Entered at Stationers' Hall.

The British Westinghouse Electric & Mfg. Co., Ltd.

LONDON AND MANCHESTER.

Circular B 1080. May, 1904.

THE No. 200 TRAMWAY MOTOR.

The Westinghouse No. 200 Tramway Motor meets the demand for a motor of thoroughly sound construction and medium power, for service on cars of moderate speed and seating capacity. It embodies all the advantages

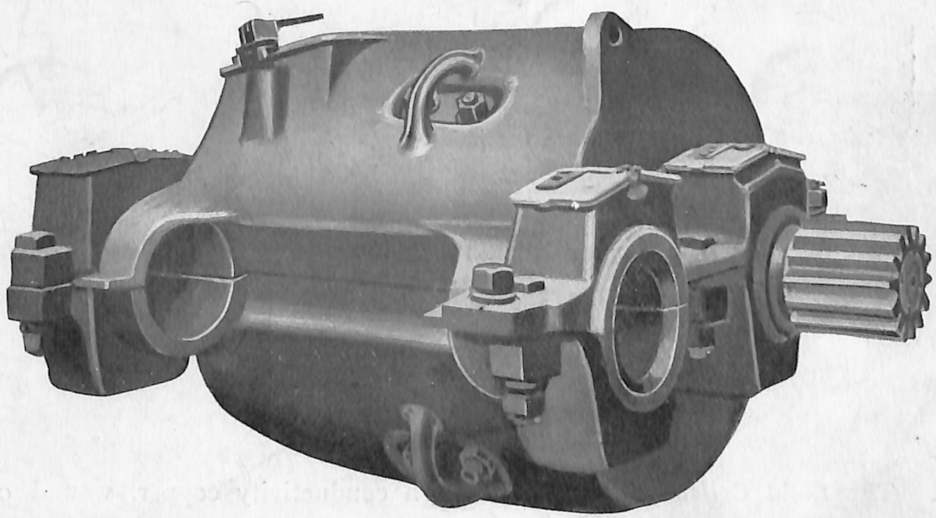


FIG. 1.—NO. 200 MOTOR FROM AXLE END.

of the most modern practice, and is the outcome of an unequalled experience in electric traction. The salient points of the No. 200 Motor are outlined in the following pages.

Constructional Details.

The Field.—The magnetic yoke of the field magnets is formed by a cast steel casing, which further serves to protect the vital parts from mechanical injury. The four pole-pieces, built up of steel laminations, are each fastened to the yoke by two bolts, and rest on machined surfaces inside the case, ensuring an efficient magnetic circuit. The nuts for the pole-piece bolts are sunk in recesses in the casing.

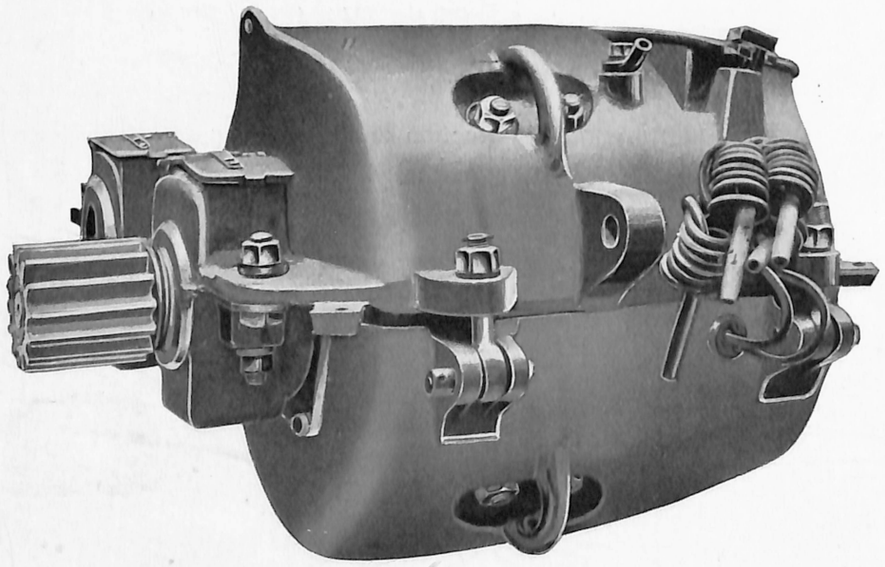


Fig. 2.—No. 200 Tramway Motor, Complete.

