GEA-624E

PACIFIC COAST EDITION

MOTORS

APPLICATIONS · RATINGS · PRICES · DATA

1942

MOTORS

1942

GENERAL ELECTRIC

SCHENECTADY, NEW YORK

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CATALOG GEA-624E

Supersedes GEA-624D

Printed in the United States of America

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HELPFUL DATA

THE PURPOSE OF THIS CATALOG

YOU can buy from General Electric the right motor for the drive you have because General Electric has the most complete line of dependable motors on the market.

The objects of this book are:

1. To help you select, at low first cost, the motors best suited for your purposes.
2. To make it easy for you to get them promptly.
3. To facilitate and direct you in the most economical methods of installing and operating them.

This is but one of the services of which we hope you will take advantage. Near you are competent electrical engineers who know G-E equipment and who will gladly be of assistance to you. Warehouses throughout the country are stocked with G-E motors that are ready for prompt shipment. Fully equipped service shops, too, stand ready to live up to their name of service at a moment's notice.

Keep this catalog handy for your assistance.

HOW TO USE THIS BOOK

1. Obtaining the Motor

(a) Keeping in mind the power available (a-c or d-c) and the job you want done, refer to the Pictorial Selector (pages 6-17) for the general kind or type wanted.

(b) If necessary, refer to "How to Select and Apply Motors" for more complete information (pages 96 to 113).

(c) Refer to the specific pages that describe the type wanted, and select the motor in accordance with the horsepower, speed, type, enclosure, and power desired.

(d) Select the control wanted. (See pages 70 to 77.)

(e) Follow ordering directions.

2. Planning for Use of the Motor

(a) Refer to pages 78 to 95 for mounting dimensions and weights.

(b) Select type of connection or driving means between motor and machine. See page 125 for assistance.

(c) Arrange for feeder equipment based on full-load currents, code letters, etc. as shown on pages 143 and 145.

(d) Check your plans with your local power company and electrical code or underwriters' inspectors.

3. Using the Motors

(a) Follow installation suggestions. (See pages 125 to 132.)

(b) Follow maintenance suggestions. (See pages 133 to 139.)

4. General Information

(a) When special features are wanted, see "Modifications and Accessories," pages 62 to 69. Consult the nearest G-E sales office about any motor you have in mind that is not listed.

(b) Prices are subject to General Electric's usual terms, as explained by its published terms of sale outlined on page 22.

(c) Information as to warranty of quality and patent infringement will be found on page 22.

(d) Definitions of motor terms appear on pages 140 to 142.

(e) Helpful data is given on pages 142 to 146.

THE ADVANTAGES OF PURCHASING G-E MOTORS

THE work will be done economically, because General Electric has the right motor for any job.

Maintenance and upkeep have been proved to be small; that is, G-E motors are built to last.

Performance is dependable, because the motors have predetermined and tested operating characteristics.

Installation is easy, because of the many convenience features built into G-E motors.

Shipment is prompt—the more so, because General Electric has factories and district warehouses located in every section of the country.

Better motors for less money result from use of the many developments and improvements that have originated in General Electric laboratories.

Reliability is assured, because General Electric constantly tests motors, beginning with the selection of the raw material and continuing through the various stages of manufacture and after completion.

Engineering service is available, near at hand wherever your plant is situated, to help you select the motor best suited to your requirements.

General Electric is no newcomer in the motor business. Its long history of steady growth, the prestige of its name and of its products, and the comprehensiveness of its lines—these are factors that contribute to the unseen values which you purchase when you buy a G-E motor.

You get service—should your apparatus ultimately require repairs—from any one of a chain of service shops distributed throughout the country—shops that are equipped with every facility for returning your equipment to original factory condition promptly.

You can rest assured of always being able to get genuine G-E renewal parts, even years later, should you want or need them.

G-E motors are always acceptable, whether for original sale or for resale on a machine. A survey made by a disinterested, impartial agency asked industrial buyers: "What make of electric motor do you prefer?" The answers showed that preferences were distributed as follows:

General Electric	62%
Manufacturer A	21%
Manufacturer B	8%
Manufacturer C	5%
Manufacturer D	3%
Manufacturer E	1%

POLYPHASE

FRACTIONAL-HORSEPOWER GENERAL-PURPOSE OPEN MOTORS

TYPE K, open, 40 C rise squirrel-cage induction motors. **See page 23.**

WHERE TO USE: For all constant-speed, steady-running jobs, where ordinary surrounding conditions exist. Having a high starting torque, these motors are suitable for hard-to-start applications. They have a smooth accelerating ability for inertia loads, and have high maximum load-carrying capacity for emergencies.

WHAT RATINGS: Built from ⅛ to ¾ hp; 860, 1140, 1725, and 3450 rpm at 60 cycles; also 50- and 25-cycle speeds; with either ball- or sleeve-bearing construction; standard voltages; 3- or 2-phase.

FEATURES: A motor built to give dependable, low-cost service. Dripproof construction. Strong frame, substantial base, cast-aluminum rotor winding. Bearings require oiling but once a year or greasing once every two years.

CONTROL: Manual, CR1061 or CR1062; automatic, CR7006 or CR7008.

POLYPHASE

FRACTIONAL-HORSEPOWER INDUSTRIAL AND MACHINE-TOOL TOTALLY ENCLOSED MOTORS

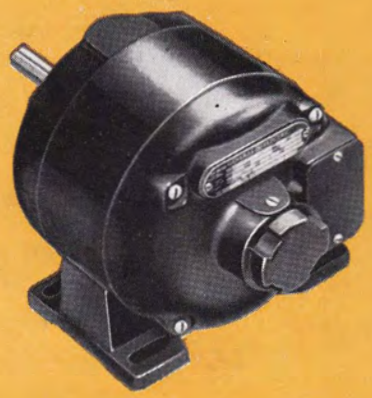
TYPE K, totally enclosed, 55 C rise ball-bearing industrial motors. **See page 24.**

WHERE TO USE: These motors are built specifically to meet the requirements of machine-tool and similar industrial applications, particularly where frequent start-stop service, plugging duty, and metal-dust atmospheres are encountered, and where other than horizontal mounting may be needed.

WHAT RATINGS: Built in ¼, ⅓, ½, and ¾ hp at 1725 rpm, 60 cycles, 3- or 2-phase voltages. 50-cycle and 25-cycle ratings also available. For d-c service, order Type BC construction for constant- and adjustable-speed duty. All are available with flange, face, or machined end-shield mounting.

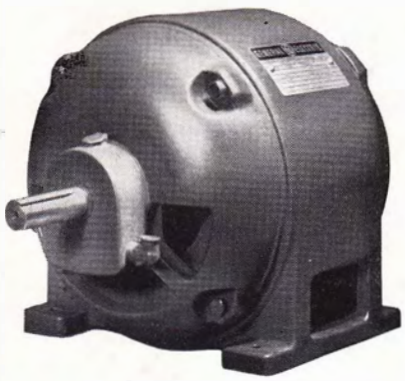
FEATURES: Protected and firmly anchored Formex wire windings, rigid base and frame, ball bearings, convenient built-in conduit box, and many other features make these motors a worth-while purchase for industrial use.

CONTROL: Manual, CR1061 or CR1062; automatic, CR7006 or CR7008.



POLYPHASE

GENERAL-PURPOSE OPEN TRI-CLAD MOTORS



TYPE K, open, 40 C rise squirrel-cage induction motors. **See page 25.**

WHERE TO USE: For the large majority of industrial applications—pumps, fans, saws, lathes, line shafts, and the like. Where constant speed; normal, "snappy" starting ability; high load-carrying capacity for emergencies; and an efficient, quiet, and reliable electric drive is wanted. Its low starting current makes this motor widely acceptable for full-voltage starting and, consequently, permits use of economical control.

WHAT RATINGS: Built from 1 to 100 hp (below 1 hp, above 100 hp, and up to 15,000 hp in other than Tri-Clad design); 450, 514, 600, 720, 900, 1200, 1800, 3600 rpm at 60 cycles; 50- and 25-cycle speeds also; either ball or sleeve bearings; 110, 208, 220/440, and 550 volts; 3- or 2-phase. Also multispeed motors (2, 3, or 4 of these speeds in one motor), if desired, and Type KG motors for high-starting-torque jobs, such as conveyors, loaded compressors, etc.; and Type KR motors for high slip, on fluctuating flywheel loads, rapid-reversing jobs, and the like.

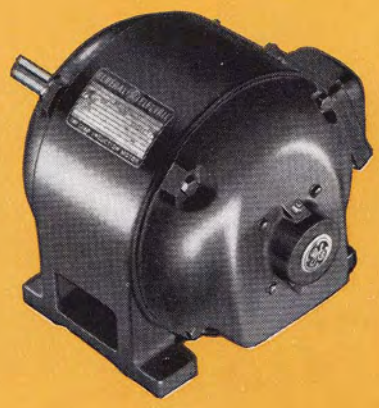
FEATURES: Here is the motor that industry asked for—a streamline, protected, dependable standard motor. Cast-iron frame, and end shields with no openings in the upper portion. Insulated with Formex wire. Cast-aluminum rotor windings. Dynamically balanced. Convenient to mount; easy to maintain.

CONTROL: Full-voltage, manual, up to 5 hp, CR1062; automatic, CR7006 or CR7008. Reduced-voltage, manual, CR1034; magnetic, CR7056.

SPLASHPROOF TRI/CLAD MOTORS

POLYPHASE

TYPES K, KG, or KR, splashproof, 50 C rise motors. **See page 28.**



WHERE TO USE: The motor to install in wet, splashy locations, such as sometimes exist in breweries; dairies; food-product, paper, and chemical plants, etc. Use where you may want to hose-clean the surrounding area regularly. Use in some outdoor locations where climate is mild and maintenance regular.

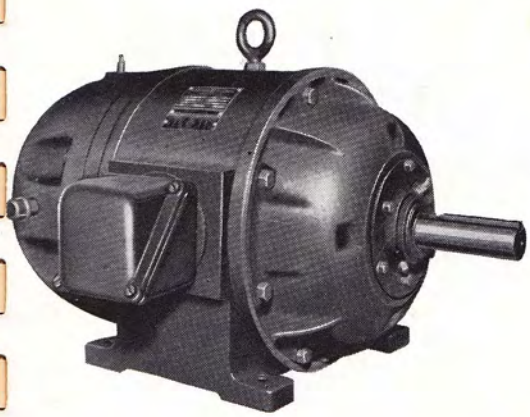
WHAT RATINGS: Built in types and ratings paralleling G-E open motors—in Tri-Clad construction to 20 hp, and in strong cast-iron construction of equivalent splash-resisting ability in larger sizes.

FEATURES: The "cast-iron" answer to liquids and splashing which might make motor operation uncertain if not protected. Deflecting end shields, watertight conduit box, moisture-resisting insulation, shaft seal, and other features to give the protection needed.

CONTROL: Same as for open motors, perhaps with different enclosure.

TOTALLY ENCLOSED MOTORS—STANDARD AND EXPLOSION-PROOF

POLYPHASE



TYPES K, KG, or KR, totally enclosed or totally enclosed, fan-cooled, 55 C rise motors—either standard or explosion-proof construction. **See page 29.**

WHERE TO USE: When magnetic or abrasive dusts, extreme moisture or outdoor conditions, severe fumes or chemical conditions which are not explosive exist, use the standard construction.

For explosive-gas conditions no more hazardous than high-test gasoline, such as may exist in dry-cleaning plants, refineries, paint and varnish departments, etc., a construction is available that has been tested and labeled by the Underwriters' Laboratories Inc., for Class I, Group D conditions.

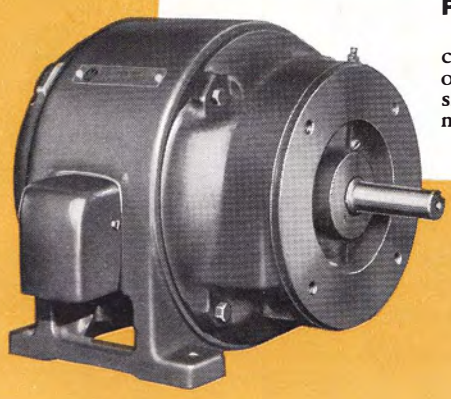
For explosive-dust conditions, such as may exist in flour mills, feed mills, grain elevators, etc., another totally enclosed construction is available that has been tested and labeled by the Underwriters' Laboratories Inc., for Class II, Group G, conditions.

RATINGS AND FEATURES: Built in types and ratings paralleling G-E open motors. Built in ratings of 1 to 600 hp at practically all speeds. These motors have the highest quality of protection that is given motors.

CONTROL: Same as for open motors, perhaps with different enclosure.

END-SHIELD-MOUNTED TRI/CLAD MOTORS

POLYPHASE



FACE-TYPE

For close-coupling of motors to machines, pumps, etc. Many motors will fit on only a few standard mounting dimensions. Stud bolts from machine to motor must be used in mounting these motors.

See page 31.

FLANGE-TYPE

Also for close-coupling to driven apparatus. Either stud bolts or through bolts from the motor to machine can be used in mounting these motors. Dimensions are standardized by NEMA. Motors either round-frame or foot-mounted.

See page 31.

POLYPHASE

VERTICAL MOTORS, SHIELDED AND GENERAL-PURPOSE

TYPE K, vertical, 40 C rise, shielded-frame induction motors or general-purpose vertical Tri-Clad motor (not shown.) **See page 32.**

WHERE TO USE: These motors are made for use on jet pumps, turbine pumps, agitators, atomizers, centrifuges, machine tools, irrigation projects, etc. Use when protection from falling objects or dripping liquids, or outdoor operation in mild climates, is desired. Use when base mounting is wanted. General-purpose motor also available for side-wall vertical mounting. Select high-thrust type if weight to be carried by shaft is considerable.

WHAT RATINGS: Built in ratings which duplicate those of G-E general-purpose horizontal open motors. Shielded motor has ring base and general-purpose motors are available with ring bases, tripod base, face-type base, or no base. Dimensions are standard. Solid shaft for most applications; hollow shaft with pin-type coupling for deep-well turbine pumps.

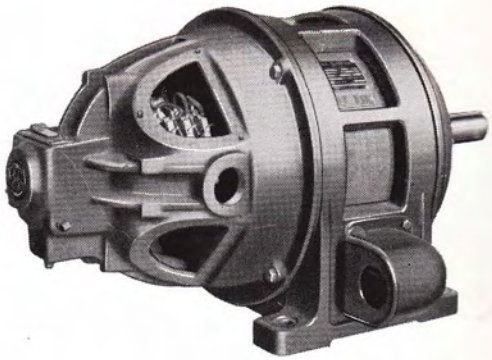
FEATURES: Attractive appearance, effective protection, high full-load speeds, ease of mounting and alignment, and interchangeability of many motors on a given mounting dimension are among the desirable features obtainable in this useful line of motors.

CONTROL: Same as for open horizontal motors.

POLYPHASE

WOUND-ROTOR COLLECTOR-RING MOTORS

TYPE M, general-purpose, open, 40 C rise, constant- or adjustable-varying-speed motors. **See page 34.**



WHERE TO USE: On applications needing adjustable speed, but where some speed change with fluctuating load is permissible, this motor, with proper control, is useful. If low starting current is imperative, and ability for extra-heavy starting and smooth acceleration is desired, this motor, properly controlled, is the best for the job.

WHAT RATINGS: In general, the ratings parallel those of comparable G-E squirrel-cage general-purpose motors. Also available with protective covers and in totally enclosed, standard construction.

FEATURES: A sturdy, long-lived construction. Extra features: large-cross-sectioned brushes; smooth, round, concentric-cast-alloy "slip" rings; adjustable-tension bronze brush holders.

CONTROL: Manual, CR3204; magnetic, CR7022 or CR7029.

POLYPHASE

SYNCHRONOUS MOTORS, GENERAL-PURPOSE

TYPES TS or QS (3- or 2-phase), general-purpose, high- or low-speed. **See page 35.**

WHERE TO USE: (1) Where good power factor or power-factor improvement is desired. (2) Where maximum efficiency is desired for steady, continuous loads of 75 hp or larger. (3) Where exact speeds must be maintained. (4) Where motor speeds less than 500 rpm in sizes larger than 20 hp are wanted.

