CANADIAN

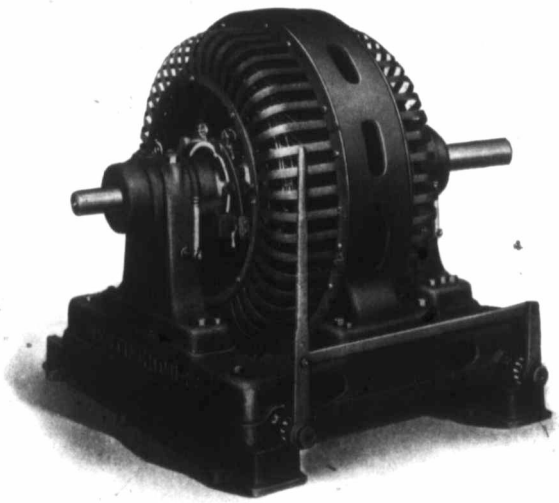
WESTINGHOUSE COMPANY, LTD.

HAMILTON, ONT.

August, 1910 *Railway and Lighting Department Circular No. 1161*

Westinghouse Belt-Driven, Alternating Current Generators—Type G

30 to 200 Kva. 60 Cycles 240 to 2400 Volts



Type G Generator, with Pedestal Bearing

These Alternators furnish a line of markedly successful machines especially designed for the needs of comparatively small central stations and industrial plants.

Simplicity of electrical and mechanical construction, ruggedness, moderate first cost, consistent performance and economy in operation and maintenance are the proven characteristics of these generators. Long and wide experience and thorough acquaintance with the problems and difficulties

encountered in actual operation were utilized in the design of this type to furnish what practical operators of small power plants need to meet industrial conditions.

The test of service has proven that the design and construction of Westinghouse Type G generators have produced a thoroughly reliable alternator that can be depended upon to successfully carry modern commercial loads of low power factor.

POWER FACTOR CONDITIONS

A fact not always appreciated is that the demands upon a generator increase as the power factor is decreased. It must also be borne in mind that the power factor is determined solely by the load and not by the generator.

The existence of loads of low power factor involves necessity for particular care on the part of a purchaser in the selection of both generators and prime movers. It should be remembered that the size of a generator is determined by the current and voltage required, expressed in **kilovoltamperes,** while the size of the prime mover is determined by the energy required, expressed in **kilowatts.** Both the kilovoltampere capacity of the generator and the kilowatts of the load, with the power factor, should be known in order that the generator and the engine may have the proper relative capacities.

The kilowatt capacity is equal to the kilovoltampere capacity at 100 per cent power factor only, a condition that practically never exists with commercial loads.

At lower power factors the kilowatt capacity is less than the kilovoltampere capacity in the ratio of the power factor. It is necessary to know the average power factor of the load to be carried by the generator in order to insure its successful operation, since, as already stated, the operating requirements become much more severe as the power factor is reduced.

Recent developments in alternating-current power practice require generators capable of operating under loads of low power factor.

For mutual advantage, both purchaser and manufacturer should carefully consider actual operating conditions upon the basis of generator capacity in kva. and load power factor.

Type G generators are designed with this particular requirement in view. The guarantees accompanying them are specific and ample.

PHASE WINDINGS

Standard Type G generators are furnished with either two-phase or three-phase windings.

For single-phase service three-phase windings will be supplied, the load being carried by any two leads of the three-phase winding.

Type G three-phase generators are guaranteed to operate single-phase at approximately 70 per cent of their three-phase ratings, as given in the following table:—

STANDARD RATINGS

The standard ratings and speeds of G generators are:—

Normal Three-Phase Rating	Single-Phase Rating	Speed in R.P.M.
30 kva.	20 kva.	1200
50 kva.	35 kva.	1200
75 kva.	50 kva.	900
100 kva.	70 kva.	900
150 kva.	100 kva.	900
150 kva.	100 kva.	600
200 kva.	140 kva.	600

The standard voltages for all sizes are 240, 480, 600, 1200 and 2400 volts.