The Field Coils.—These are of high conductivity copper, wound on moulds, and thoroughly insulated with fullerboard and mica, taped and varnished. The external connections are made by long flexible conductors passing through the case in insulated bushes, which prevent chafing of the insulation. A terminal sweated on with a special clip contact provides for connection to the cable leads. This method dispenses entirely with the making of connections inside the motor casing.

Armature.—The armature is of the drum wound type with slotted core. The core and windings are so spaced as to afford ample ventilation when the armature is revolving. A constant circulation of air is kept up, and the temperature of the whole material of the motor is thereby equalised.

Armature Coils.—These coils are of copper strap, formed to exact shape and size on metal moulds, and then insulated and grouped in sets of three. Each set is encased in a stout insulating cell of fullerboard and mica, and the whole is then taped and varnished. The complete coils are so shaped as to slip easily into the slots, without using undue force. Thus the insulation remains uninjured during winding, and can therefore be guaranteed as of the highest quality and absolutely uniform. Three steel wire bands serve to

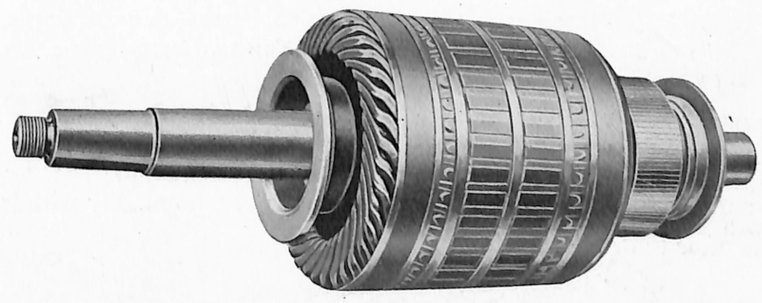


Fig. 3.—Armature, No. 200 Tramway Motor.

retain the coils in their places in the slots. These band wires are wound in grooves in the core, of such depth that the wires do not project above the surface. The maximum clearance is thus available to allow for eccentricity of the armature in the field caused by wear of the bearings. Moreover, should undue wear allow the core to touch the pole faces in revolving, the band wires, being sunk in grooves, are protected, and will not break and allow the armature coils to be thrown out. The ends of the coils, clear of the field poles, are further secured by two bands of steel wire, which prevent coil spreading in case an excessive speed should be attained.

The arrangement of the winding on the two-circuit principle secures a

perfect balance of armature circuits, even when the armature is considerably out of centre. This system of connection is characteristic of all Westinghouse tramway and railway motors, and is largely responsible for their sparkless running under all conditions of load. The armature complete weighs 396 lbs.

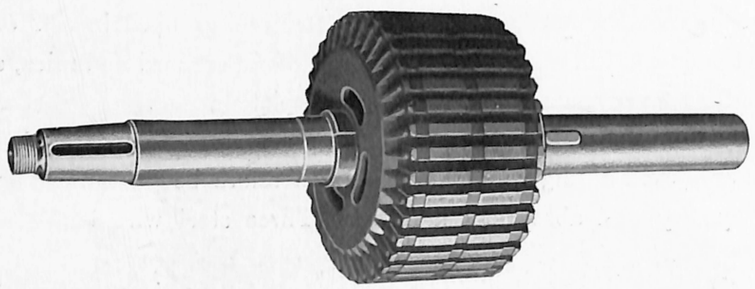


FIG. 4.—ARMATURE CORE, NO. 200 TRAMWAY MOTOR.

Brush Holders.—These are securely bolted to the upper half of the field casing, and thoroughly insulated from it. They can be readily withdrawn at any time after the removal of one nut.

Commutator.—The commutator is built of 111 segments of hard drawn copper insulated from each other by mica sheets. The large diameter gives ample cooling surface, while the generous depth of the segments permits of a wide margin for wear. Further, the great number of segments lowers the potential drop between adjacent bars, thus favouring sparkless commutation.