WHAT RATINGS: Horsepowers, 20 to 7500. Speeds, 514 to 3600 (high-speed) and 80 to 514 (low-speed). Either unity-power-factor or 0.8 leading-power-factor ratings obtainable. Open, dripproof, or enclosed construction. Many optional varieties of mounting arrangements and starting combinations.

FEATURES: Starting, pull-in, and pull-out torques can be selected to suit exactly each application, such as pumps, compressors, fans, motor-generator sets, ball mills, line shafts, etc. Compact, proved design.

CONTROL: Reduced-voltage, magnetic, CR7061; semimagnetic, CR7062. Full-voltage, magnetic, CR7065; semimagnetic, CR7066.

FRACTIONAL-HP GENERAL-PURPOSE SPLIT-PHASE OPEN MOTORS

SINGLE-PHASE

TYPE KH, open, split-phase induction motor. **See page 38.**

WHERE TO USE: For constant-speed, moderate-torque applications where high starting torque is not a requisite. Typical applications are oil burners, ironers, office appliances, instruments, small machine tools, floor surfacers, etc.

WHAT RATINGS: Built in 1/60 to 1/3 hp at 1800 rpm; 3600, 1800, 1200, and 900 rpm, 60 cycles; and in the corresponding 50-cycle ratings. Available in either ball- or sleeve-bearing designs at standard voltages. Enclosed motors also available.

FEATURES: Economical to buy. Streamline, dripproof protection; sturdy frame and assembly; dependable, long-lived built-in transfer switch; solid base; can be furnished with resilient base, or belt-tightener base and built-in Thermo-Tector protection.

CONTROL: Manual, CR1061 or CR1062; automatic, CR7006 or CR7008.

FRACTIONAL-HP GENERAL-PURPOSE OPEN CAPACITOR-MOTORS

SINGLE-PHASE

TYPE KC, open capacitor-type induction motor. **See page 39.**

WHERE TO USE: For constant-speed applications where relatively high starting torque is required, or where minimum operating noise and minimum radio intereference are essential. Typical applications are commercial-refrigeration units, fans, air-conditioning equipment, etc.

WHAT RATINGS: Built in ratings of 1/8 hp, 1800 rpm, up to and including 1 hp, 3600 rpm, 60 cycles, and in the corresponding 50-cycle ratings; 3600, 1800, 1200, and 900 rpm. Available in either ball- or sleeve-bearing designs at standard voltages. Enclosed and explosion-proof motors also built.

FEATURES: The use of dependable motor-mounted G-E capacitors adds extra starting ability, quiet operation, and compact design to the many other mechanical benefits built into all G-E fractional-horsepower motors.

CONTROL: Manual, CR1061 or CR1062; automatic, CR7006 or CR7008.

GENERAL-PURPOSE OPEN TRI/CLAD CAPACITOR-MOTORS

SINGLE-PHASE

TYPES KC and KCJ, open, 40 C rise capacitor-type induction motors. **See page 39.**

WHERE TO USE: In applications that require dependability, quiet operation, freedom from radio interference, and a wide choice of torque requirements. The KC (normal-torque) is designed for fans, blowers, centrifugal pumps, and other applications requiring moderate starting torques. The KCJ (high-torque) is designed for applications requiring high starting torques, such as compressors, loaded conveyors, reciprocating pumps, etc.

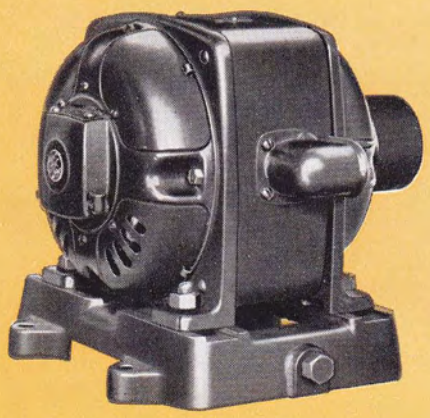
WHAT RATINGS: Type KC is available from ½ hp at 900 rpm up to and including 5 hp at 3600 rpm. Type KCJ is available from 1 to 3 hp at 1800 rpm. Available in either ball- or sleeve-bearing designs at standard voltages. Furnished for both 60-cycle and 50-cycle operation.

FEATURES: Built with extra protection and pleasing contours. Dependable electrolytic or Pyranol capacitor compactly mounted in end shield or on frame. Long-lived transfer mechanism. Many convenience features.

CONTROL: Manual, CR1062; automatic, CR7006 or CR7008.

SINGLE-PHASE

REPULSION-INDUCTION OPEN MOTORS



TYPES SCR (standard), **SCA** (reversible), open induction motors. **See page 41.**

WHERE TO USE: Use Type SCR motors when a single-phase, constant-speed motor is desired in the larger ratings where capacitor-motors are not yet available. Use Type SCA motors when a reversible, constant-speed, single-phase drive is wanted.

WHAT RATINGS: Types SCR and SCA built for 50- or 60-cycle operation: Type SCR from 1 hp at 900 rpm to 10 hp at 1800 rpm, and Type SCA from ½ hp at 900 rpm to 10 hp at 1800 rpm. Both types available at standard voltages in either ball- or sleeve-bearing design.

FEATURES: High starting and accelerating torques. High full-load speed. Built-up, solid, long-wearing commutator. Rigid, adjustable brush assembly. Light weight; easy to install.

CONTROL: Manual, CR1062; automatic, CR7006. In addition, CR1026 control is available for reduced-voltage starting of the Type SCR; and, for the Type SCA, CR3300 reversing switches (manual) and CR7009 (magnetic) switches can be obtained.

SINGLE-PHASE

SHADED-POLE MOTORS FOR APPLIANCES AND SMALL DEVICES

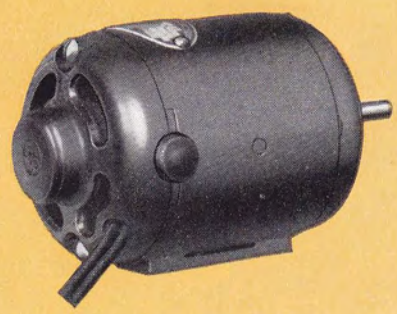
TYPE KSP—Shaded-pole, 3.5, 5, 12 watts; 110 volts, 60 cycles.

WHERE TO USE: These small constant-speed motors can be used to drive practically any small device that does not require a high starting torque, such as small fans, advertising devices, instruments, toys, motion-picture projectors, and the like. It is a handy, inexpensive little motor to have for odd jobs; and makes a fine gift to the boy who is mechanically minded.

FEATURES: It operates quietly, is free from vibration, and does not interfere with radio reception. Generous oil reservoirs and oil returns provide adequate lubrication; only occasional oiling is required. It can be plugged into the nearest lighting socket or service outlet. More information can be had by asking for Bulletin GEA-1844.

SINGLE-PHASE OR D-C

UNIVERSAL, VARYING-SPEED SERIES MOTORS



TYPE P—Universal series, 1/50 to 1/5 hp, 110 or 220 volts, a-c/d-c.

WHERE TO USE: These are small, compact, high-speed motors for use on food mixers, sirens, electric cleaners, office devices, sewing machines, paint sprayers, and for similar applications where duty is intermittent, where constant speed is not required, and where the load is permanently connected and fairly constant. Generally, these motors are purchased as "motor parts," and built into the tool or device by the manufacturer. (See "Series-motor Parts," page 14.)

FEATURES: Because they are compact, powerful, yet light in weight, they are excellent for the applications listed above. They operate at very high speeds at no load, with application of load reducing speed, and are sturdily built for this service. The motors have high starting torque. Detailed information is given in Publications GEA-1942 and GEA-1988.

TOTALLY ENCLOSED MOTORS, STANDARD AND EXPLOSION-PROOF

SINGLE-PHASE

TYPE SCR, totally enclosed, fan-cooled, 55 C rise motor—either standard or explosion-proof. **See page 41.**

WHERE TO USE: Where conditions exist that are similar to those described for enclosed polyphase motors on page 7.

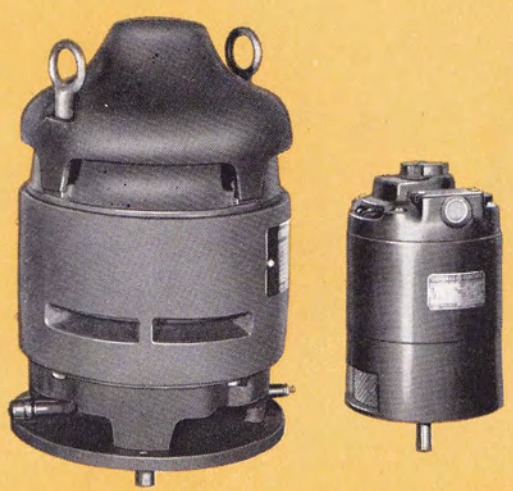
WHAT RATINGS: Built for 60-cycle operation from ½ hp at 900 rpm to 10 hp at 1800 rpm. Ball-bearing construction; standard voltages; 3600, 1800, 1200, 900 rpm. Also 50-cycle speeds. Motor construction for explosive-gas conditions, Class I, Group D, or explosive-dust conditions, Class II, Group G, available.

FEATURES: All motor operating parts are enclosed in one unit. Protection prolongs life and promotes safe operation. High starting torques and full-load speeds, sealed-in leads, protected cooling fan, are some additional desirable features.

CONTROL: Same as for open motors.

VERTICAL SINGLE-PHASE MOTORS

SINGLE-PHASE



TYPE KC, (larger sizes), **Type KH** (smaller sizes), vertical, shielded, dripproof ball-bearing motors.

WHERE TO USE: The principal use for these motors is on water-pump assemblies for supplying running water to homes, farms, and for irrigation. Most motors are furnished as part of the complete pump. The motors are suitable for outdoor operation and normal-torque applications.

WHAT RATINGS: Built from ¼ hp to 3 hp at 1800 rpm or 5 hp, 3600 rpm, standard voltages, all 60- and 50-cycle speeds, standard ring base.

FEATURES: Streamline, compact appearance, protected construction. Starting switches and capacitors are snugly protected inside the motor. Mounting is ring base with widely acceptable mounting dimensions. Many ratings will fit on same pump casing or other casting. These motors are quiet and dependable.

CONTROL: Same as for open horizontal motors.

FRACTIONAL-HORSEPOWER GENERAL-PURPOSE CONSTANT-SPEED D-C OPEN MOTORS

DIRECT-CURRENT

TYPE BC, open, 40 C rise, compound-wound direct-current motor. **See page 44.**

WHERE TO USE: For general-purpose constant-speed applications where the power supply is d-c, or where the necessity of especially fine speed adjustment warrants the use of d-c motors plus a-c/d-c conversion apparatus.

WHAT RATINGS: Built compound-wound in constant-speed design from 1/20 hp, 1725 rpm, up to and including 1 hp, 3450 rpm. Also available as shunt- or series-wound motors. Furnished with either ball or sleeve bearings in standard voltages.

FEATURES: Solidly bonded, compact armature; filter capacitor for radio-interference suppression, compound-wound for stable operation. Long-lived commutator and brushes.

CONTROL: Manual, full-voltage, CR1061 or CR1062.

DIRECT-CURRENT CONSTANT-SPEED

INTEGRAL-HORSEPOWER, GENERAL-PURPOSE, D-C OPEN MOTORS CONSTANT-SPEED

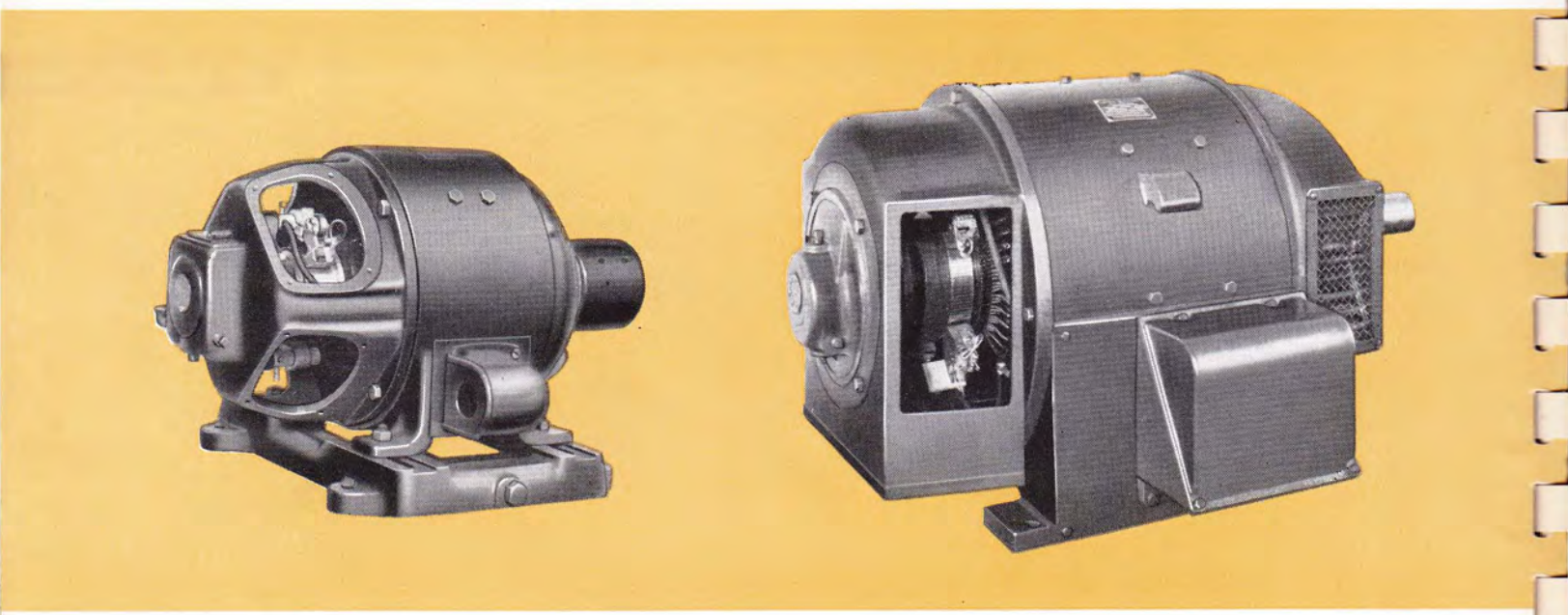
TYPES B and CD; shunt-, series-, and compound-wound; open, 40 C rise. **See page 45.**

WHERE TO USE: Where the power supply is d-c, or for applications where it is desirable to obtain a large variety of accurately controllable speeds over speed ranges of less than 3:1 from a constant-voltage source. With adjustable-voltage supply, these motors can be made part of a flexible system that will give rapid reversal, change of speed, or uniform acceleration with an economical control system.

WHAT RATINGS: Type B in Frames 203–284 and Type CD in Frames 66–95, from ½ hp, at 850 rpm up to and including 60 hp at 1750 rpm. Type CD in the "1000 Series" frames also available from 15 hp at 500 rpm up to and including 20 hp at 1750 rpm. Furnished in many standard voltages with either ball or sleeve bearings.

FEATURES: These are heavy-duty motors, made for rough service in mines, factories, ships, etc. They feature: rolled-steel frames; compensating-tension brush holders; built-up, rigid commutators; and solidly bonded, conservatively insulated field and armature coils.

CONTROL: See below.



DIRECT-CURRENT ADJUSTABLE-SPEED

ADJUSTABLE-SPEED

TYPES B and CD, shunt-, series-, and compound-wound; open; 40 C rise. **See page 45.**

WHERE TO USE: For applications where it is desirable to obtain a large variety of accurately controllable speeds over speed ranges of more than 3:1. These motors may be rated on a constant-horsepower, tapered-horsepower, or one-hour basis, thus providing great flexibility to suit a wide variety of applications.

WHAT RATINGS: Type B in Frames 203–284 and Type CD in Frames 66–95, from ½ hp at 850–3400 rpm up to and including 15 hp at 500–1800 rpm. Type CD in the "1000 Series" frames also available from 10 hp at 300–1200 rpm up to and including 200 hp at 200–800 rpm. Many standard voltages with either ball or sleeve bearings.

