings and attached to a vertical screw shaft at the other end, so as to enable the operator to vary the frictional contact between the friction gearing at will, and also affording an easy and convenient means for raising the whole machine to effect a change of armatures.

In order to avoid damage to the gearing and other parts of the electro-dynamic machine from shock, the whole machine is maintained in about equal resilience by means of alternating laminæ of iron and India rubber placed over the bearings of the drivers in lieu of the ordinary springs, and again in the pedestals at either end of the electro-dynamic machine. The object of using these laminated cushions is to avoid the too considerable motion which would result from the use of the ordinary springs, and at the same time provide a degree of resilience which enables the machine to run over very rough roads without the least derangement of parts.

The cab contains also a voltmeter, which shows the engineer the difference of potential on the track, just as the ordinary pressure gauge now indicates the pressure in a boiler.

The rails are the ordinary 56 pound steel rail, insulated by means of the Daft insulator, which consists of an umbrella of cast iron with head so formed as to readily admit of locking the base of the rail by means of two cap screws and washers. The standard is formed of any suitable insulating material ; the standard now in use on the elevated road consists merely of baked hard wood saturated with asphaltum, which has so far been found to afford ample insulation for all practical purposes —the leakage with four miles of track now involved (two miles of double track), plus the switches, being inconsiderable. The joints are made by drilling holes in the web of the rail, and riveting strips of copper from one to the other ; this method has been found entirely satisfactory, both here and on the road now in operation in Baltimore — the resistance having thus been reduced to nearly the calculated line resistance.

No difficulty has been experienced in making the switches, though in some instances a considerable interval has to be bridged by momentum alone, due to the necessity for leaving out the third rail in order to permit the passage of the ordinary steam locomotives ; this difficulty would of course be removed in the event of the entire road being operated electrically. The maximum gradient is one of 105 feet per mile between 23d and 34th Streets. This has been surmounted with ease with fairly well loaded trains, and on several occasions an average speed of 29 miles an hour has been attained.

The track is vitalized by dynamos (Fig. 1) situated at the main station on 15th Street, about 200 yards from the track, it having been considered desirable to place the vitalizing machines as near one end of the track as possible, so as to show the influence of distance in lowering the potential.

The effect of these two miles is, therefore, rendered equal to four miles where the station is centrally placed, and the loss of energy at the extreme end is barely observable. The vitalizing