Hand-Holes, Inspection, &c.—A large rectangular opening in the upper half of the motor casing provides access to the commutator and brushes. This aperture is closed with an iron lid secured by two bolts; a close fit being ensured by a thick felt insertion. Just beneath the commutator a hand-hole is also provided, which allows access to the lower casing, and permits the removal of anything which may have dropped into the case. Inspection of the armature clearance is allowed for by the provision of two small holes, one at each end of the field yoke. The casing being in halves,

B1080

The No. 200 Tramway Motor.

hinged together along the side remote from the car axle, the armature or any part can be examined by dropping the lower half of the casing, thus completely opening up the motor.

Bearings.—The armature bearings are placed directly in the motor casing, and a long bearing surface is secured without unduly increasing the width of the motor by a special design of wiper ring, which projects well inside the case. A special method of lubrication is adopted, allowing the use of

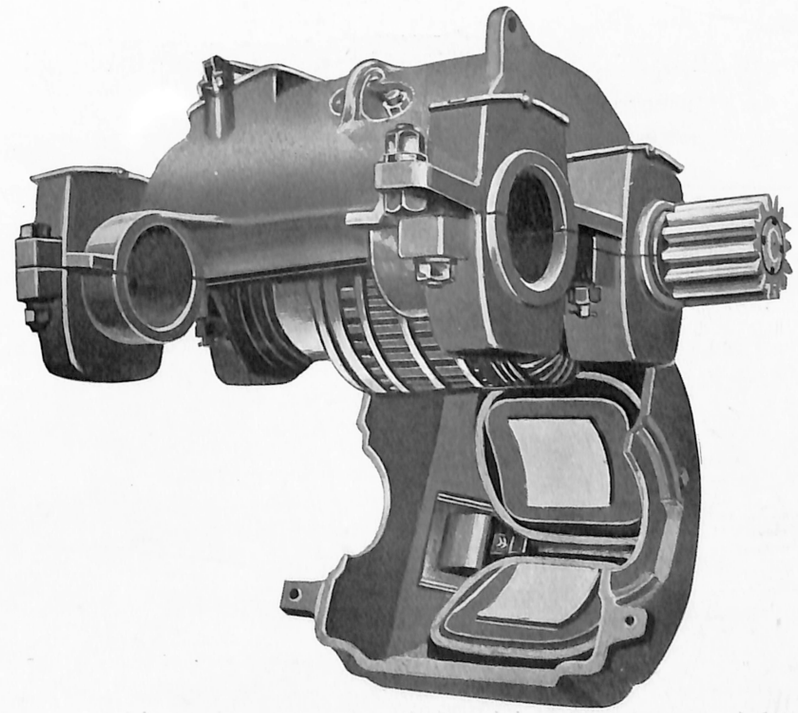


FIG. 5.—NO. 200 TRAMWAY MOTOR, OPEN.

either oil or grease, or both, at will. The large size of the wiper rings entirely prevents the grease finding its way along the shaft on to the armature and commutator. An ample bearing surface has been provided for, the dimensions being as follows:—

Commutator end, 6in. long by 3in. in diameter.
Pinion end, 8in. ,, 3in. ,,

Reduction Gear and Gear Case.—The gear case is divided horizontally and bolted securely to the motor case so that the lower half can be removed without disturbing the upper half. The gears are of cast steel, and can be lubricated through a small opening in the upper half covered by a spring lid. The pinion is of forged steel, taper bored to fit the armature shaft, to which it is also keyed. The pinion and gear have a 5in. face, and the standard gear ratio used with the No. 200 Motor consist of a 14-tooth pinion and a 68-tooth gear.

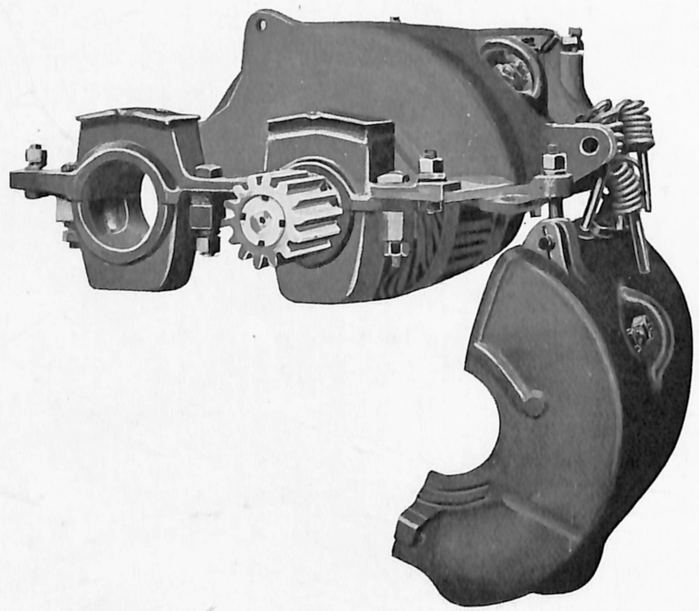


FIG. 6.—NO. 200 TRAMWAY MOTOR, OPEN.