CONTROL:

Manual

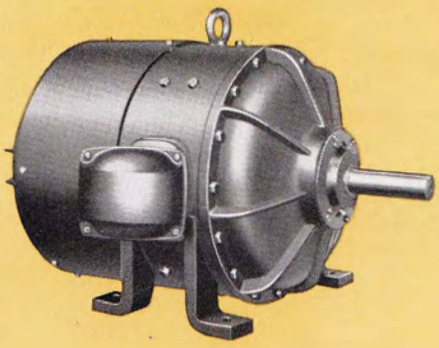
CR1003, starting duty only.
CR1203, starting duty & speed regulation.
CR1220-B1, machine duty—speed regulation by armature control
CR1224-B1, fan duty—speed regulation by armature control
CR1240-B1, machine duty—speed regulation by armature and field control
CR1244-B1, fan duty—speed regulation by armature and field control

Magnetic

CR4061, all services up to 10 hp, 115 volts, or 20 hp, 230 volts
CR4065, nonreversing
CR4066, nonreversing, dynamic braking
CR4068, reversing, dynamic braking

D-C MOTOR ENCLOSURES

DIRECT-CURRENT



ENCLOSURES AVAILABLE AND WHERE TO USE **See page 48.**

To meet the many different kinds of adverse conditions to which direct-current motors are subjected, General Electric has supplemented the heavy-duty open motor with a complete line of protected and enclosed machines.

ENCLOSURE	WHERE TO USE
1. Dripproof	When dripping liquids may exist.
2. Protected	When objects may fall or bounce near by.
3. Dripproof, protected	Under a combination of above conditions.
4. Splashproof	Where splashing or hosing down may occur.
5. Totally enclosed	Where extreme dust, corrosive atmosphere, moisture, etc., may prevail.
6. Totally enclosed, fan-cooled	Where extreme dust, corrosive atmosphere, moisture, etc., may prevail.
7. Explosion-proof	For explosive-gas conditions classified as Class I, Group D.
8. Class BM motors	Built to the specifications of the Bureau of Mines for protection in coal mines or collieries.

CONTROL: Types same as open motors, with enclosures as desired.

D-C CRANE AND HOIST MOTORS

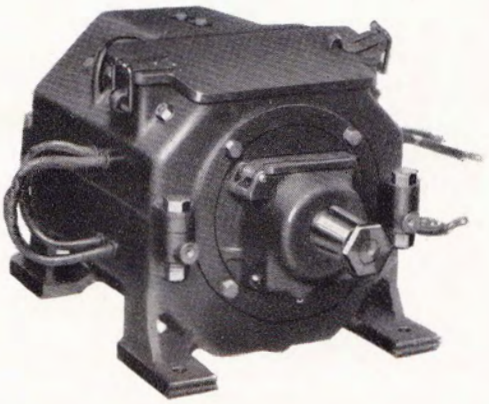
DIRECT-CURRENT

TYPE CO, totally enclosed, series- and compound-wound, rated 55 C rise in either 30-min or 15-min intermittent ratings.

WHERE TO USE: These are heavy-duty motors designed specifically for average crane and hoist jobs, with their frequent starts and stops, but with the necessity for intermittent ratings only.

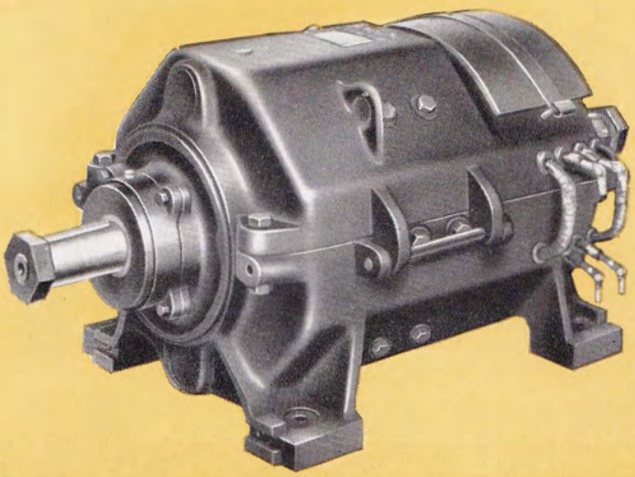
WHAT RATINGS: From 3 to 130 hp at standard speeds and voltages in either sleeve- or ball-bearing construction.

CONTROL: A variety of controllers, both manual and magnetic, is available.



D-C MILL MOTORS

DIRECT-CURRENT



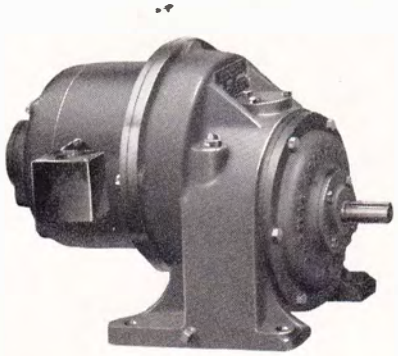
TYPES MD (totally enclosed) **and MDP** (protected, self-ventilated) series-, shunt- or compound-wound; 75 C rise. TYPE MD rated intermittently at either 30 min or 60 min; TYPE MDP rated either continuous or 60 min intermittent.

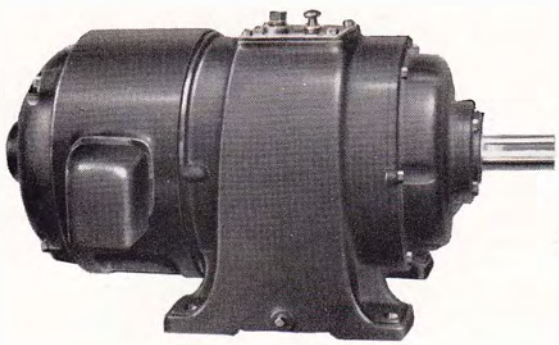
WHERE TO USE: These are extra-heavy-duty motors designed specifically for the severe operating conditions met in steel-mill auxiliary-equipment service. They may also be used in place of Type CO motors on very severe crane and hoist applications where the 75 C temperature rating is wanted. Type MDP is specifically a pump motor, and is used for extremely severe applications.

WHAT RATINGS: Standard speeds. Type MD at 230 volts from 5 to 660 hp; at 550 volts from 5 to 330 hp. Type MDP at 230 volts from 7 to 645 hp; at 550 volts from 7 to 330 hp.

CONTROL: A variety of controllers, both manual and magnetic, is available.

SPEED REDUCERS — CLASS I PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS





TYPES: In fractional-horsepower sizes, there are Types K, KH, and KC for a-c service, and Type BC, compound-wound, for d-c service. In integral-horsepower sizes, there are Types K, KG, KR, M, and KC for a-c service, and Type B, shunt-wound, for d-c service. **See page 50.**

WHERE TO USE: The Class I motorized speed reducer is designed for applications where the load is reasonably constant and must be driven at low speed. It combines a normal-speed motor with a built-in, helical reduction gear. This combination results in an efficient, sturdy, self-contained unit that is often the most economical means of obtaining a dependable source of power for the operation of many types of machinery at a large variety of standard speeds below 800 rpm.

WHAT RATINGS:

Types and Horsepowers				Output Speeds at Full Load (±3 Per Cent) —AGMA & NEMA Standards			
Fractional-hp*		Integral-hp*		Revolutions per Minute, 1–75 Hp			
Type	Hp	Type	Hp				
K	⅛ to ¾	K	1 to 50	780	280	100	37
KH	⅛ and ⅙	KG	3 to 50	640	230	84	30
KC	⅛ to ¾	M	1½ to 50	520	190	68	25
BC	⅛ to ¾	B	1 to 7½ hp	420	155	56	20
		KC	1 to 3 hp	350	125	45	16.5
							13.5

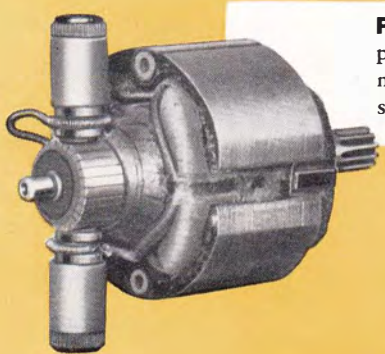
*Standard voltages and frequencies.

All of the above integral-horsepower ratings are available at standard output speeds. The fractional-horsepower ratings are available with either a coaxial-shaft construction or with a worm-gear drive having a right-angle shaft, at output speeds from 780 to 13.5 rpm. All types and ratings are available in totally enclosed, explosion-proof, splashproof, and vertical constructions, if desired.

FEATURES: A complete line of Pacific, General Electric Motorized, Speed Reducers is available. They are unusually quiet and easy to install, and promote safety in any plant by eliminating belts, etc. Furthermore, they save space, minimize shutdowns, and reduce power and maintenance costs.

CONTROL: Same as for standard motors.

GENERAL — SERIES-MOTOR PARTS, A-C/D-C



FOR PORTABLE DEVICES— portable tools, electric cleaners, motion-picture projectors, and similar applications.

FOR BUSINESS MACHINES— A compact, powerful motor with governor control for office appliances and projectors.

G.E. co-operates closely with manufacturers making portable tools and office devices. Ask for Publication GEA-1988.

SELF-STARTING SYNCHRONOUS INDUCTOR MOTORS

GENERAL

TYPE SMY—Self-starting synchronous inductor motors. **See page 42.**

WHERE TO USE: Self-starting synchronous inductor motors for electric instruments, indicating instruments, recording instruments, small regulating or controlling devices, remote-control devices, and other applications where a long-lived source of low-speed torque or power at constant speed is needed.

WHAT RATINGS: Single-phase, 115 volts, 60 cycles.

20 Frame	2 oz-in.	100 rpm
20 Frame plus built-in gear reducer	48 oz-in.	1 rpm
	24 oz-in.	2 rpm
	12 oz-in.	4 rpm
50L Frame	20 oz-in	75 rpm
50H Frame	40 oz-in	75 rpm
54H Frame	75 oz-in	75 rpm

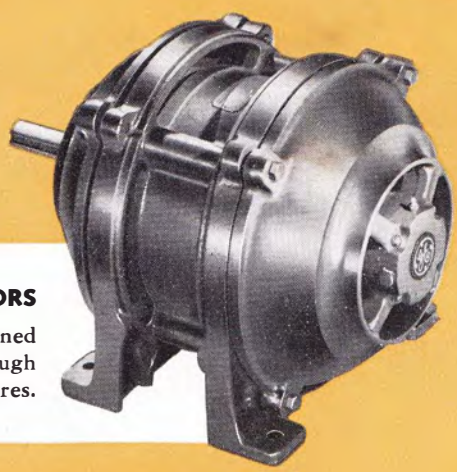
FEATURES: These are compact, quiet, useful motors. They have alnico magnet fields, slotted rotor and stator for synchronous speed. Can't overheat. Instantaneous start. No starting-current surge. Ask for Bulletin GEA-3307.

A-C TEXTILE MOTORS

GENERAL

LOOM MOTORS

Totally enclosed, dust-tight, efficient loom motor. Ask for Bulletin GEA-1556.

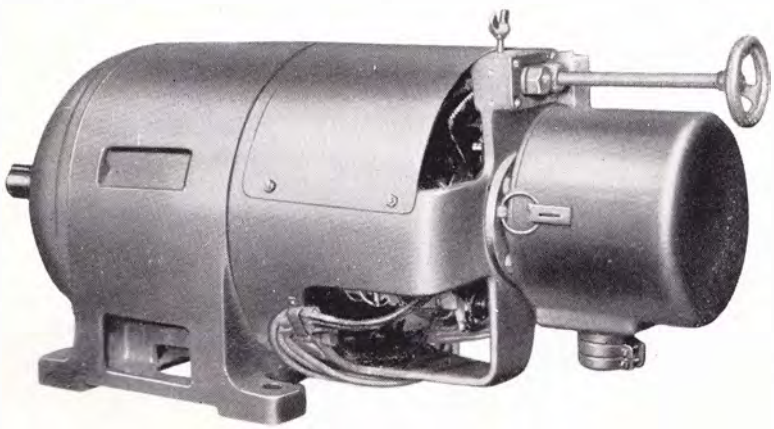


SCREENLESS OPEN MOTORS

Screenless open motor designed for positive expulsion through motor of lint-laden atmospheres. Ask for Bulletin GEA-1557.

A-C ADJUSTABLE-CONSTANT-SPEED MOTORS

GENERAL



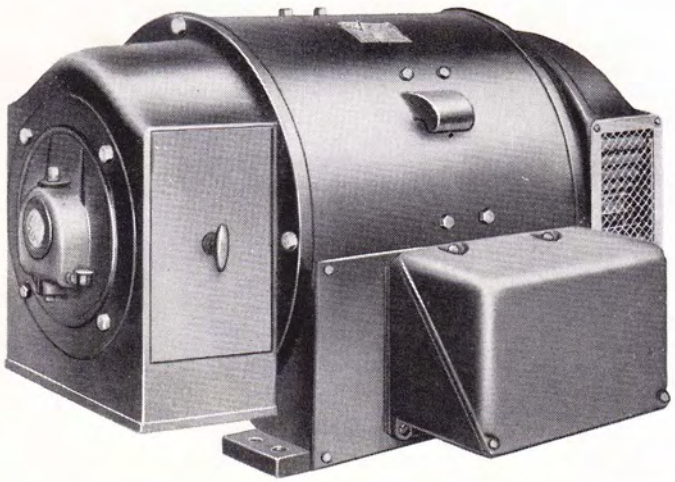
Type BTA motors were developed by General Electric to cover that wide field of application where adjustable-speed a-c motors with constant-speed characteristics are beneficial. Type BTA motors are generally built for a 3:1 speed range, and are rated on a constant-torque basis, with the horsepower output directly proportional to speed, but they can also be furnished in other speed ranges. In standard ratings, this motor is available in sizes 50 hp and smaller. Ask for Publication GEA-712.

GENERAL

A-C GENERATORS

One of many G-E custom-built a-c generators for gas- or diesel-engine drive, or for frequency changing.

GENERAL



D-C GENERATORS

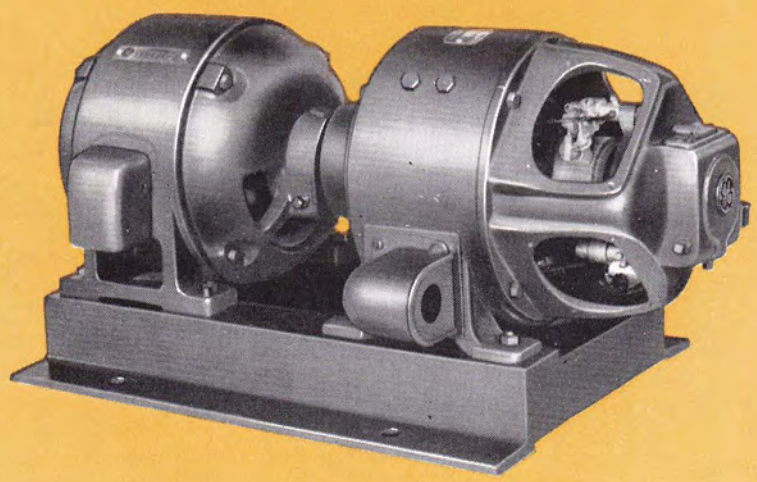
See page 61.

Wherever a d-c source of power is needed, there is a G-E generator that will match the requirements. Information on request.