GENERAL DESCRIPTION

These machines are built with particular provision for belt drive, but can be readily adapted for direct connection to either water wheels or other drive.

All belted machines are firmly supported on cast iron bedplates.

Fig. 2—Bracket Bearing Type G Generator, Main Pulley Side

The Westinghouse standard of excellence in material and construction has been so thoroughly maintained that these machines are giving gratifying service results everywhere.

30, 50 and 75 Kva. machines are provided with bracket bearing housings. This construction requires a minimum of floor space and is sufficiently rigid for the smaller sizes.

100, 150 and 200 Kva. sizes are constructed with substantial pedestal bearings directly supported upon the bedplate.

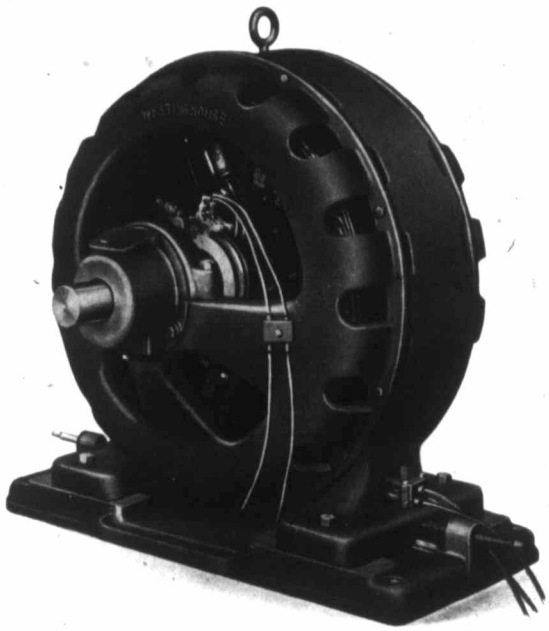


Fig. 3—Bracket Bearing Type G Generator, Collector Side

The best of machines of capacity above 75 kva., no matter how well designed and built, are occasionally subject to objectionable vibration due to extraneous sources such as faulty foundations, poor belt splicing and other causes.

The pedestal type of machine is unquestionably more rigid and less subject to being affected by such objectionable conditions, and the Westinghouse Company is convinced by experience that the somewhat greater floor space and cost required for this design is fully warranted in the larger sizes

Excitation All Type G generator shafts are extended on the collector end to carry an exciter pulley.

The pedestal type units are so built that direct connected exciters may be easily attached if desired.

For the smaller sizes, with bracket bearings, belted exciters are recommended in all cases. Experience has proven that direct connected exciters on bracket bearing machines of this character are usually unsatisfactory.

With the ample ventilating spaces between field coils and the winding design characteristic of Type G alternators, a continuous exciting current

Fig. 4—Stator Core, Type G Generator

corresponding to 125 volts on the collector rings may be carried without injurious heating in any part of the field.

Ventilation Particular attention has been paid in Type G design to thorough ventilation. The air passages of frame, armature core and end projections of armature windings are elsewhere referred to. The type of rotor construction not only affords free air circulation between the field coils, but enables the rotor to act as an effective ventilator for the stationary part.

THE STATOR

The Yokes or Armature Frames of cast iron are of rugged construction and so proportioned as to combine ample strength and rigidity with economy

of material and thorough ventilation. Interior transverse ribs at once strengthen the frame and provide ventilated support for the core laminations.

The Armature Core is built up of punched laminations of thoroughly annealed and japanned sheet steel firmly secured to transverse ribs on the interior of the frame. In the 150 and 200 kva. sizes the laminations are dovetailed to the ribs; and in all sizes they are assembled under heavy pressure and held in place by securely keyed endplates. All steel used in Type G armatures is carefully tested for magnetic qualities, all but the best being rejected.

The Armature Slots are open, permitting easy winding by use of form wound coils, which are held in place by hard fibre wedges.

Malleable Iron Finger Plates are used in all machines of 75 kva. and above at each end of the armature core, for supporting the teeth of the laminations, and the laminations are secured under heavy pressure and firmly held in place by steel endplates keyed to the frame.

The Armature Coils are completely formed and insulated before being placed in the core and are interchangeable.