Weight.—The total weight of the motor, complete with gear and gear case, is 2,080 lbs.

Principal Dimensions:—

COMMUTATOR.—Length $2\frac{3}{4}$in.; diameter $8\frac{1}{2}$in. No. of segments 111.
ARMATURE DIAMETER.—13in.
BEARINGS.—Pinion End 8in. x 3in. Commutator End 6in. x 3in.
AXLE BEARINGS.—Adapted to any axle from $3\frac{1}{4}$in. to $4\frac{1}{2}$in. diameter. We recommend 4in. diameter. Length 8in.

For further dimensions see drawings on page 11.

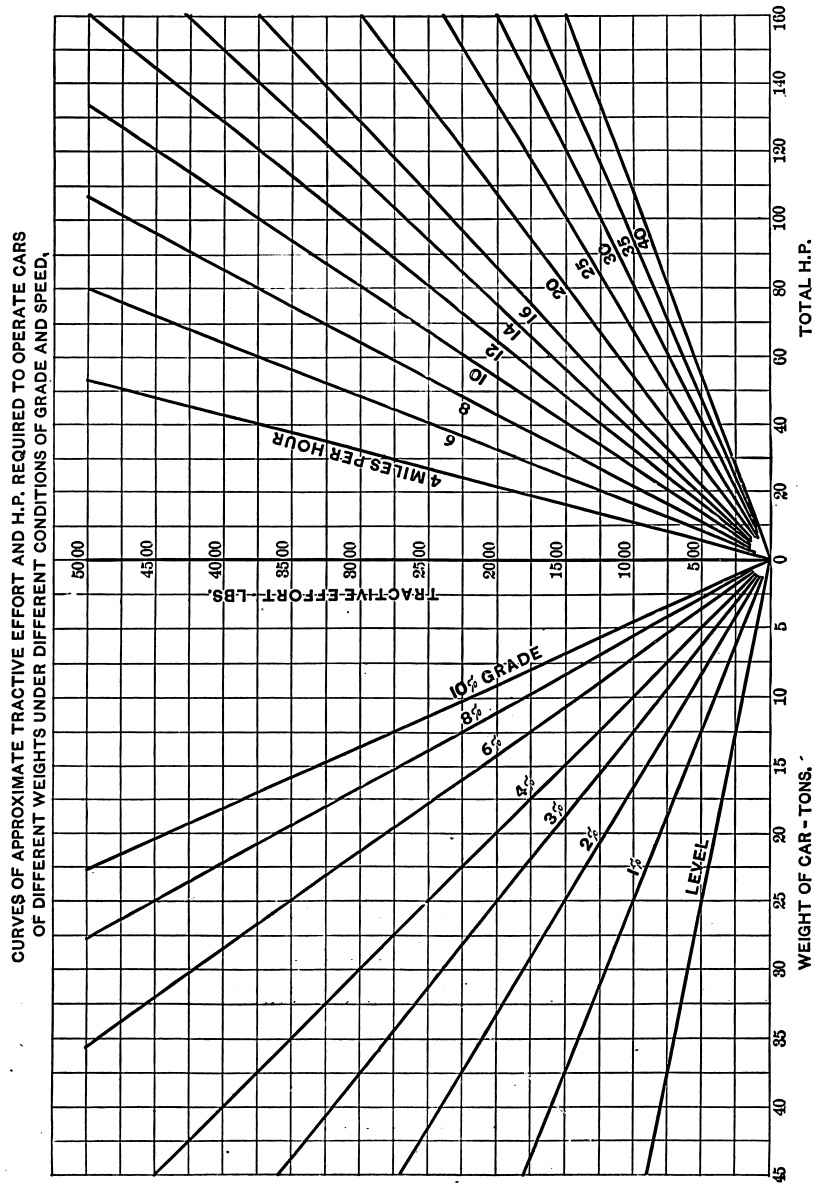
Rating.—On page 9 is shown an approximate performance curve for the No. 200 Motor at 500 volts. Should a motor of power slightly different to that indicated be required, the capacity can be varied to meet the requirements.