GENERAL

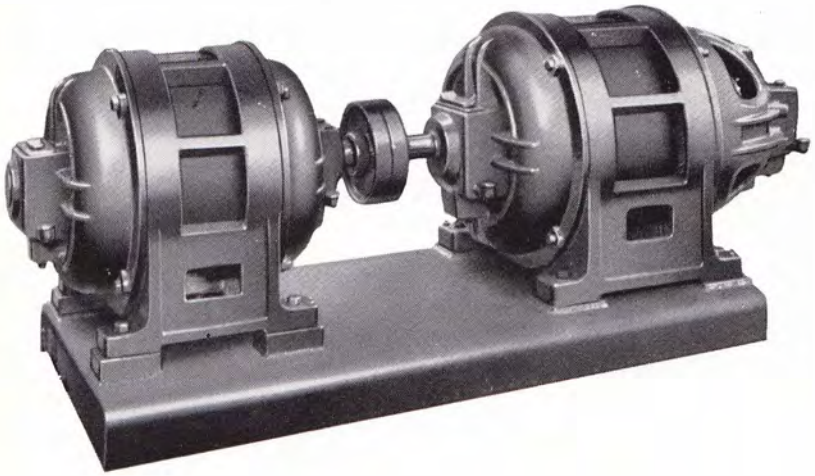
MOTOR-GENERATOR SETS

As a separate means of changing from one power supply to another, compact and complete G-E motor-generator sets function most dependably and efficiently. **See page 60.**



INDUCTION FREQUENCY CONVERTERS

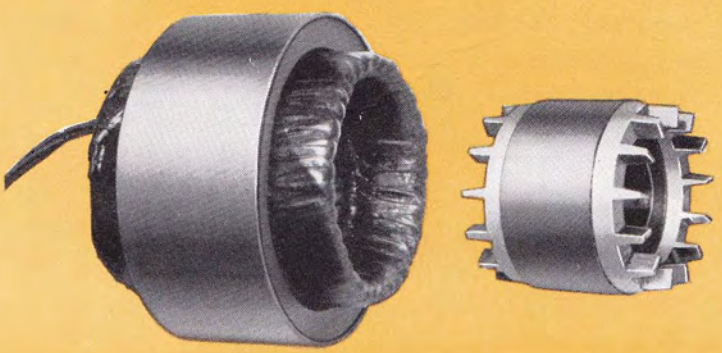
GENERAL



To supply high-frequency polyphase power most economically for driving hand tools, buffers, drills, etc., use G-E Type MM induction frequency converters. Ask for Publication GEA-750.

SHELL-TYPE MOTORS

GENERAL

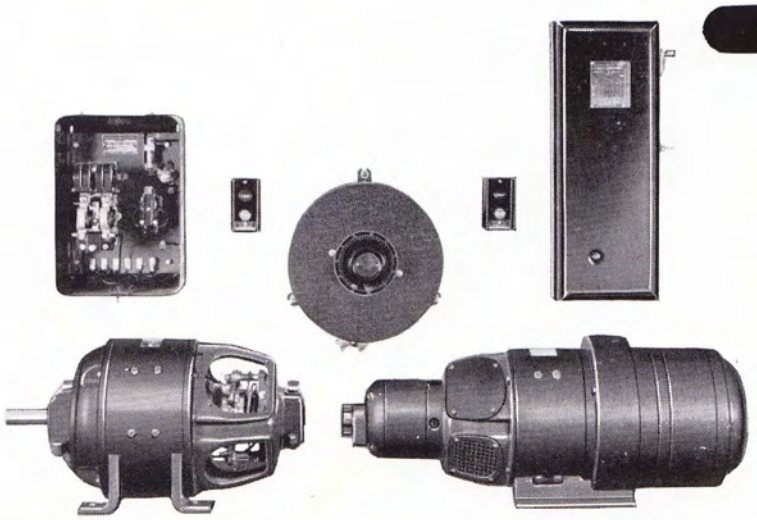


For use in conjunction with induction frequency converters, at frequencies as high as 500 cycles, or on conventional frequencies, a complete line of shell-type motors is available in a wide range of horsepower ratings. The advice of General Electric engineers, based on years of experience in applying and co-ordinating these motors and converters, can be obtained at the nearest G-E office.

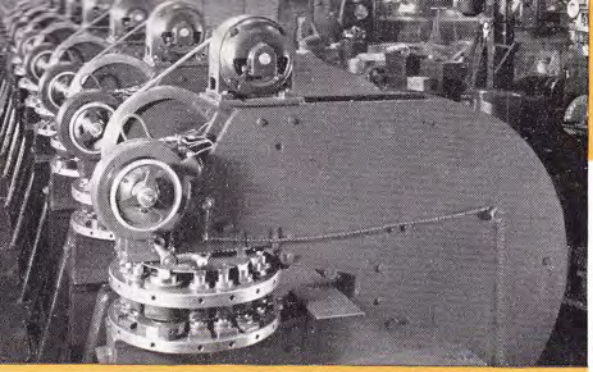
G-E SPEED VARIATOR

GENERAL

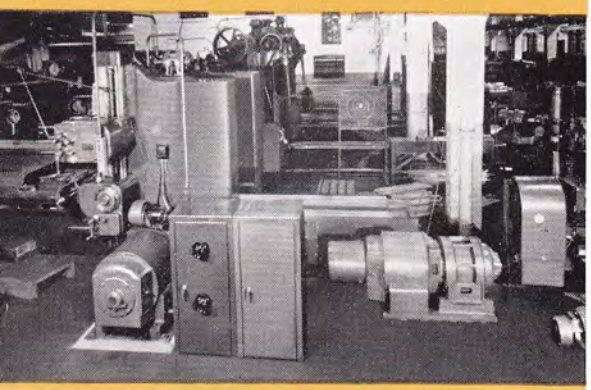
A compact, complete unit—motor, motor-generator set, and control—which permits adjustable-speed drive from polyphase power. Gives the speed desired for best production on machine tools, printing presses, textile machines, test stands, etc.



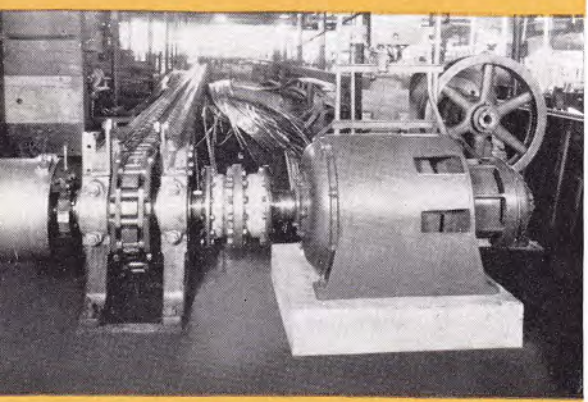
FUNDAMENTAL STEPS TO



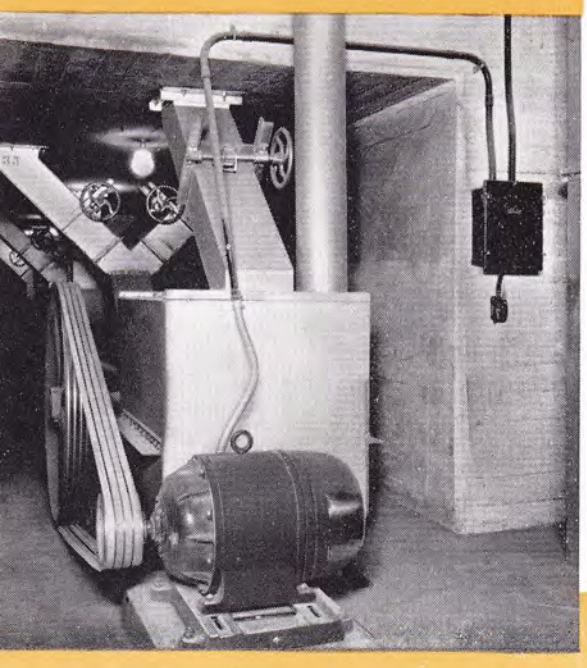
A battery of machines with Tri-Clad motors



A variable-voltage d-c-motor planer drive



A wire-drawing equipment with gear-motor drive



A totally enclosed motor in a Western grain elevator

Following is an outline of considerations which may influence the selection of a motor. A more complete guide form can be found on page 96. Naturally, special problems and conditions may be beyond the scope of these guides. General Electric application engineers are daily helping solve new problems successfully.

1. *Find what power is available, or is desired.**

Polyphase (3- or 2-phase).
Single-phase; or d-c.
Voltage.
Frequency (if alternating current).

* Motor-generator sets are available to convert to the power desired.

2. *Select horsepower needed to drive load.*

(a) By asking manufacturers of machines to be driven what horsepower is required.

(b) By temporarily connecting or belting a motor of a size larger than estimated would be needed, and then measuring the power required by means of wattmeter.

$$\text{Hp} = \frac{\textit{Watts measured} \times \textit{estimated efficiency of motor.}}{746}$$

$$\text{Hp} = \frac{\textit{Torque} \times \textit{speed of shaft (rpm)}}{5280}$$

(c) By consulting handbooks and calculating the power required.

(d) If load is fluctuating or intermittent, or reversing, consult a G-E sales engineer.

3. *Select speed of motor.*

(a) By asking manufacturers of machines to be driven.

(b) By calculating pulley and gear ratio (hp remains the same).

(c) Consider standard speeds of induction motors for direct drive.

(d) Consider standard speeds of gear-motors or speed reducers for low-speed direct drive.

(e) Consider if different speeds of multispeed motor will improve results desired.

(f) Consider if adjustable speed of Speed Variator, adjustable-constant-speed a-c motor, direct-current motor, or wound-rotor motor would be beneficial.

4. *Check starting torque necessary.*

(a) By spring balance at end of pipe wrench applied to shaft to be driven. Torque = spring-balance measurement in pounds, times the distance in feet from center of shaft to where spring balance is fastened to wrench.

(b) By checking manufacturer of machines to be driven. Divide this torque by the torque needed for horsepower required. See 2(b).

TAKE IN SELECTING MOTORS

If the ratio is around 1.25-1.75 or less, use normal-starting-torque motors (if induction motors are to be used).

If the ratio is 2.0 or more, use high-starting-torque motors (if induction motors are to be used).

5. *Examine surroundings and type of drive, and select proper enclosure.*

(a) If ordinary industrial conditions, use open motor.

(b) If splashing liquids or moisture exist, use splashproof motors.

(c) If excessive conditions of moisture, fumes, etc., are prevalent, use totally enclosed, fan-cooled motors, or open motors with special insulation.

(d) If outdoors in mild climate, use splashproof motors, but regular check will have to be made.

(e) Best motor for outdoors, all climates—totally enclosed, fan-cooled (extreme cold may necessitate heaters for lubricant).

(f) If exposed to explosive-gas atmosphere, no more hazardous than gasoline, use motors built for conditions identified as Class I, Group D.

(g) If exposed to explosive-dust atmosphere, no more hazardous than flour, use motors built for conditions identified as Class II, Group G.

6. *Determine type of bearing.*

(a) Sleeve bearings for horizontal operation.

(b) Ball bearings, if preferred, and to take end thrust.

(c) Ball bearings, if motor is tilted or vertical.

7. *Consider capacity of power line.* (*See 1.*)

(a) Check with power company the permissibility of starting motors at full voltage.

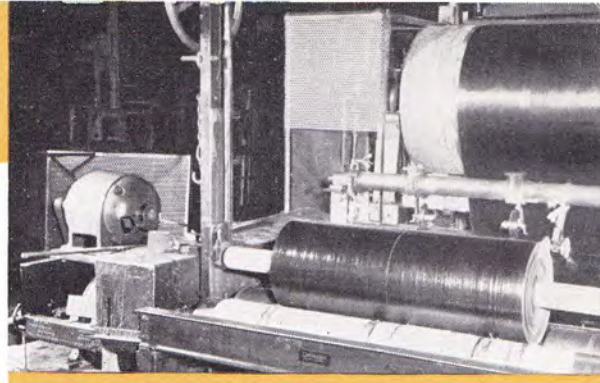
(b) Investigate advantage of improving power factor by adopting a synchronous motor as the drive.

8. *Having done these, check G-E Pictorial Selector, pages 6-17, and determine type.*

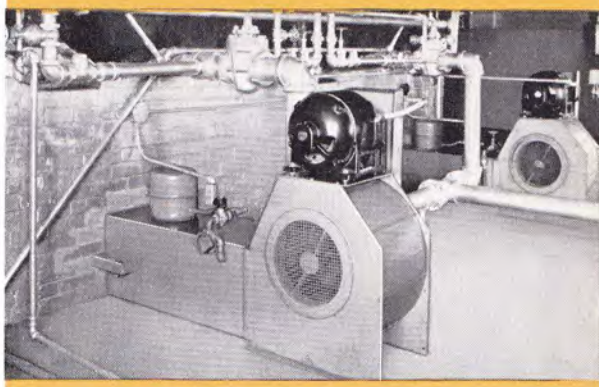
9. *Specify:*

Type	Phase	Mounting arrangement
Horsepower	Frequency	Speed range, if variable
Speed	Enclosure	Shunt-, compound-, or series-wound, if d-c
Voltage	Bearings	

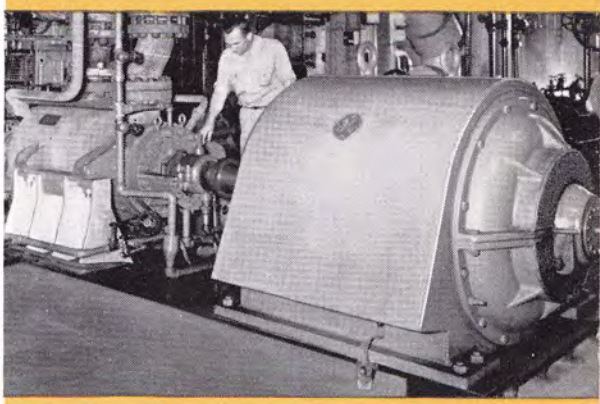
10. *Order from the salesman who gave you catalog, or directly from the nearest G-E office.*



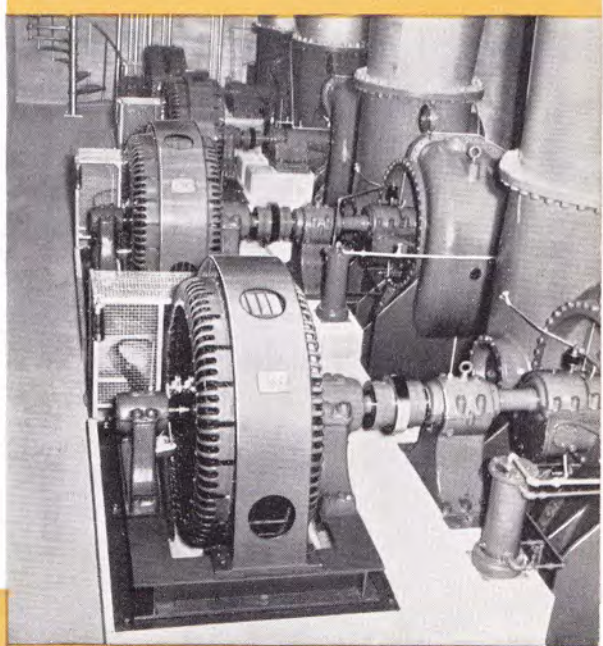
Tri-Clad motor driving a paper-coating machine



Tri-Clad motors and modern industrial stoker



A 800-hp, 3600-rpm, boiler-feed-pump motor



Synchronous motors driving irrigation pumps in Texas

SUMMARY OF PRINCIPAL TYPES

TABULATED BY POWER SUPPLY

POLYPHASE

Fractional-hp Motors

Type K—General-purpose.

Type M—Wound-rotor.

Integral-hp Induction Motors

Type K—Normal-starting-torque, low-starting-current.

Type KG—High-starting-torque, low-starting-current.

Type KR—High-starting-torque, low-starting-current, high-slip.

Type KE—Quiet-operating elevator motors.

Type M—Wound-rotor, adjustable-varying-speed.

Type BTA—Commutator-type, adjustable-constant-speed.

Integral-hp Synchronous Motors

Type SK—Reluctance (small-hp).

Type TS—High- and low-speed (large-hp).

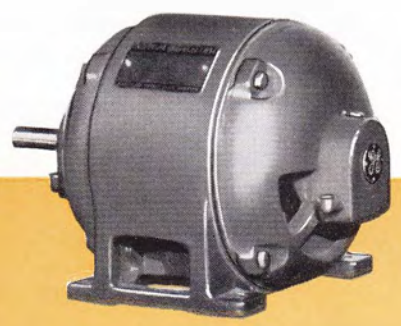
Integral-kw A-c Generators

Type A—Revolving-armature, high-speed.

Type ATB—Revolving-field.

Type MM—Two-unit induction frequency converters.

Type MMA—Single-unit induction frequency converters.



SINGLE-PHASE

Fractional-hp Motors

Type KSP—Shaded-pole.

Type P—Series, universal.

Type KH—Split-phase, normal-starting-torque.

Type KC—Capacitor-start, high-starting-torque.

Type KCP Permanent-split-capacitor, low-starting-torque.

Type BA—Series-motor parts.

Type SMY—Reluctance, low synchronous speed.

Integral-hp Motors

Type KC—Normal-starting-torque, capacitor.

Type KCJ—High-starting-torque, capacitor.

