tive a possibility for passenger service, as it enables a motor of reasonable size to start a passenger train without the use of gearing to furnish the necessary power. Direct-current motors can certainly be constructed to handle passenger trains at high speed if desired, so that in this respect the advantage is greatly in its favor. The direct-current motor has obtained its reputation for ruggedness from its capacity to withstand heavy loading without injury, and this quality is of the greatest importance in railroad work.

Conclusion.—If in place of discussing the relative advantage of single-phase and direct-current traction, the start is made from the direct-current system with its simple and strong electrical apparatus developed after years of experience by simply an increase of voltage, and assuming that this increase does not lead to unforeseen difficulties, the question becomes, What is gained by the use of single-phase current?

It does not save in cost of installation or operation.

Its application is not more flexible.

It introduces a locomotive that is more complicated, in which the motor is necessarily far more expensive and elaborately constructed, and which weighs considerably more than one for direct current.

It reduces cost of sub-station attendance at the expense of locomotive maintenance, and consequent reduction in reliability.

The general advantages to be gained by electrification are too well known to bear repetition, but it might be mentioned from the data now becoming available from those installations now in operation that results obtained confirm estimates very closely. The engineers of the Chicago, Milwaukee and St. Paul Ry. estimate that at least a saving of 25 per cent. will be made in operating costs on the 440-mile division now to be electrified in the Western States, and part of this saving is confirmed by the showing already on the Butte, Anaconda and Pacific Ry., where power cost has been found to be but one-third of the previous coal cost. The decision to electrify the suburban lines of the Pennsylvania Ry. about Philadelphia was made to relieve the existing congestion by increasing the capacity of terminal 15 to 20 per cent., or sufficient to relieve the situation for the next five or six years and at less expense than any other method.

PROGRESS OF NEW GANGES BRIDGE.

The largest steel bridge ever made for shipment from England is rapidly nearing completion. Six spans are being constructed by an engineering firm at West Bromwich, and the remaining nine at Darlington. This bridge will carry the Indian State Railway over the Ganges at a point about 120 miles above Calcutta, and it will be just a mile in length.

Steel to the quantity of 30,000 tons (all rolled in England) is being employed in its construction, 20,000 tons for the superstructure, and 10,000 tons for the piers. Each of the sections has a span of 345 feet, a height of 49 feet, and a weight of 1,400 tons. To hold the sections in position steel caissons were sunk 150 feet below the bed of the river. The shipment of these 15 spans to India will entail an outlay of some $300,000, and the total cost of the bridge will be $6,250,000. The erection of the bridge is under the direction of the Public Works Department of India. The first span shipped from West Bromwich arrived at Calcutta on May 26 last, and it was erected in three weeks' time before the rainy season, with its river floods, sets in. It is hoped that this bridge will be open to traffic this year.

A gigantic floating dock, said to be the largest in the world, is being constructed at Odessa. It will be capable of carrying a vessel of 40,000 tons, and will cost $2,000,000.

SOME PRACTICAL POINTS ON MODERN ROAD-WORK.*

By W. H. Maxwell, A.M.I.C.E.

IN the planning of new through routes, directness of line is usually an important feature to be considered, from an engineering and utilitarian point of view, but leads to monotony in the use of the road, and from an æsthetic standpoint compares unfavorably with winding roads.

As a general rule, it will be more advantageous to carry a new through route past the outskirts of a town, and connect up with some good branch road to the urban area, rather than attempt to carry the new main thoroughfare through the heart of a populated centre, as the difficulties and costs of widening existing narrow roads through built-up areas are necessarily excessive, owing to the property and business interests disturbed. Very wide roads are not favored by shopkeepers, as they are not conducive to good trade—the bulk of pedestrian traffic usually keeping to one side of such a road.

Curves on a new main road should, of course, be as easy as circumstances will permit, but a radius of 100 ft. should be the minimum where fast through traffic is to be accommodated. On this curve, a person travelling along the centre line of a clear 40-ft. roadway could see approaching traffic within the limits of the road-width about 120 ft. ahead. Under similar conditions, with a 150-ft. curve, a distance of about 150 ft. ahead could be seen. On rural roads, traffic invariably uses the centre of the road by preference, and modern high speeds render an ample, unobstructed view essential.

The easing of curves invariably quickens the speed and reduces that degree of commendable caution in drivers which formerly existed. On a sharp curve the motorist is bound to materially reduce his speed or perish.

Curves should in all cases be freed from side sight-blocking obstructions, and for increased safety to fast traffic, the road surface on the outside curve should be given a suitable degree of super-elevation.

On a part of the Holyhead road on the north of the city of Coventry, Telford adopted a ruling or maximum longitudinal gradient of 1 in 35. Such a moderate gradient will present no impediment to fast driving, either up-hill or down, and in one on which tar-macadam and all modern methods of surfacing may be used with safety, but in hilly country will be difficult to maintain, except by much contouring and consequent increased length of route, or by heavy cutting and bridge work.

Dead-level roads are to be avoided. If the longitudinal inclination is less than about 1 in 100, the surface water will be difficult to drain away and more cross camber must be provided. With a longitudinal gradient of 1 in 50, or sharper, the camber may be flattened considerably, as the needful surface drainage is obtained longitudinally. This flattening of cross-section should not, however, be carried too far, otherwise watercourses will speedily form down the centre of the roadway on steep gradients.

Suitable cambers for different surfaces under ordinary conditions are: granite macadam, 1 in 25; tar-macadam, 1 in 30 or 1 in 40 on incline; creosoted deal paving, 1 in 36; hard wood and granite, 1 in 45; and asphalt paving,

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