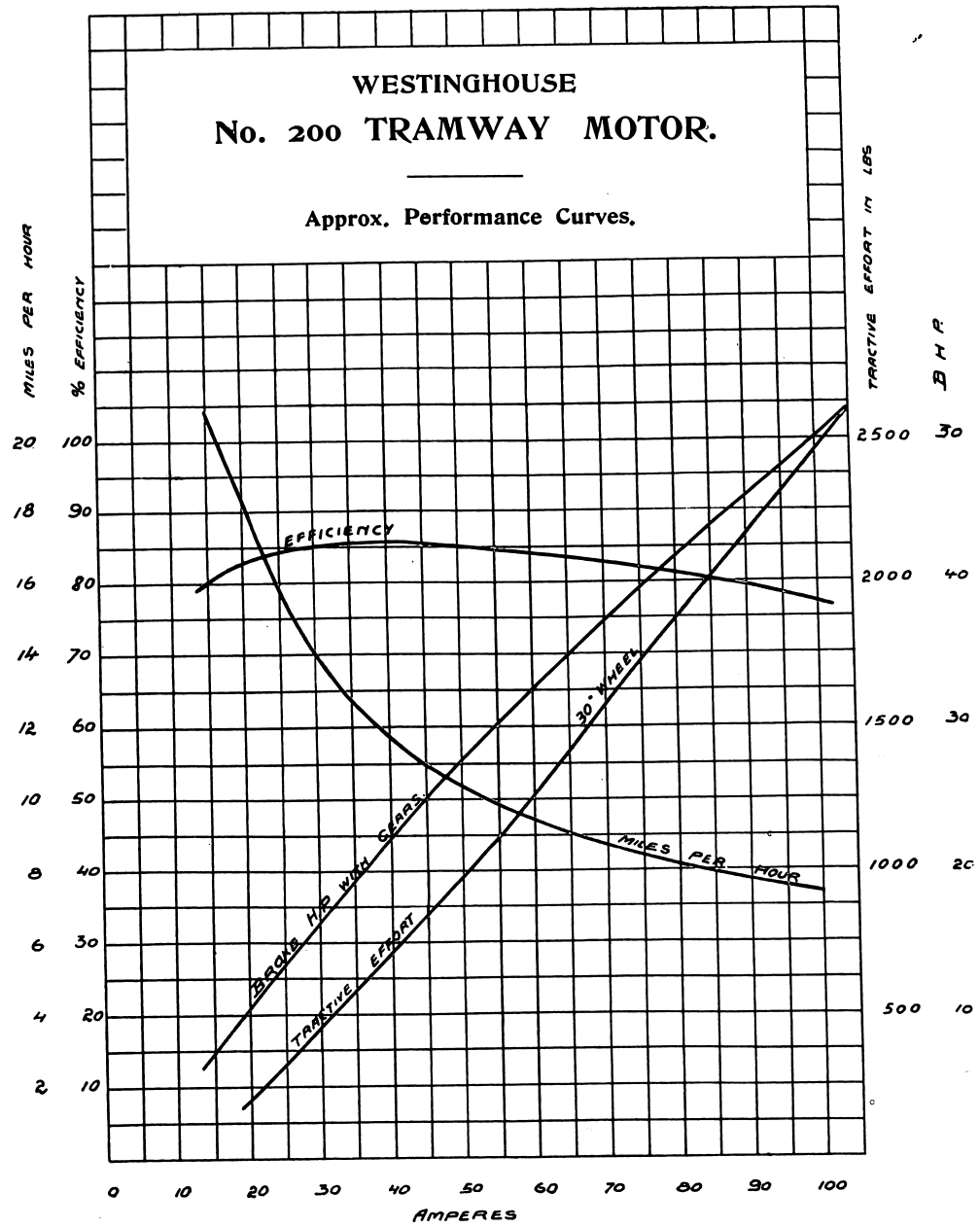
Power Required in Service—Use of Curves.—The tractive effort required to operate a car of moderate size at medium speeds under reasonable conditions of track and road bed may generally be assumed as about 20 lbs. per ton on a level, with 20 lbs. per ton additional for each per cent. of grade. The tractive effort required in any given case is practically the same for all speeds within reasonable limits. The actual horse power exerted, however, will, of course, increase as the speed increases. It may be found at once by the formula:

$$\text{Horse power} = \frac{\text{Miles per hour} \times \text{tractive effort}}{375}$$