Type SCR—Repulsion-induction.

Type RB—Adjustable-varying-speed, repulsion.

Type SCA—Reversible, repulsion-induction.

DIRECT-CURRENT

Fractional-hp Motors

Type BC—Shunt-wound.

Type P—Series, universal.

Integral-hp Motors

Types B & CD—Shunt, contant-speed. Compound, constant-speed; shunt-wound adjustable-speed; series, varying-speed.

Type MD—Mill-type, totally enclosed motors.

Type MDP—Mill-type, protected self-ventilated motors.

Type CO—Heavy-crane-duty motors.

Integral-kw D-c Generators

Types B & CD—High-speed generators.

Type LDR—Low-speed generators.

Type MPC—High- and low-speed generators, larger ratings.

Type MCF—Compensated-winding, large-size generators.

PRINCIPAL TYPES OF ENCLOSURES AVAILABLE FOR G-E MOTORS

Conditions Around Motor	POWER SUPPLY		
	Polyphase	Single-phase	Direct-current
Normal service	Open	Open	Open
Flying objects and dripping liquid	Open, f-hp sizes; Tri-Clad, 1-100 hp; Dripproof, larger	Open, f-hp sizes; Tri-Clad, integral-hp capacitor; Dripproof-protected, repulsion-ind.	Open, f-hp; Protected, integral-hp; Dripproof-protected, integral-hp
Splashing, hosing	Splashproof	Splashproof	Splashproof
Extreme dust or Corrosive fumes or Extreme moisture, acids, or alkalis	Totally enclosed to 3 hp; Totally enclosed, fan-cooled to 600 hp; Totally enclosed, self-ventilated; Totally enclosed, surface-cooled	Totally enclosed, f-hp Totally enclosed, 1 to 3 hp—Type SCR only Totally enclosed, fan-cooled, Type SCR only	Totally enclosed to 3 hp Totally enclosed, fan-cooled to 60 hp Totally enclosed, separately ventilated
Outdoor mild climates	Enclosed, waterproof, f-hp; Splashproof, integral-hp	Enclosed, waterproof, f-hp; Splashproof, integral-hp	Enclosed, waterproof, f-hp; Splashproof, integral-hp
Outdoor damp and cold	Enclosed, waterproof, f-hp; Totally enclosed to 3 hp Totally enclosed, fan-cooled to 600 hp	Enclosed, waterproof, f-hp; Totally enclosed to 3 hp, Type SCR only Totally enclosed, fan-cooled, Type SCR only	Enclosed, waterproof, f-hp; Totally enclosed, waterproof to 3 hp Totally enclosed, fan-cooled, waterproof
Explosive gases	Explosion-proof for Class I, Group D, conditions	Explosion-proof for Class I, Group D, conditions, Type SCR only	Explosion-proof for Class I, Group D, conditions
Explosive dusts	Motors for Class II, Group G, conditions	Motors for Class II, Group G, conditions, Type SCR only	Motors for Class II, Group G, conditions
Coal dust and gases in mines	Class BM motors—inspected and tested by Bureau of Mines	.....	Class BM motors—inspected and tested by Bureau of Mines

G-E MOTOR TYPES BY SPEED CLASSIFICATIONS

Speed Classification	POWER SUPPLY		
	Polyphase	Single-phase	Direct-current
Constant-speed	Synchronous, Types TS and SK	Synchronous inductor, Type SMY	Flat-compounded
Constant-speed (close regulation)	Squirrel-cage, Types K, KG; Wound-rotor, no regulating resistance, Type M	Split-phase, Type KH; Capacitor Types KC, KCJ, KCP; Repulsion-induction, Types SCR, SCA	Constant-speed motor
Constant-speed (wide regulation)	Squirrel-cage, Type KR; Wound-rotor, some regulating resist.	.....	Compounded, over and under
Varying-speed	.....	Universal, Type P	Universal, Type P
Adjustable-varying-speed	Wound-rotor, Type M, with secondary control	Brush-shifting; repulsion-induction, Type RB	Series-wound motor; Constant-speed motor, arm. control
Adjustable-constant-speed	Brush-shifting motor, Type BTA; G-E Speed Variator; Squirrel-cage motors with variable-frequency supply	Permanent-split capacitor-motor with regulator and tapped winding	Adjustable-speed motor; Shunt motor with adjustable-voltage supply
Multispeed	Two-winding and consequent-pole-wound, squirrel-cage	Multispeed capacitor-motor	.....
High-speed	Squirrel-cage, high-frequency, Type KT built-in motors	Universal, Type P	Universal, Type P
Low-speed	Gear-motors or speed reducers; Synchronous motors, Type TS	Gear-motors or speed reducers; Synchronous inductor, Type SMY	Gear-motors or speed reducers

MOTORS AND CONTROL

The apparatus described in this catalog will be sold subject to the Company's standard domestic terms of sale.

STANDARD DOMESTIC TERMS OF SALE

Prices: Prices are subject to change without notice. This catalog is prepared to supply general information and is not a quotation or offer to sell on the part of the *Company*. Information as to current prices can be obtained from the nearest General Electric sales office. The minimum billing charge shall be $1.00 plus transportation charges.

Boxing: Prices include boxing or packing for domestic shipment.

Discounts: Discounts are allowed on orders for GO-7 motors (or GO-10 control) exceeding $500. For further details, refer to the *Company* at time of purchase.

Payment: Cash in full within 30 days from date of shipment.

If, in the judgment of the *Company*, the financial condition of the *Purchaser* at any time does not justify continuance of production or shipment on the terms of payment specified, the *Company* may require full or partial payment in advance.

Pro rata payments shall become due as shipments are made. If shipments are delayed by the *Purchaser*, payments shall become due from date when the *Company* is prepared to make shipment. If manufacture is delayed by the *Purchaser*, payment shall be made based on the contract price and per cent of completion. Apparatus held for *Purchaser* shall be at the risk and expense of the *Purchaser*.

Title: The *Company* reserves the right to retain title to any apparatus sold and to have such apparatus remain personal property until all payments shall have been made in full in cash.

Taxes: The amount of any present or future sales or other similar tax applicable to the apparatus sold shall be added to the purchase price and shall be paid by the *Purchaser* in the same manner and with the same effect as if originally added thereto.

Delivery: Delivery shall be made f.o.b. point of shipment, transportation to any railroad destination in the U.S.A. prepaid free of expense to the *Purchaser*, provided the *Company* is allowed to select:

1. The point of origin of shipment.
2. The method of transportation.
3. The routing of shipment.

Additional delivery expense incurred will be paid by the *Purchaser*.

Shipping dates supplied by the *Company* are approximate, are subject to intervening requirements of the National Defense Program or of any war in which the United States may be engaged, and are based on prompt receipt of all necessary information at the factory. In case of delay in furnishing complete information, dates of shipment may be extended for a reasonable time based on conditions at the factory.

The *Company* shall not be liable for delay in delivery due to causes beyond its reasonable control or due to acts of God, acts of the *Purchaser*, fires, strikes, floods, epidemics, quarantine restrictions, war, insurrection or riot, civil or military authority, compliance with priority orders or preference ratings issued by the Government, freight embargoes, car shortages, wrecks or delays in transportation, unusually severe weather, or inability to obtain necessary labor, materials, or manufacturing facilities due to such causes, and in the event of any such delay the date of delivery shall be extended for a length of time equal to the period of the delay. The *Company* shall not be liable in any event for special or consequential damages due to delay in delivery.

Warranty: The *Company* warrants that the apparatus sold will be of the kind and quality described in the specifications, and no other warranty, except of title, shall be implied. The conditions of any tests shall be mutually agreed upon and the *Company* shall be notified of, and may be represented at, all tests that may be made. If any failure to comply with the specifications appears within one year from the date of shipment, the *Purchaser* shall notify the *Company* thereof immediately and the *Company* shall thereupon correct the defect, or defects, by repair, or by replacement f.o.b. factory of the defective part or parts. But if the apparatus is installed or its installation supervised by the *Company*, said one year shall run from the completion of installation provided same is not unreasonably delayed by the *Purchaser*. The liability of the *Company* (except as to title) arising out of the supplying of said apparatus or its use, whether on warranties or otherwise, shall not in any case exceed the cost of correcting defects in the apparatus, and upon the expiration of said one year, all such liability shall terminate.

It is understood that if the *Purchaser* fails to comply with the stipulated conditions of operation or fails to permit the *Company* to inspect defects before repairing, or alters or adds to the product in any way, the *Company's* responsibility shall terminate.

Patents: The *Company* will defend any suit or proceeding brought against the *Purchaser* so far as based on a claim that any apparatus, or any part thereof, sold by the *Company* constitutes an infringement of any patent of the United States, if notified promptly in writing and given authority, information, and assistance (at the *Company's* expense) for the defense of same, and the *Company* shall pay all damages and costs awarded therein against the *Purchaser*. In case said apparatus or any part thereof is in such suit held to constitute infringement and the use of said apparatus or part is enjoined, the *Company* shall, at its own expense, either procure for the *Purchaser* the right to continue using said apparatus or part; or replace same with noninfringing apparatus; or modify it so it becomes noninfringing; or remove said apparatus and refund the purchase price and the transportation and installation costs thereof. The foregoing states the entire liability of the *Company* for patent infringement by said apparatus or any part thereof.

FRACTIONAL-HP POLYPHASE SQUIRREL-CAGE INDUCTION MOTORS

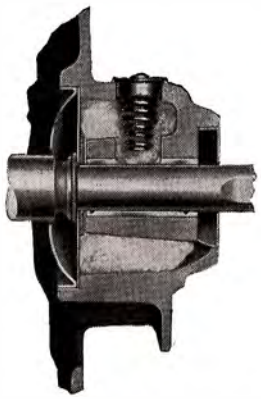
GENERAL ELECTRIC fractional-horsepower polyphase squirrel-cage motors are built to give dependable, low-cost service. The two general types of construction available are suitable for the large majority of industrial applications requiring constant-speed operation. These are the standard general-purpose type and the industrial and machine-tool type.

Standard General-purpose Motor Construction

These motors, with their dripproof construction, heavy steel base, and sleeve or ball bearings, are particularly useful for applications of a general character where motor drive from a polyphase industrial circuit is needed.

The outstanding features of these motors include:

1. Strong, welded, rolled-steel frame with uniform air gap for maximum performance.
2. Windings of Formex wire, effectively insulated to prevent short circuits, grounds, etc., even under conditions of moisture, oils, mild acids, and alkalis.
3. A one-piece, cast-aluminum rotor winding which is practically indestructible.
4. Sturdy end shields to give rigid support to rotating parts.
5. Sleeve bearing concentrically bored to mirror-like finish for long bearing life and quiet operation—oiling required but once a year.
6. Accurately fitted, aligned, and protected ball bearings require greasing only once every two years.



Cutaway view of wool-packed sleeve bearing

Fractional-hp Type K polyphase induction motors

F-hp General-purpose, Constant-speed Motors

Solid Base—3- or 2-phase, 60/50 Cycles

TYPE K, POLYPHASE			MODIFICATION CLASS (SEE TABLE AT RIGHT)	OPEN SLEEVE-BEARING	TOTALLY ENCLOSED, BALL-BEARING
Frame	Hp	Speed, Rpm		220 and 440 Volts	220 and 440 Volts
43	1/6	1725	B	* $16.00	* $20.75
45		1140	B	* 18.00	* 22.75
63		860	C	30.00	35.50
47	1/4	3450	B	* 16.00	* 20.75
43		1725	B	* 16.00	* 20.75
45		1140	B	* 23.00	* 27.75
63		860	C	36.00	41.50
47	1/3	3450	B	* 18.00	* 22.75
45		1725	B	* 18.00	* 22.75
63		1140	C	30.00	35.50
73		860	C	45.00	50.50
49	1/2	3450	B	* 23.00	* 27.70
63		1725	C	25.00	30.50
73		1140	C	36.00	41.50
67	3/4	3450	C	32.00	37.50
73		1725	C	32.00	37.50
73	1	3450	C	38.00	43.50

* For 220 volts only. Add 10% to open sleeve-bearing-motor prices for 440 volts.

ADDITIONAL INFORMATION

Modifications

1. **General Information**
2. **Special Shafts**

} See page 62.

	Price Addition	
	Lots 1	
	Class B	Class C
3. Standard Voltages		
(a) 110 or 550 volts	10%	10%
(b) 440 volts	10%	....
(c) 380 volts—50 cycles	10%	....
(d) 220/440 or 220/380 volts	20%	....
4. Enclosure		
Both end shields	**$1.00**	**$1.50**
5. Explosion-proof		
Class I, Group D, solid base, single-voltage	**8.00**	**12.00**
6. Ball Bearings		
For horizontal or vertical service	**3.75**	**4.00**

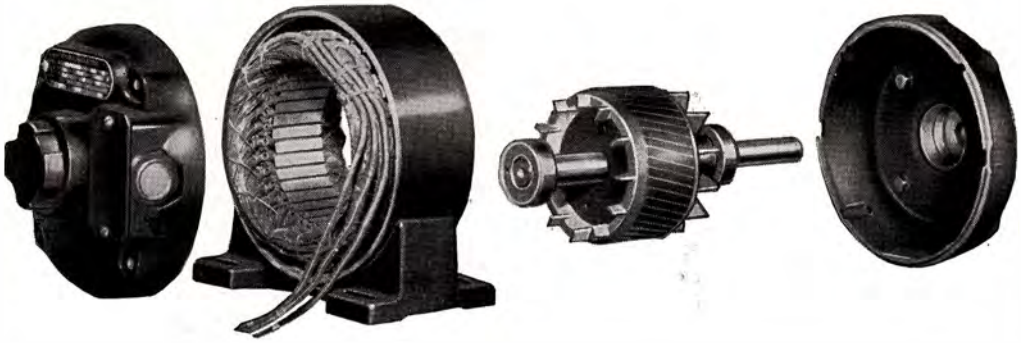
Dimensions: Open—GEM-851 and page 79.
Explosion-proof—GEM-872.
Descriptive Publication: GEA-1974.
Control: See page 72.

Industrial and Machine-tool Motor Construction

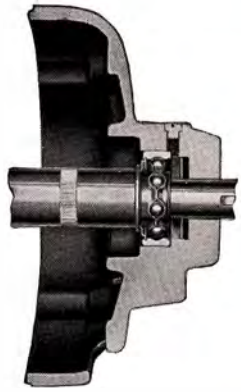
These motors are of totally enclosed, ball-bearing construction. They have a rigid base and extra features which make them particularly useful on industrial applications where frequent "start-stop" service, plugging, and metal-dust atmospheres are encountered. Their major features are as follows:

1. Firmly anchored windings to stand up under start-stop service and momentary overload plugging.
2. Totally enclosed construction prevents the entrance of dust, chips, compounds, etc., from the motor.
3. Rigid base for permanent alignment on machines.
4. Ball bearings to meet thrust conditions where encountered.
5. Variety of mountings available for ease and convenience in "tailoring" motors to fit the machines they are to drive.
6. Convenient conduit box permits connections to be made easily, quickly, and permanently.