In all sizes the coil ends are so formed that an air space is left between them, permitting free circulation of air.

The coils are securely braced against vibration or shock. In the larger sizes their ends are secured to an insulated steel supporting ring.

The connections are simple and readily accessible, the simplicity of the winding and interchangeable character of the coils being an appreciated advantage of these generators.

Brush Holders. There are two brushes per ring, rendering it possible, if desired, to remove brushes during operation.

The brush holders are substantially constructed and of the sliding shunt type. Carbon brushes are exclusively used.

The Bearings of all Type G generators are self-oiling and are built of cast iron shells of ample size, split to allow them to be readily opened or removed

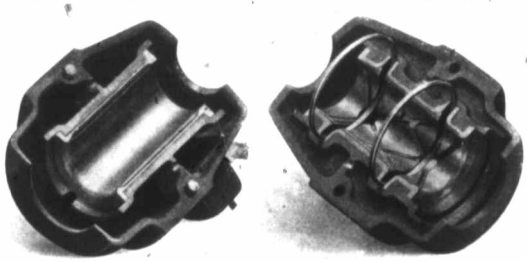


Fig. 5—Bearing Housing Open, Showing Bearings and Oil Rings, Bracket Construction

and lined with grooved babbitt. They are fitted with lubricating rings carrying the oil from a well in the bottom of the shell. The shaft is provided with

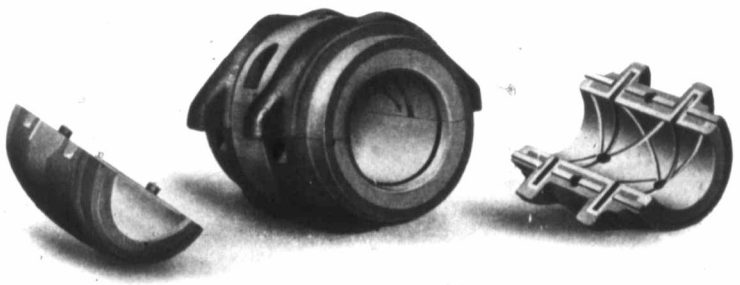


Fig. 6 Rear Bearing and Halves of Collector Side Bearing Pedestal Construction

effective oil throwers and catchers which prevent oil from working along the shaft to the generator and the bearings are guaranteed to run without leaking. Tightly covered openings in the upper shell afford facilities for observation of the condition of the rings and lubrication at any time.

The bearing seat is cylindrical, but narrow enough to adjust itself to the alignment of the shaft rendering these bearings practically "self-aligning."

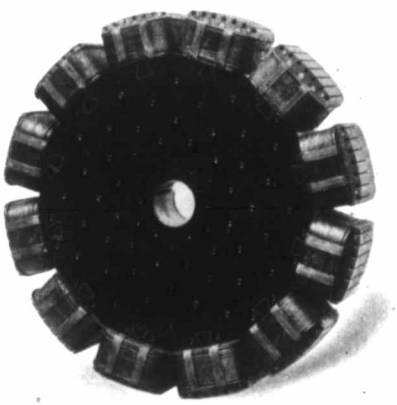


Fig. 7—Rotor of Type G Generator 600 R.P.M.

THE ROTOR

The central portion of the revolving part is a laminated spider, built up of thin steel plates assembled upon a mandrel and firmly riveted together under hydraulic power.

The core is accurately bored and the spider is pressed upon the shaft in the same manner as a cast steel spider.

The Poles are also built up of steel laminations of the same thickness as those of the spider and riveted together. Each pole is dovetailed into the spider and retained by two taper steel keys.