The lines on page 8 have been laid out on the above basis, and from them may be found the tractive effort required to propel a car of any given weight up various grades as well as the actual horse power exerted by the motors when the car is running under these conditions at any particular speed. By the proper use of these curves in combination with the motor curves on page 9, the approximate performance of a car equipped with No. 200 motors may be determined.

Thus the procedure would in general be as follows: Find from the curve on page 8 the tractive effort required for the car under the existing conditions. From the number of motors the tractive effort per motor then follows at once. By reference to the performance curve on page 9, the current necessary to produce this tractive effort may now be ascertained as well as the speed at this load. It must be borne in mind that the above refers only to the motor when running. In selecting an equipment for a given service, due attention must be paid to the heavy currents required for starting, as these, in many cases, will be found to be a most important element.


CURVES OF APPROXIMATE TRACTIVE EFFORT AND H.P. REQUIRED TO OPERATE CARS OF DIFFERENT WEIGHTS UNDER DIFFERENT CONDITIONS OF GRADE AND SPEED.
TRACTIVE EFFORT—LBS.
TOTAL H.P.
WEIGHT OF CAR - TONS.
4 MILES PER HOUR
6
8
10
12
14
16
20
25
30
35
40
10% GRADE
8%
6%
4%
3%
2%
1%
LEVEL


WESTINGHOUSE
No. 200 TRAMWAY MOTOR.
Approx. Performance Curves.
MILES PER HOUR
% EFFICIENCY
TRACTIVE EFFORT IN LBS
B H P
EFFICIENCY
30" WHEEL
BRAKE H.P. WITH GEARS
TRACTIVE EFFORT
MILES PER HOUR
AMPERES

Suspension.

The nose method of suspension is used with the Westinghouse No. 200 Motors, as shown in the outline drawings on page 11. The chief advantages of this form of suspension are :—

Greater Strength and Simplicity.

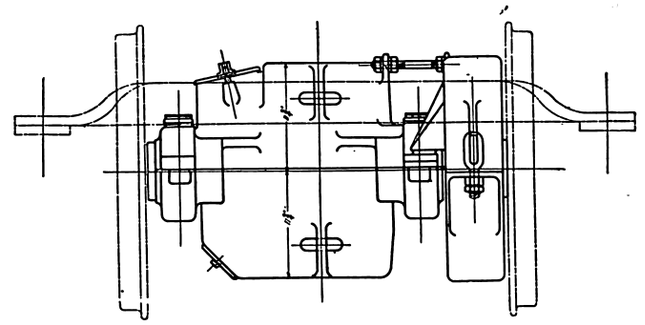
Ease with which each Motor can be Removed.—It is only necessary to remove one bolt to free the motor from the truck, after taking off the axle bearing caps and disconnecting the leads.

Adaptability.—The motor can be easily adapted to any truck, as there are only two points of attachment to the frame required.

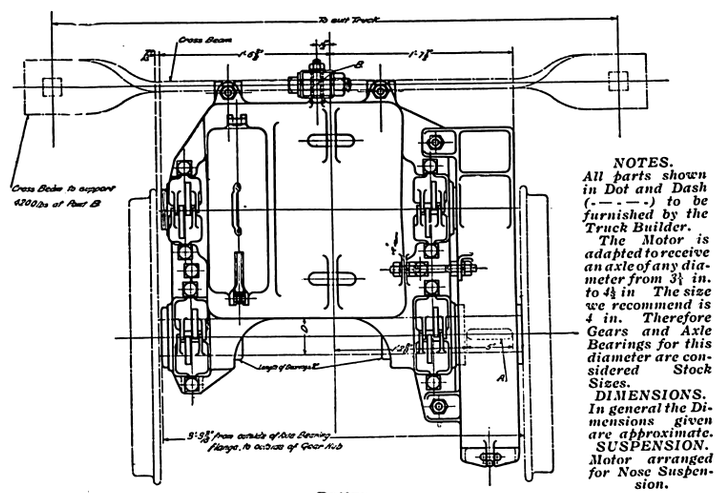
Flexibility.—All jar to the motors and car is entirely prevented, as both upward and downward motions of the motor are taken up by springs.