Fig. 1
The sturdy Type K fractional-hp motors for machine-tool and other industrial applications



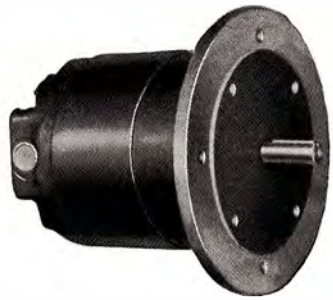
Disassembled view, showing construction details of G-E machine-tool motors



Compact, rigid ball-bearing construction

Rabbeted machine mounting, Style F-1

Flat-face mounting, Style F-2



Flange mounting, Style F-3

Industrial or Machine-tool Motor—3-phase or 2-phase, 60 Cycles, A-c—Totally Enclosed, Ball-bearing

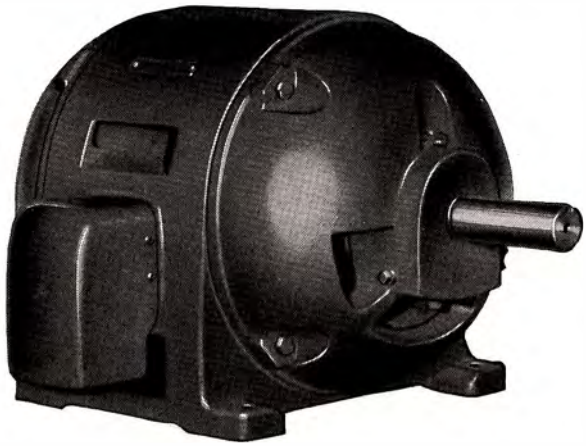
Hp 55 C Rise	60 CYCLES, THREE-PHASE 1725 RPM (LIKE FIG. 1)			50 CYCLES, THREE-PHASE 1425 RPM (LIKE FIG. 1)		
	Volts	Model No.	Price	Volts	Model No.	Price
¼	220 440 550	5K43AC2026 5K43AC2027 5K43AC2028	**$20.75** **22.35** **22.35**	220 440 ...	5K43AC2029 5K43AC2030	**$20.75** **22.35** .....
⅓	220 440 550	5K45AC1601 5K45AC1602 5K45AC1603	**22.75** **24.55** **24.55**	220 440 ...	5K45AC1604 5K45AC1605	**22.75** **24.55** ...
½	220 440 550	5K63AC2257 5K63AC2258 5K63AC2259	**30.50** **30.50** **33.00**	220 440 ...	5K63AC2265 5K63AC2266	**30.50** **30.50** .....
¾	220 440 550	5K65AC136 5K65AC137 5K65AC138	**37.50** **37.50** **40.70**	220 440 ...	5K65AC139 5K65AC140	**37.50** **37.50** ...

For prices of Styles F-1, F-2, and F-3, refer to the Company.

INTEGRAL-HP TRI/CLAD POLYPHASE SQUIRREL-CAGE MOTORS

Open, Constant-speed

NO OTHER standard motor, we believe, has ever met the requirements of industry with so well-balanced a combination of performance characteristics, convenience features, and provisions for protection. Streamline appearance—smooth, quiet performance—ample starting, pull-up, and maximum torque—protection—low starting current—all cast-iron enclosure—new bearing designs—New Formex wire insulation system. These and many other features make the new Tri-Clad motor applicable to a much wider field of use than any previous general-purpose design. Wherever you have a general-purpose application, and need a *constant-speed*, economical, dependable drive, specify Tri-Clad motors.



Tri-Clad motor, typical of larger sizes

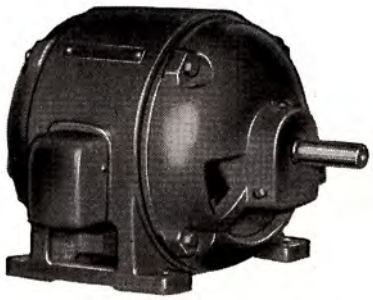
Electrical Types (See page 104)

The Tri-Clad Type K motor is a normal-torque, normal-slip motor that has low-starting-current characteristics which make it widely acceptable for full-voltage starting, thus permitting the use of a simple, inexpensive control of the across-the-line type.

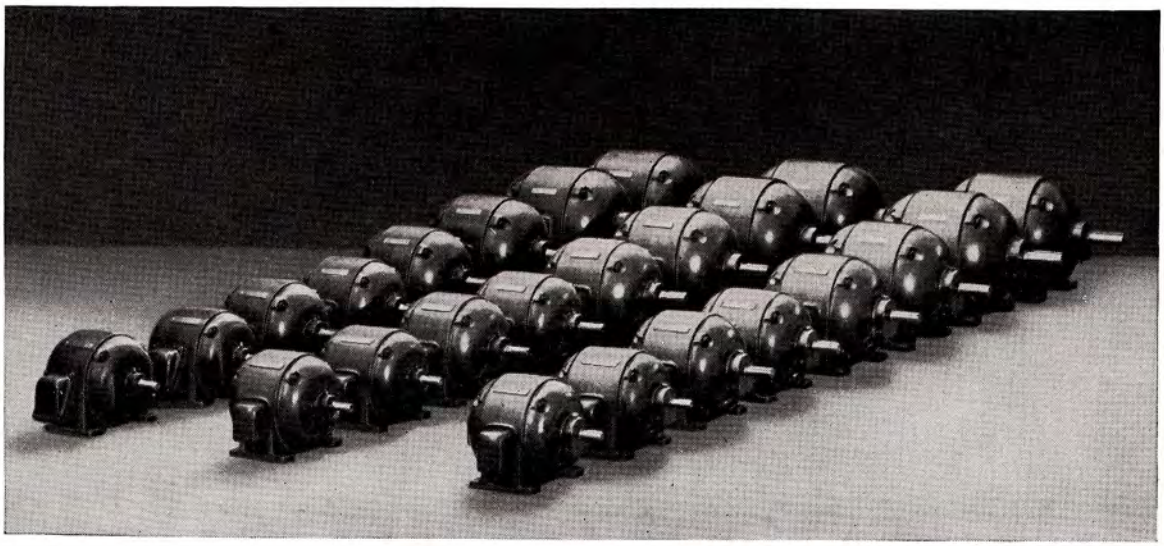
The Tri-Clad motor is also built in the Type KG high-starting-torque, high-slip construction which is particularly suitable for starting such applications as loaded compressors, conveyors, etc.

The Tri-Clad motor is also available in Type KR, a high-starting-torque, high-slip electrical design. This type of construction lends itself best where pulsating flywheel loads are encountered or frequent starting and reversing may be necessary.

Multispeed motors having two, three, or four different constant speeds are also available.



Tri-Clad motor, typical of smaller sizes

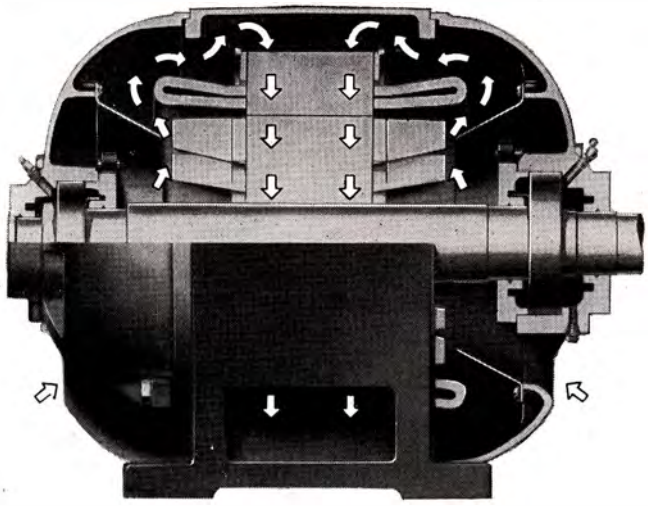


Tri-Clad motors with uniform construction and appearance, from the smallest to the largest

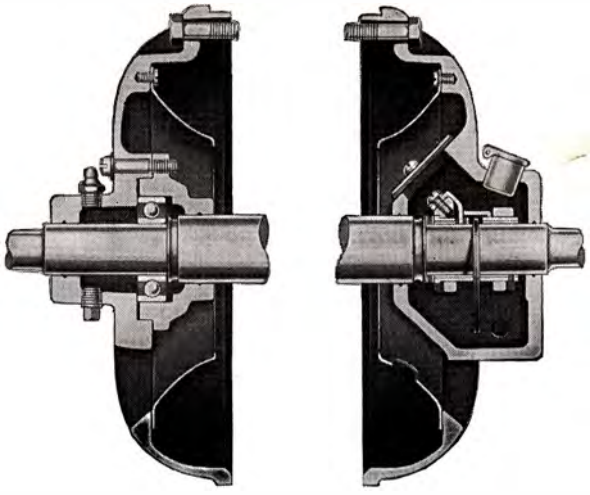
Mechanical Construction

The following features of Tri-Clad motors are of outstanding importance.

1. They have extra protection against physical damage. The one-piece cast-iron frame and end shields protect the vital parts from external blows, falling objects, dripping liquids—keep them safe and secure even under "slam-bang" conditions. The entire stator frame, including integrally cast feet, is built to give all-round strength without excess weight.
2. They have extra protection against electrical breakdown. The stator windings are of Formex wire—the toughest magnet wire ever developed—which gives extra protection against moisture, oil, abrasion, and heat aging. New synthetic bonding varnish and Glyptal No. 1201 Red on end windings make a sturdy unit with a durable finish.

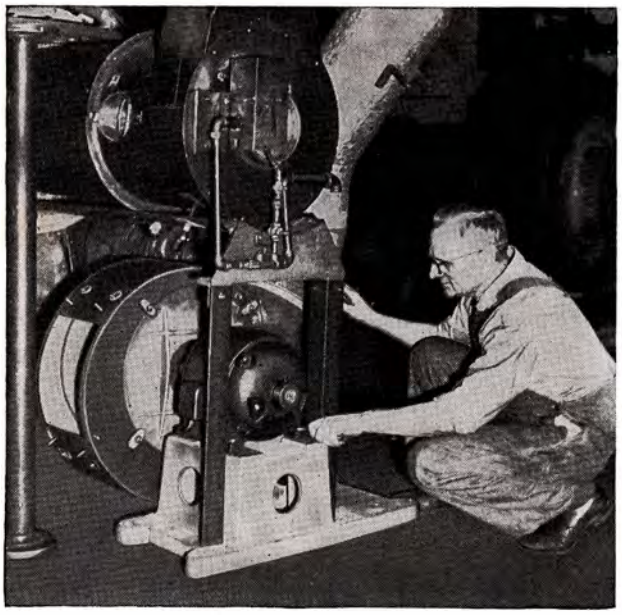


Cutaway view of Tri-Clad ball-bearing motor, showing compact construction and double-end ventilation

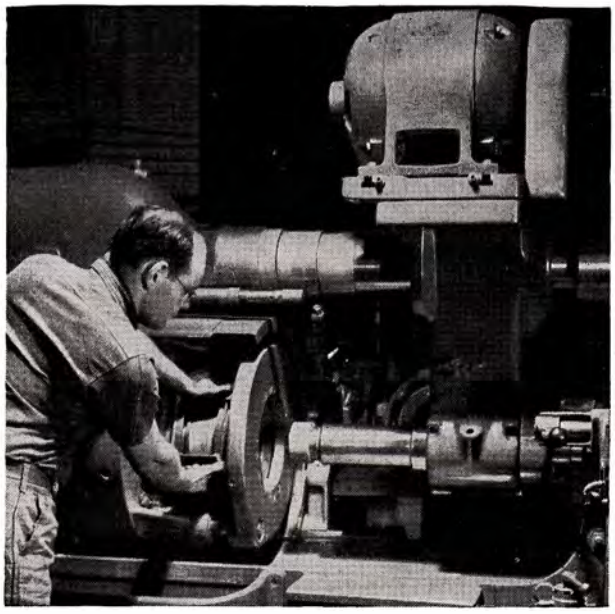


Cutaway views showing internal construction of ball-bearing and sleeve-bearing end shields

3. They have extra protection against operating wear and tear. Sleeve bearings of new design have a scientifically determined length and diameter, and a method of grooving that assures a continuous oil film over the entire bearing surface. A new and simple ball-bearing mounting assures correct alignment. Bearings can be cleaned and greased without disassembly.
4. Tri-Clad motors have a modern streamline appearance that harmonizes with the most modern machine design and factory layout.
5. Tri-Clad motors have extra convenience features which help you to install them faster and to keep them in service with less attention. You save time with the new Tri-Clad motors because they are easy to handle, are quickly mounted, are easy to wire, and are convenient to lubricate.



Tri-Clad motors are easy to install



Tri-Clad motors give smooth, efficient performance

Open, Horizontal Squirrel-cage Induction Motors

3- and 2-phase, 60 and ‡50 Cycles—110 (326 Frame and below), 208, 220, 440, 550 Volts, Constant-speed—Full-voltage Starting*

† Frame	Hp, Continuous, 40 C Rise	Sync Speed, Rpm	Prices: TYPE K MOTOR ONLY Sleeve-bearing	TYPE K MOTOR ONLY Ball-bearing	TYPE KG MOTOR ONLY Sleeve-bearing	TYPE KG MOTOR ONLY Ball-bearing
204	¼	600	$50	$54		
204	⅓	720	50	54		
224		600	59	63		
204	½	900	44	48		
224		720	59	63		
225		600	66	70		
203	¾	1200	39	43		
224		900	51	55		
225		720	66	70		
254		600	80	84		
203	1	1800	35	39		
204		1200	42	46		
225		900	58	62		
254		720	80	84		
254		600	89	93		
203	1½	3600	44	48		
204		1800	42	46		
224		1200	49	53		
254		900	70	74		
254		720	89	93		
284		600	97	102		
204	2	3600	51	55		
224		1800	49	53		
225		1200	55	59		
254		900	81	85		
284		720	97	102		
324		600	123	129		
224	3	3600	58	62		
225		1800	55	59		
254		1200	67	71	$70	$74
284		900	92	97	97	102
324		720	123	129	...	...
326		600	147	154	...	...
225	5	3600	70	74		
254		1800	67	71	70	74
284		1200	88	92	92	97
324		900	118	124	124	130
326		720	147	154	...	...
365		600	194	204	...	...
254	7½	3600	92	97		
284		1800	88	92	92	97
324		1200	112	118	118	124
326		900	141	148	148	155
365		720	194	204	...	...
404		600	238	250	...	...
284	10	3600	118	124	...	...
324		1800	112	118	118	124
326		1200	134	141	141	148
364		900	176	185	189	198
404		720	238	250	...	...
405		600	279	293	...	...
324	15	3600	141	148	...	...
326		1800	134	141	141	148
364		1200	176	185	189	198
365		900	216	227	232	244
405		720	279	293	...	...
444		600	321	337	...	...
326	20	3600	168	176	...	...
364		1800	160	168	172	181
365		1200	216	227	232	244
404		900	254	267	273	287
444		720	321	337	...	...
445		600	400	420	...	...

If motors with 225 per cent starting torque are required in ratings 3 hp, 1800 rpm, and smaller use Type K prices and specify 225 per cent starting torque

† Frame	Hp, Continuous, 40 C Rise	Sync Speed, Rpm	Prices: TYPE K MOTOR ONLY Sleeve-bearing	TYPE K MOTOR ONLY Ball-bearing	TYPE KG MOTOR ONLY Sleeve-bearing	TYPE KG MOTOR ONLY Ball-bearing
364S	25	§3600	$194	$204	...	...
364		1800	185	194	$199	$209
404		1200	254	267	273	287
405		900	292	307	336	353
445		720	400	420	...	...
504		600	463	486	...	...
364S	30	§3600	267	280	...	...
365		1800	254	267	273	287
405		1200	292	307	336	353
444		900	364	382	419	440
504		720	463	486	...	...
505		600	546	573	...	...
365S	40	§3600	322	338	...	...
404		1800	307	322	353	371
444		1200	364	382	419	440
445		900	421	442	484	508
505		720	546	573	...	...
542		600	615	646	...	...
404S	50	§3600	401	421	...	...
405		1800	382	401	439	461
445		1200	421	442	484	508
505		900	496	521	570	599
542		720	632	664	...	...
546		600	696	731	...	...
405S	60	§3600	464	487	...	...
444S		1800	444	464	508	533
505		1200	496	521	570	599
542		900	572	601	658	691
546		720	699	734	...	...
556		600	791	831	...	...
444S	75	§3600	599	629	...	...
445S		§1800	521	547	599	629
542		1200	595	625	684	718
546		900	672	706	773	812
556		720	803	843	...	...
558		600	909	954	...	...
445S	100	§3600	833	875	...	...
542S		§1800	666	699	766	804
544		1200	779	818	896	941
556		900	824	865	948	995
558		720	986	1035	...	...
6334		600	1116	1172	...	...
539Z	125	§3600	1032	1084		
546S		§1800	794	834		
546S		§1200	928	974		
558		900	1043	1095		
6334		720	1152	1210		
6335		600	1280	1344		
549Z	150	§3600	1196	1256		
547S		§1800	920	966		
557S		§1200	1078	1132		
558		900	1205	1265		
6335		720	1290	1355		
564		600	1436	1508		
549Z	200	§3600	1528	1604		
557S		§1800	1175	1234		
559S		§1200	1410	1481		
6335		§900	1520	1596		
564		720	1550	1628		
566		600	1729	1815		

ADDITIONAL INFORMATION

*** Full-voltage Starting**—The newly designed Type K Tri-Clad motors have starting and running characteristics which permit them to replace entirely former Types K and KF. Their low currents make them acceptable for full-voltage starting, except where limited line capacity may necessitate the use of current-reducing controllers. For low-starting-current motors in frame sizes other than Tri-Clad, Type KF motors are available.