The pole pieces are thereby securely held in place during operation; but poles and coils may be easily taken out when desired, by removing the

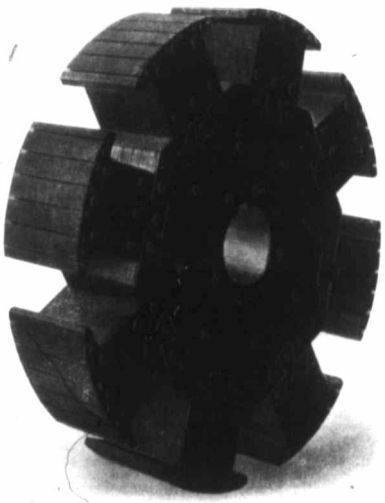


Fig. 8—Rotor Core with Pole Pieces Assembled on Spider

appropriate cage windings and knocking out the steel keys. An advantage of this construction that will appeal to discriminating buyers is the absolute uniformity of quality of material throughout the rotor.

The Field Coils of Type G generators are wound with wire, the coils being designed with special care to provide ample opportunity for heat dissipation.

Cage Damper Winding. Type G pole pieces, with the exception of those for 30 and 50 kva. sizes, are provided with partially closed slots in the pole face for the copper bars of a "squirrel cage" winding. This winding acts as an effective damper to prevent hunting between machines operated in parallel.

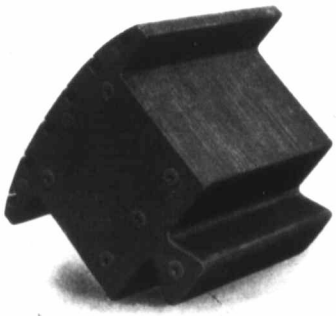


Fig. 9—Pole Piece Showing Dovetail Projection

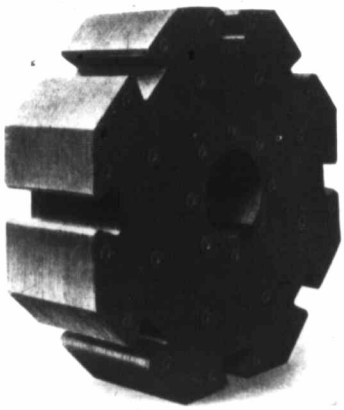


Fig. 10 Laminated Steel Rotor Spider of Type G Generator

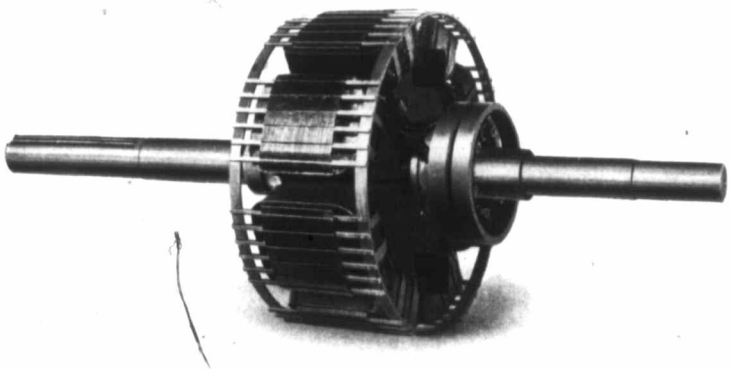


Fig. 11—Rotor With Squirrel Cage Winding 75 Kva. and Larger Belted Generators

The cage damper winding is also effective in single phase operation in reducing eddy currents and consequent heating in pole faces.

The Collector Rings of the smaller sizes, 30 and 50 kva., are of a special brass, shrunk over mica insulation on an iron bushing which is pressed on to the shaft.

All sizes from 75 kva. upward have cast iron collector rings insulated from the bushing by V shaped mica.

BRACKET BEARING CONSTRUCTION

The distinctive features of the bracket bearing machines are in the following particulars:

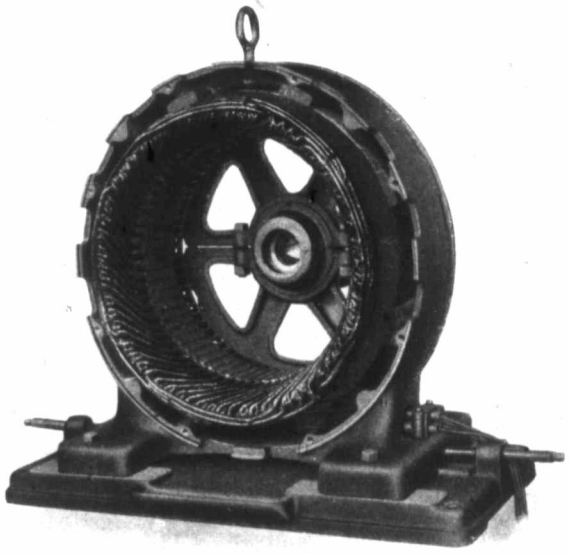


Fig. 12—Frame, Bedplate and Armature Winding
Bracket Bearing Generator

The Frames of 30, 50 and 75 kva. machines are of cylindrical form with substantial supporting feet, the whole being mounted on a bedplate of cast iron, both construction and mounting contributing to steady running.

Cast Iron Bearing Brackets of ventilating type are firmly bolted to the frame. The front or collector end brackets are cast in one piece with a continuous ring. The bearing housing is carried on three arms in the lower

semi-circle and secured in place by a semi-circular casting truly bolted to the bracket at each end.

The rear or pulley-end brackets are split horizontally and the bearing housing clamped between the halves of the bracket.

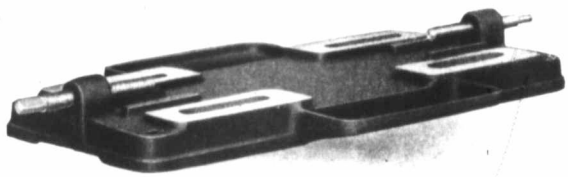


Fig. 13—Bedplate for Bracket Bearing Generator

This construction permits removal of one half of the bracket for inspection of the generator or removal of the bearing.

In assembling the generator each half of the bearing housing at the pulley end is permanently attached to its part of the bearing bracket, and the two halves are brought and held in perfect alignment by dowel pins.

The design of the front bearing bracket provides a large opening for access

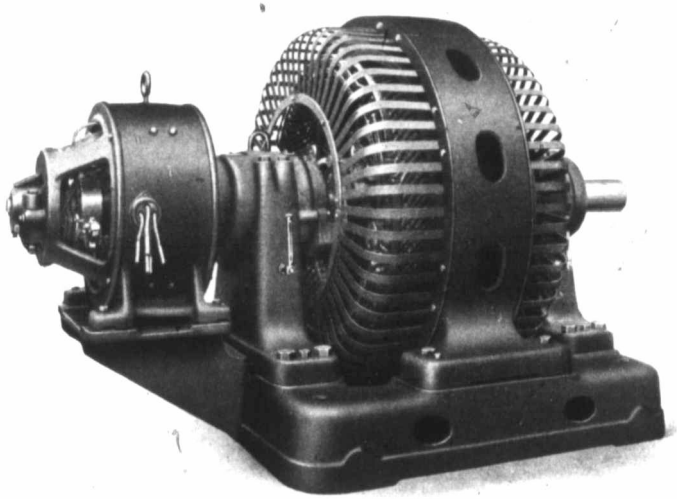


Fig. 14—Pedestal Bearing Generator With Direct Connected Exciter
200 Kva., 600 R.P.M.

to the collectors and brush holders. The field leads running to the brush holders are conveniently cleated to the outside of the bracket.

Bedplates of Cast Iron provided for bracket bearing frames have slots at the corners, under the frame feet, for the holding-down bolts, permitting longitudinal motion through several inches for belt adjustment.

Belt Tension Adjustment is provided for by screw bolts, one working through a lug at each end of the bed plate. By means of these screws the generator may be moved in either direction desired, within the limits of the bed plate slots.

Fig. 15—Armature Winding, Pedestal Bearing Type G Generator

PEDESTAL BEARING CONSTRUCTION

The pedestal bearing machines differ from those of smaller size in the following details:

For convenience and economy in manufacture and handling, the larger sizes of Type G generators have frames, bearing pedestals and bedplates of separate castings.

The Frames of pedestal bearing machines are of the box girder section now recognized as Westinghouse standard for all alternator frames other than those of bracket bearing construction. This frame design gives strength and rigidity and allows ample ventilation.