B1080

The No. 200 Tramway Motor.

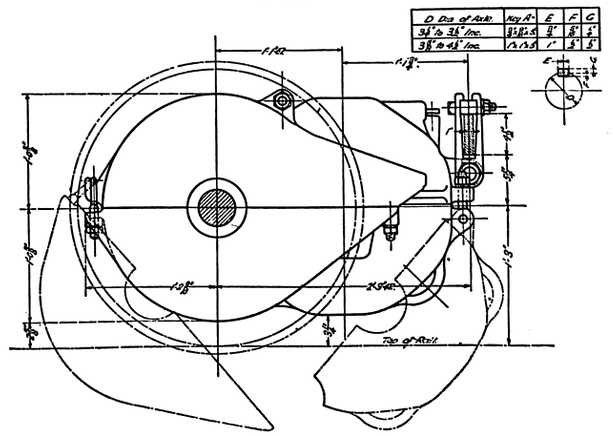


VIEW FROM AXLE SIDE



TOP VIEW

O. Dia of Axle	Key A	E	F	G
3 1/2 to 3 3/4 Inc.	7/8 x 5	11"	8"	1'
3 7/8 to 4 1/2 Inc.	1 x 5	1'	8"	1'



VIEW FROM PINION END

7446

The British Westinghouse Electric & Mfg. Co., Ltd.

This Company operates in the British Empire with the exception of Canada; and also in Norway and Sweden.

Head Offices:

LONDON: Westinghouse Building, Norfolk Street, Strand, W.C.

Works:

MANCHESTER: Trafford Park.

Branch Offices:

MANCHESTER	Haworths Buildings, 5, Cross Street.
GLASGOW	Castle Chambers, 65, Renfield Street.
NEWCASTLE-ON-TYNE	Collingwood Buildings, Collingwood Street.
CARDIFF	Phoenix Buildings, Mount Stuart Square, Bute Docks.
SHEFFIELD	Market Place Buildings.
BIRMINGHAM	Central House, New Street.

Colonial Agents:

For Australia, New Zealand and Tasmania:—

SYDNEY	NOYES BROS., 109, Pitt Street.
MELBOURNE	NOYES BROS., 15 & 17, Queen Street.
DUNEDIN	NOYES BROS., 1, Crawford Street.

Selling Agents in New Zealand:—

WELLINGTON, CHRISTCHURCH, DUNEDIN	TURNBULL & JONES, Ld.

For India, Upper and Lower Burmah and Island of Ceylon:—

CALCUTTA	JESSOP & CO., Ld., 93, Clive Street.

For South Africa:—

JOHANNESBURG	C. C. GEORGE & CO., Box 1934.

Foreign Companies:

WESTINGHOUSE ELECTRIC & MFG. CO.
PITTSBURG, PA., U.S.A.
for North America, South America (except British and French Possessions), Cuba, Puerto Rico, Hawaiian Islands, Philippine Islands, China (except British Possessions and Dependencies) and Japan.

CANADIAN WESTINGHOUSE CO., LIMITED,
HAMILTON, ONT.,
for Canada.

SOCIÉTÉ ANONYME WESTINGHOUSE,
LE HAVRE, 2, Boulevard Sadi Carnot,
for France, Belgium, Spain, Portugal, Holland, Switzerland, Italy, their Colonies and Countries under their protectorate.

WESTINGHOUSE COMPANY, LIMITED, (Electric Department),
ST. PETERSBURG. Head Office: Nevsky Prospect No. 11,
for the Russian Empire in Europe and Asia.

WESTINGHOUSE ELECTRICITÄTS-ACTIENGESELLSCHAFT,
BERLIN, W., 19, Jägerstrasse,
for Germany, Austria-Hungary (including Bosnia and Herzegovina), the Balkan States, Greece, Turkey in Europe and Turkey in Asia.