† Optional Frames—Motors in Frames 203 through 445 are now of Tri-Clad construction. The horsepower ratings of Tri-Clad motors, Frames 364 through 445, are built, even with superior operating performance, in standardized smaller frame sizes than they are in other than Tri-Clad construction. Motors of other than Tri-Clad construction in the larger frames are available on request.

‡ 50-cycle Operation—All open-type, 40 C, general-purpose, 60-cycle polyphase motors, when operated on 50 cycles at maintained voltages, will operate without injurious heating not exceeding 50 C rise. Synchronous speeds are 5/6 of those at 60 cycles.

224/440 Volts: Type K motors (Frame 505 and smaller) for either 220 or 440 volts, three-phase, have nine unconnected leads, with terminals, brought through the terminal board. A suitable nameplate, showing connections, is fastened to the motor frame above the conduit terminal box, so that the purchaser can readily connect for either voltage desired. Likewise, most two-phase motors will have eight leads brought out, so that the purchaser can connect for either 220 or 440 volts. The Type K (Frame 542 and larger) motors are connectible at terminal board for one voltage only.

§ Direct Connection—The motors marked ¶ are for direct connection only, and prices cover motors with standard, straight short shafts.

High Voltage—Motors in Frame 444 and larger are available as standard for operation at 2200 volts. Refer to the Company for prices, frames, and control.

Modifications: See page 64. **Dimensions:** See page 81.

Descriptive Bulletin: GEA-3580. **Control:** See page 72.

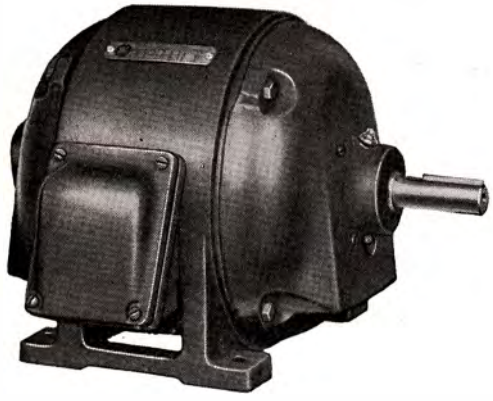
TRI/CLAD SPLASHPROOF POLYPHASE SQUIRREL-CAGE MOTORS

Here is the "cast-iron" answer to application conditions of splashing water or spattering liquids which might make motor operation uncertain in many places. This is a motor designed for use in locations and industries that require hosing down of areas and machines for cleanliness, or where wetness is a factor in everyday production. These motors also can be considered for some outdoor applications in mild climates where regular maintenance is provided.

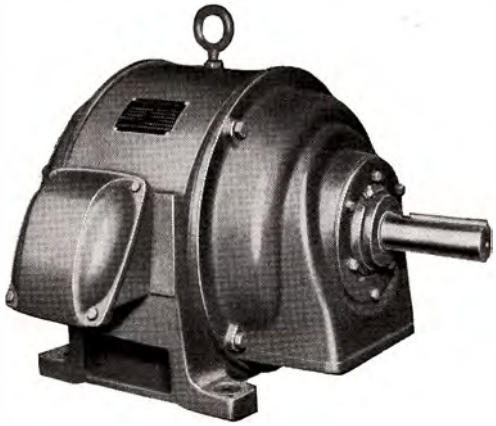
The splashproof design, available in Types K, KG, and KR, incorporates the many advantageous features of the Tri-Clad open motor—streamline appearance, convenience features, protection, and desirable operating characteristics. It also possesses the following important features which help it withstand "splashy" conditions:

1. One-piece cast-iron frame for corrosion resistance
2. Cast-iron deflecting end shields.
3. Cast-integral baffles.
4. Nonabsorptive insulation of tough Formex wire.
5. Moisture-resistant bonding and penetrating varnish and Glyptal No. 1201 Red on windings.
6. Water-tight cast-iron conduit box.
7. Cast-iron enclosed ball bearings for protection of bearing and lubricant.
8. Seal in end shield along shaft, to exclude liquids from the bearing.

Typical applications are found for this motor in tanneries, dairies, breweries, other food-product plants, paper mills, oil fields, etc.



Tri-Clad splashproof motor



Typical splashproof motor in Frame 364 and larger

Splashproof, Horizontal, Ball-bearing, Type K Induction Motors, Constant-speed, Full-voltage Starting

3- and 2-phase; 60 Cycles; 110†, 208, 220, 440, or 550 Volts

Hp	Sync. Speed, Rpm	* Frame	Price	Hp	Sync Speed, Rpm	* Frame	Price
½	900	204	$52	10	3600	284	$133
					1800	324	130
¾	1200	203	47		1200	† 326	153
	900	224	60		900	† 365	203
1	1800	203	43	15	3600	324	160
	1200	204	50		1800	326	153
	900	225	67		1200	† 365	203
					900	404	251
1½	3600	203	52	20	3600	326	188
	1800	204	50		1800	364	186
	1200	224	58		1200	404	251
	900	254	81		900	405	291
2	3600	204	59	25	1800	365	212
	1800	224	58		1200	405	291
	1200	225	64		900	444	340
	900	254	92				
				30	1800	405	291
3	3600	224	67		1200	444	340
	1800	225	64		900	445	415
	1200	254	78				
	900	284	106	40	1800	444	355
					1200	445	415
5	3600	225	79		900	504	488
	1800	254	78	50	1800	445S	434
	1200	284	101		1200	504	488
	900	† 324	136		900	505	567
7½	3600	254	104	60	1800	504S	510
	1800	284	101		1200	505	567
	1200	† 324	130				
	900	† 326	160	75	1800	505S	593

ADDITIONAL INFORMATION

Dimension Prints
Frame 326 and below—GEM-1095—See page 81.
Frame 364 and above—GEM-968—See page 82.

Descriptive Bulletins
Frame 326 and below—GEA-3595.
Frame 364 and above—GEA-1619.

Modifications—See page 64.

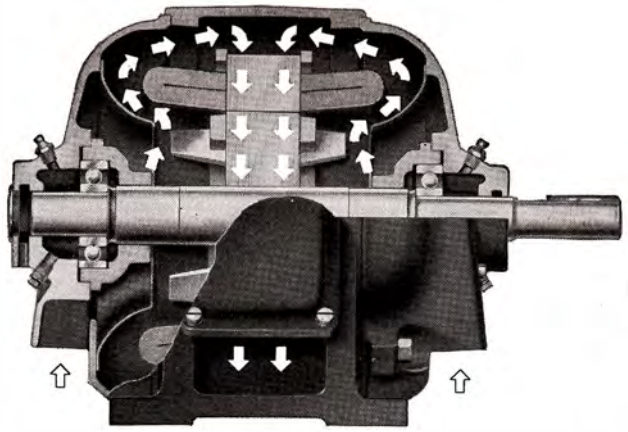
Full-voltage Start—These motors are all suitable for full-voltage starting.

* **Tri-Clad Motors**—Are those built in Frame 326 and below. Motors in larger frames are of an equivalent splash-resisting cast-frame design.

† **Voltages**—110-volt motors are available through Frame 326 as standard. Standard stock motors are reconnectible 220/440 volts, except 2-phase motors in frames marked †.

Control—See page 72.

Other Ratings—Splashproof motors in larger sizes and other speeds are available on request.



Cutaway view, showing internal construction of Tri-Clad splashproof motor

TOTALLY ENCLOSED POLYPHASE SQUIRREL-CAGE MOTORS

Standard Construction

Are the conditions surrounding the equipment you wish to drive abnormally severe? If so, you will want a motor construction that completely protects the windings and the bearings, so that your equipment will keep running dependably and motor maintenance will be low. General Electric totally enclosed motors of standard construction provide this extra protection against severe conditions. These motors are applied where extreme-moisture conditions, abrasive or conductive dusts, acid or alkali fumes, etc. exist. They also are the best "outdoor" motor where the weather is variable and regular attention is not probable or desirable.

Explosion-proof Construction

To reduce the possibilities of explosions and to help keep factory-insurance rates down, General Electric has built and had tested at the Underwriters' Laboratories, Inc. an ever-increasing number of sizes of explosion-proof motors. There are two types of explosion-proof motors.

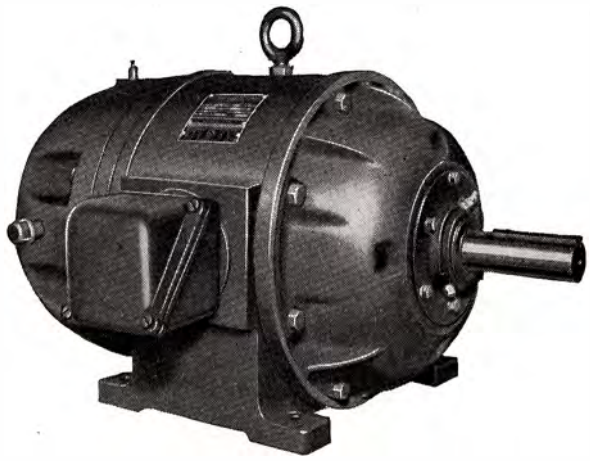
1. The motors tested and listed by the Underwriters' Laboratories for Class I, Group D, conditions are suitable for application in dry-cleaning plants, paint and varnish factories, alcohol and acetone plants, gasoline refineries, and wherever the gas involved is no more hazardous than high-test-gasoline vapor.

2. The motors tested and listed by the Underwriters' Laboratories for Class II, Group G, conditions are suitable for many applications in flour mills, feed mills, grain elevators, starch, sugar, and cocoa plants, and wherever no more-hazardous explosive-dust conditions may prevail.

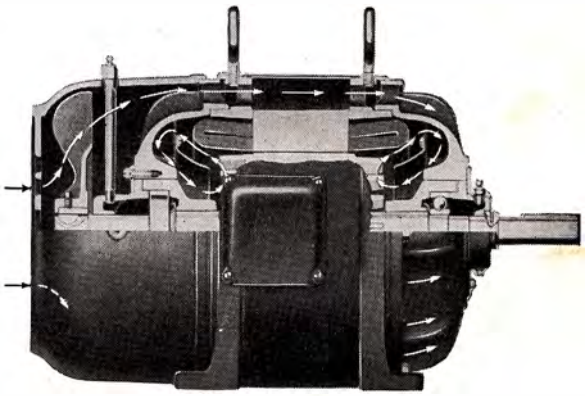
General

Totally enclosed motors are available up through 600-horsepower ratings, and down through the fractional-horsepower sizes. In the larger sizes, they are built with an external cooling fan which keeps their size and cost down. They are furnished in practically all the types in which G-E open motors are built, and have comparable characteristics.

Carefully selected materials of the highest grade have been incorporated in these motors—sturdy cast parts; long, close-fitting machined joints for strength; one-piece, nonsparking-alloy fan; and many other high-quality features make totally enclosed motors the logical choice when "nothing but the best will do."



Totally enclosed, fan-cooled induction motor incorporating the one-piece, cast double-shell stator construction



Cutaway view of totally enclosed, fan-cooled motor, showing the neat, compact arrangement of parts

Explosion-proof, totally enclosed, fan-cooled induction motor

Totally Enclosed, Fan-cooled-Squirrel-cage Induction Motors, Standard and Explosion-proof

Horizontal, 3- and 2-phase, 60 Cycles, Constant-speed, Full-voltage Starting, 110 (326 Frame and below), 208, 220, 440, and 550 Volts

Frame	Hp, Continuous, 55 C Rise	Sync Speed, Rpm	Prices			
			TYPE K, NORMAL-STARTING-TORQUE		TYPE KG, HIGH-STARTING-TORQUE	
			Standard	Explosion-proof	Standard	Explosion-proof
204	½	900	$52	$68		
204	¾	1200	47	63		
224		900	60	78		
204	1	1800	43	59		
204		1200	50	66		
225		900	67	85		
224	1½	3600	68	86		
224		1800	51	69		
225		1200	65	83		
254		900	81	103		
224	2	3600	78	96		
225		1800	76	94		
225		1200	82	100		
254		900	113	135		
224	3	3600	85	103		
225		1800	82	100		
254		1200	99	121	$102	$124
284		900	135	159	140	164
225	5	3600	97	115	...	...
254		1800	99	121	102	124
284		1200	131	155	135	159
324		900	178	209	184	215
*254	7½	3600	124	146	...	...
284		1800	131	155	135	159
324		1200	172	203	178	209
326		900	201	232	208	239
*284	10	3600	161	185	...	...
324		1800	172	203	178	209
326		1200	194	225	201	232
365		900	263	308	276	321
*324	15	3600	201	232	...	...
326		1800	194	225	201	232
365		1200	263	308	276	321
404		900	320	386	336	402
*326	20	3600	228	259	...	...
364		1800	247	292	259	304
404		1200	320	386	336	402
405		900	358	424	377	443
*365S	25	3600	282	327	...	...
365		1800	272	317	286	331
405		1200	358	424	377	443
444		900	438	529	482	573
*404S	30	3600	371	437	...	...
405		1800	358	424	377	443
444		1200	438	529	482	573
445		900	546	637	601	692
*405S	40	3600	477	543	...	...
444		1800	453	544	499	590
445		1200	546	637	601	692
504		900	695	786	758	849
*445Z	50	3600	650	741	...	...
445S		1800	602	693	659	750
504		1200	695	786	758	849
505		900	818	909	890	983
*504Z	60	3600	752	843	...	...
504S		1800	760	851	826	917
505		1200	818	909	890	983
6325		900	1082	1190	1168	1276
*505Z	75	3600	1046	1137	...	...
505S		1800	895	986	973	1063
6325		1200	1105	1216	1194	1305
6325		900	1182	1300	1283	1401
*6325Z	100	3600	1441	1585	...	...
6325S		1800	1176	1294	1276	1394
6325		1200	1289	1418	1406	1535
6326		900	1566	1723	1690	1847
*6326Z	125	3600	1759	1935		
6326S		1800	1509	1660		
6326S		1200	1763	1939		
6333		900	1982	2180		
*6328Z	150	3600	2038	2242		
6328S		1800	1748	1923		
6333S		1200	2048	2253		
6335		900	2290	2519		
*6329Z	200	3600	2603	2863		
6333S		1800	2233	2456		
6335S		1200	2679	2943		
6338S		900	2888	3177		

Totally Enclosed Not Fan-cooled: 204, 224, 204, 204, 225, 224, 224, 225, 254

Totally Enclosed Not Fan-cooled: 204, 224, 204, 204, 225, 224, 224, 225, 254

If motors with 225% starting torque are required in these sizes, use Type K prices and specify 225% starting torque.

ADDITIONAL INFORMATION

Low-starting-current Motors—All these motors are designed to withstand full-voltage starting. Type KG motors have low starting current. Type KF low-starting-current motors are available, 7½ hp and up, at no extra cost, and can be considered where a system of limited line capacity is encountered. (See page 119.)

***3600-rpm Motors**—Are furnished Type KF only. Orders must specify both the direction of rotation wanted and the direction of air flow desired. (Air flow, Frame 504 and larger, toward pulley end only.)

Explosion-proof—The motors listed are for Class I, Group D, hazardous-gas conditions, and have been tested and listed by the Underwriters' Laboratories.

Motors for Class II, Group G Conditions—Motors in Frame 6339 and smaller can be furnished for Class II, Group G conditions, and can be obtained with the Underwriters' Laboratories label. Prices are the same as for standard fan-cooled motors. These motors must be ordered specially (standard fan-cooled motors in stock are NOT applicable) to insure their meeting the Underwriters' Laboratories specifications.

Enclosed (Not Fan-cooled)—The motors so listed do not have fans, as they can be more economically furnished with smaller dimensions without them. Motors in ratings 2-15 hp can be obtained not fan-cooled, but at progressively increased prices and dimensions as the size increases.

Smaller-hp Enclosed Motors—See page 23.

220/440 Volts—Same as for open motors.

Modifications—See page 64.

Control—See page 72.

Descriptive Bulletins—Standard, GEA-1326.
Explosion-proof, GEA-1341.

Dimensions—See page 82.

Not fan-cooled, standard, GEM-549.
Explosion-proof, GEM-861.