The End Bells for protecting the armature windings of the larger generators are of sheet steel segments built up into a rigid circle, and are practically indestructible.

The Belt Tension Gear of the pedestal bearing construction is simple, positive and easily operated.

The Bedplate, to which the generator is firmly secured, is mounted upon two slide rails, each fitted with a ratchet-operated tension screw. The screws are entirely within the slide rails. They are stationary longitudinally and work in nuts attached under the bedplates.

The two levers operating the ratchets on the screw heads are so connected mechanically that both tension screws are moved alike by one handle.

TYPE G GENERATORS AS SYNCHRONOUS MOTORS

Type G generators are so designed that they may be used as synchronous motors. The cage-type damper winding provided on all generators of 75 kva. rating and above is similar to the secondary winding of a cage-wound induction motor; so that these generators, when used as synchronous motors, are self-starting where the starting torque required is not more than 30 per cent at starting and 15 per cent as synchronism is approached.

OUTLINES AND DIMENSIONS

Outlines, dimensions and performance data of Type G generators will be promptly furnished by any of the Westinghouse offices.

ALPHABETICAL LIST OF CIRCULARS

In Force July 1, 1910

SUBJECT		Circular No.	Date of Issue
Ammeters	See Meters		
Arc Lamps	Multiple Alternating Current	1092	June, 1907
	Direct Current Multiple	1102	May, 1907
	Direct Current Series Multiple	1103	Aug., 1909
	Recent Types and Their Operation	1506	Sept., 1909
	Series, Cooper Hewitt Rectifier System	1155	May, 1910
	Series Points for Consideration When Purchasing	1501	March, 1909
Arc Light System	Series Alternating	1084	May, 1907
Balance Coils		1081	July, 1907
Brakes	Electric Motor Friction	1158	Nov., 1908
Circuit-Breakers	Automatic, Carbon Break	1107	Sept., 1907
	Type G A. Oil	1186	April, 1910
	See also Oil Switches, etc.		
Compensators for	Alternating Current Circuits	1026	March, 1909
Control	Unit Switch System of Multiple	1091	March, 1907
Controllers	Machine Tool	1142	April, 1907
	Regulating and Reversing, for D.C. Motors	1143	July, 1907
	For Mining and Railway Service	1086	July, 1910
Converter	See Rotary Converters		
Drop in Alternating Current Lines		1500	Feb., 1909
Economy Coils and Low Voltage Tungsten Lamps		1180	June, 1909
Electric Motor Vehicle Equipments		1059	March, 1907
Electric Heat in the Manufacture of Hats		1175	July, 1910
Electrically Heated Apparatus	Matrix Driers	1176	Jan., 1910
Fan Motors		1165	Feb., 1910
Generators, A.C.	See Alternators		
	Type G	1161	July, 1910
	Engine Type	1111	Jan. & May, 1907
	Self-Contained	1115	Feb., 06 & May, 07
	Type S and Type R	1156	Aug., 1908
	Type S with ABC Engines	1141	May, 1907
	Types R & S and Alamo Engines	1162	Feb., 1909
Lamps	Tungsten	1160	Feb., 1909
	Tungsten Illumination	1507	April, 1910
Lightning Arrester	Electrolytic	1146	Sept., 1907
	See also Protective Apparatus		
Materials for Switchboard Panels		1177	Aug., 1910
Mercury Rectifier	Battery Charging Outfits	1148	May, 1910
	Arc Lighting System	1155	May, 1908
Meters	Portable and Precision	1104	Jan., 1908
	Iron Loss Voltmeter	1185	Feb., 1910
	Portable D.C. Ammeters and Voltmeters, Type R	1181	Sept., 1909
	Electrostatic Voltmeter	1130	Sept., 1907
Motors, Small Power	For A.C. Circuits	1163	May, 1909
Motors, A.C.	Type CCL Polyphase Induction	1118	Oct., 1908
	Type DA	1163	May, 1909
	Type HF Polyphase Induction	1152	Feb., 1908
	Type MS Polyphase Mill Motors	1164	Feb., 1910

ALPHABETICAL LIST OF CIRCULARS

In Force July 1, 1910 Continued

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