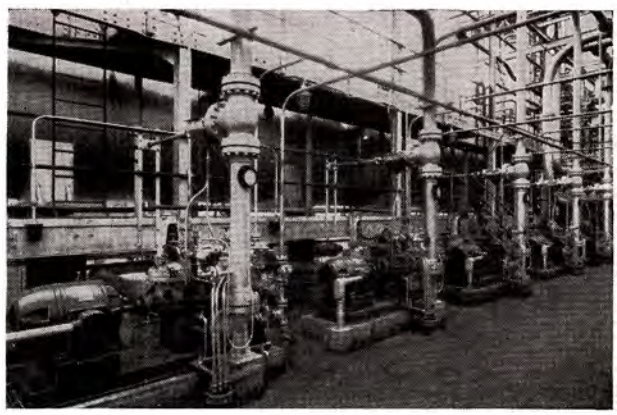
Fan-cooled, standard and explosion-proof, Frames 204-326, GEM-860.

Fan-cooled, standard, Frames 364-505, GEM-853.

Fan-cooled, standard, Frames 364-505, GEM-766.

Fan-cooled, explosion-proof, Frames 364-505, GEM-854.

Fan-cooled, standard and explosion-proof, Frames 364-505, GEM-767.

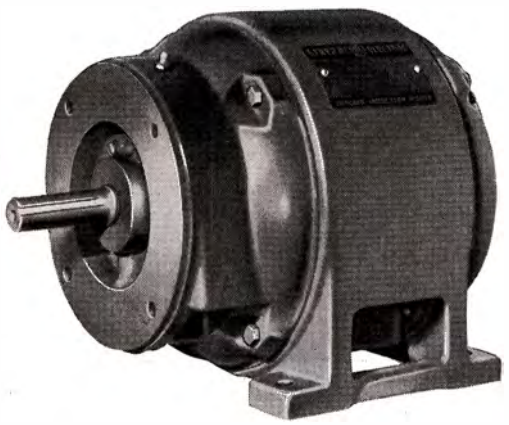


G-E drives provide dependable, economical service, combined with protection against explosion, for these centrifugal pumps operating out of doors in a large Texas refinery

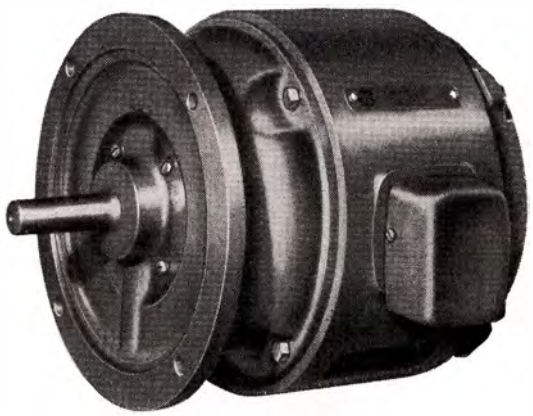
TRI/CLAD MOTORS

WITH FACE-TYPE AND "STYLE B" FLANGE-TYPE END SHIELDS

Of great convenience to many manufacturers of machines, pumps, fans, etc., are the complete lines of standard end-shield-mounted motors that can be obtained from General Electric. These motors provide an economical means of building the motor and driven machine into a compact unit which is attractive in appearance. The motors may be either mounted on the driven unit or the driven unit may be fitted onto the motor itself. What's more, many different kinds of G-E motors, all in a wide range of horsepower ratings, have the same mounting dimensions. Thus, the best type and size of motor can be selected for the different conditions encountered, without, in most cases, any changes in housing of the driven machine. Price additions are listed below. It is merely necessary to select the rating and construction desired—open, fan-cooled, direct-current (to Frame 284), or single-phase—and make the addition as shown for the corresponding frame size of the motor selected.



Tri-Clad induction motor, foot-mounted, with face-type end shield for close-coupled mounting



Tri-Clad induction motor with Style B flange-type end shield and round frame

The principal differences between the face-type and "Style B" flange-type end shields are as follows.

The flange-type end shield permits bolting the motor to the driven machine by inserting bolts (either through bolts or studs) from the motor to the driven unit. The flange-type end-shield mounting dimensions are somewhat larger in diameter than the face-type. They are NEMA standardized. Somewhat larger overhung loads can be mounted on the flange-type than on the face-type, particularly when through bolts are used.

The face-type end shield permits bolting of the driven unit to the motor by studs inserted from the driven unit into the motor end shield.

When the motor is overhung from the machine, round-frame construction generally gives a better-looking unit. The additions for obtaining round motor frames, less feet, are given on page 65.

End thrust from the load or from the mounting is very often present when these motors are used. Therefore, ball-bearing motors are used exclusively.

*Price Additions for Face-type and Flange-type End Shields

For Integral-horsepower, 3- and 2-phase Induction Motors, 200 Hp and Smaller

Motor Frame †	NEMA STYLE B FLANGE WITH MACHINING ‡ No. of Motors				FACE-TYPE END SHIELD WITH MACHINING ‡ No. of Motors			
	1	2–4	5–24	25 or More	1	2–4	5–24	25 or More
203, 204	$9	$8	$6	$5	$3	$3	$2	$2
224, 225	12	10	8	7	4	3	3	2
254	16	14	11	9	5	4	4	3
284	20	17	13	11	6	5	5	4
324, 326	24	20	15	12	8	7	6	5
364, 365	32	25	18	18	10	9	7	7
404, 405	38	30	21	21	12	11	8	8
444, 445	46	36	36	36	15	13	13	13
504, 505	56	46	46	46	18	15	15	15

* Price additions should be made to price of ball-bearing motor.

† If motor without feet is required, make regular addition for "round frame." See Modifications, page 65.
Flange-type end shields for Frame 326 and smaller are regularly furnished with solid face, and Frame 364 and larger with open face. The opposite of standard can be obtained, but order must state type desired.

‡ Motors must be identical electrically and mechanically, and the Company must be permitted to complete shipment within 90 days following the initial shipment.

VERTICAL SOLID-SHAFT MOTORS

200 Hp and Smaller—All Types and Frequencies

Three- and two-phase; 110, 208, 220, 440, 550, and 2200 Volts

Sometimes it is advantageous or necessary to mount a motor in a vertical position. In many cases, standard horizontal, ball-bearing foot-mounted motors can be used in a vertical position—the motor being mounted against the side wall of a building or machine by means of its feet. Horizontal motors from stock may not be suitable. They should be furnished from the factory.

On the other hand, end-shield-mounted round-frame vertical motors can generally be more closely coupled to the load and can be given greater enclosure protection. General Electric has available vertical motors with many types of standard bases to suit different requirements—open Tri-Clad motors which are protected from falling objects, liquids, etc., and totally enclosed motors and explosion-proof constructions protected against more severe conditions.

The accompanying illustrations show the different constructions and bases available, and the following additions to the price of the corresponding horizontal motor apply.

Lines of Tri-Clad vertical pump motors, both solid- and hollow-shaft, are also available. Prices and information upon request.

Tri-Clad motor mounted vertically by means of motor feet against the side wall. Drip cover for protection furnished as an extra feature

Totally enclosed, fan-cooled vertical motor with Style B flange base, normal- or high-thrust, Frames 204-326
Dimensions: GEM-908, Fig. 4

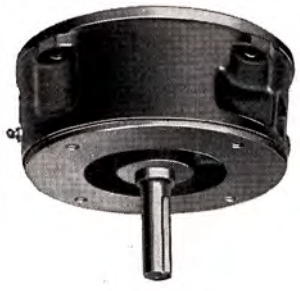
Face-type base for motor shown above
Dimensions: Base and shaft same as GEM-892

Vertical shielded induction motor with ring base, normal- or high-thrust, Frames N-6301 to N-6312. Dimensions GEM-955, page 86

Vertical general-purpose Tri-Clad motor with NEMA standard ring base, Frames 203 to 326. Dimensions GEM-1111; page 85

Style B flange base for vertical general-purpose Tri-Clad motors, Frames 203 to 326. Dimensions base and shaft same as GEM-1090

Tripod base for vertical general-purpose Tri-Clad motor, Frames 203 to 326. Dimensions GEM-1111; page 85



Face-type base for vertical general-purpose Tri-Clad motor, Frames 203 to 326. Dimensions base and shaft, same as GEM-1089

No-base construction for vertical general-purpose Tri-Clad motor, Frames 203 to 326. Dimensions GEM-1111; page 85

Price Additions

For open and shielded (dripproof) vertical motors, add to the price of the open, horizontal motor; for totally enclosed motors, add to the price of the totally enclosed, horizontal motor; and for totally enclosed, fan-cooled, vertical motors, add to the price of the totally enclosed, fan-cooled horizontal motor. The frame size of the horizontal motor used for the basic price should be used as the basis for selecting price additions for vertical features.

Price Additions (Add to Horizontal, Ball-bearing Motor)
For 3600- and 3000-rpm Motors, 40 Hp and Larger, Refer to the Company

NORMAL THRUST

‡Horizontal Motor Frame (Use Price of Ball-bearing Motor for Motors in Frames Larger than 505)	Vertical Motor Frame (For Finding Dimensions)	†General-purpose 40 C Rise			†Shielded (Drip-proof) 40 C Rise		†△Totally Enclosed, Fan-cooled, 55 C Rise	
		No Base	△ Face-type Base	*Ring or △ Style B Flange Base	Face-type Base	Ring Base	Face-type Base	Style B Flange Base
203–204	Same as Horizontal ¶	$3	$4	$10	$6	$12	§ $3	§ $9
224–225		5	6	14	7	15	6	14
254		8	10	21	13	24	10	21
284		10	13	27	16	30	13	27
324–326		15	18	34	22	38	18	34
364–365	N6301, N6302	..	...	..	31	53	31	59
404–405	N6301, N6302	..	...	..	40	66	40	73
444–445	N6305, N6306	..	...	..	53	84	63	110
504–505	N6307, N6308	..	...	..	72	110	84	141

* Tripod base can be furnished at same price as ring base for open motors in Frame 326 and smaller.
† These price additions apply for squirrel-cage motors only. For vertical, enclosed, wound-rotor-motors, refer to the Company.
‡ These are horizontal-motor frames to be used for pricing purposes only. Vertical motors on dimension prints have frame numbers as shown in second column.
§ These motors are totally enclosed, not fan-cooled.
¶ Dimensions of frames for shielded motors on request.
△For deductions allowed on quantity orders, refer to the Company.

Maximum Recommended Thrust Loads

The values listed in the following table are the maximum recommended thrust loads in pounds, consistent with reasonable bearing life, to be carried by normal-thrust, vertical, solid-shaft, squirrel-cage induction motors. **These values apply only when the load is direct-connected to, and properly aligned with, the motor, and when the direction of thrust is downward. Where upward or radial thrust is required, refer to the Company.**

FRAME		THE BALL-THRUST BEARING OF VERTICAL SQUIRREL-CAGE INDUCTION MOTORS WILL SUPPORT, IN ADDITION TO THE ROTOR, SHAFT, AND HALF-COUPLING, THE FOLLOWING NET WEIGHT IN POUNDS. THESE VALUES APPLY TO NORMAL-THRUST, SOLID-SHAFT MOTORS					
Horizontal, Open or Totally Enclosed, Fan-cooled	Vertical, Shielded (Dripproof)	3600 Rpm	3000 Rpm	1800 Rpm	1500 Rpm	1200 Rpm	1000 Rpm and Below
203–204		120	130	150	160	170	180
224–225		380	400	480	510	510	510
254		480	510	600	640	690	690
284		440	460	550	560	640	660
324–326		520	540	640	660	740	780
364–365	N6301, N6302	940	1000	1100	1100	1100	1100
404–405	N6303, N6304	1050	1100	1200	1200	1200	1200
444–445	N6305, N6306	....	....	1300	1300	1300	1300
504–505	N6307, N6308	....	....	1500	1600	1700	1700

EXAMPLE:

Required: 1—Type K, 10-hp, 1800-rpm, 220-volt, 3-phase, 60-cycle totally enclosed (standard), normal-thrust, vertical induction motor with ring base.
Type K-324, 10-hp, 1800-rpm, 220-volt, horizontal, totally enclosed (standard) ball-bearing motor price.. **$178**
Add for totally enclosed, normal-thrust, vertical, ring base, Frame 324..... **24** **$202**

GENERAL-PURPOSE WOUND-ROTOR MOTORS

WOUND-ROTOR induction motors are available with both constant- and adjustable-varying-speed characteristics. Their field of application is principally:

1. On those constant-speed applications requiring frequent starting or reversing under heavy load, or where exceptionally high starting torque is required, or which impose severe starting duty.

2. On those applications requiring adjustable-varying-speed characteristics. (Adjustable-varying-speed characteristics mean that the speed can be adjusted to any value over a considerable range, but, once adjusted, will vary with change in load.)

The wound-rotor induction motor differs from the squirrel-cage induction motor in that the former has a wire-wound rotor with terminals brought out to collector rings. It differs in appearance from the squirrel-cage motor, principally with respect to the end shield on the collector-ring (or slip-ring) end of the motor.

Wound-rotor induction motors are the same for both constant- and adjustable-varying-speed services; the speed characteristics desired are obtained by selecting controllers of the proper types.

General Electric manufactures a complete line of wound-rotor induction motors. In this catalog, sizes are listed from ½ hp at 1200 rpm up to and including 75 hp at 1800 rpm. Other speeds and horsepower ratings can be obtained on request. The complete line of General Electric wound-rotor induction motors is uniform in essential mechanical and electrical characteristics. These motors are designated Type M.

All G-E wound-rotor induction motors can be furnished with either sleeve or ball bearings, and in various types of enclosure and frame modification to meet the requirements of any specific application.

A skeleton-frame wound-rotor induction motor

Wound-rotor, Type M, Open, General-purpose, Constant- and Adjustable-varying-speed

110 (326 Frame and smaller), 208, 220, 440, 550 Volts — **3-phase or 2-phase, 60 and 50 Cycles**

Frame	Hp	Sync Speed, Rpm	PRICES Sleeve-bearing	PRICES Ball-bearing
224	½	1200	$100	$105
		900	110	116
224	¾	1200	109	114
224		900	133	140
224	1	1800	113	119
224		1200	122	128
225		900	144	151
224	1½	3600	173	182
224		1800	115	121
224		1200	133	140
254		900	156	164
225	2	3600	180	189
225		1800	120	126
225		1200	144	151
254		900	171	180
225	3	3600	204	214
225		1800	136	143
254		1200	165	173
284		900	194	204
254	5	3600	249	261
254		1800	166	174
284		1200	201	211
324		900	240	252
284	7½	3600	296	311
284		1800	197	207
324		1200	241	253
326		900	288	302
324	10	3600	$345	$362
324		1800	230	242
326		1200	275	289
365		900	341	358
326	15	3600	482	506
326		1800	321	337
365		1200	347	364
404		900	422	443
364	20	1800	384	403
404		1200	419	440
405		900	496	521
365	25	1800	432	454
405		1200	476	500
444		900	548	575
405	30	1800	478	502
444		1200	525	551
445		900	606	636
444	40	1800	566	594
445		1200	617	648
504		900	699	734
445S	50	1800	643	675
504		1200	703	738
505		900	789	828
504S	60	1800	719	755
505		1200	791	831
505S	75	1800	825	866

ADDITIONAL INFORMATION

50-cycle Operation: All open 40 C, 60-cycle motors will operate on 50 cycles without injurious heating. Synchronous speeds are 5/6 of those at 60 cycles.

Reduced Speed: The horsepower output at 50 per cent below normal speed will be approximately 40 per cent of normal horsepower.

Dimensions: GEM-650E, 326 and below. See page 82.
GEM-655—364 and above.

Descriptive Bulletin: GEA-1698.

220/440 Volts: All 220- or 440-volt motors in Frames 204-505 have sufficient leads brought out so they can be connected 220/440 volts.

Enclosures:

(a) Semiprotected—(collector end).

Price Additions

Frame	Solid or Screened Top Half	Perforated or Screened Bottom Half
224–225	$1	$1
254–284	2	2
324–326	3	3
364–365	4	4
404–405	6	6
444–445	8	8
504–505	11	11

(b) Totally enclosed and totally enclosed, fan-cooled. Refer to Company.

Modifications: See page 64.

Control: See page 72.

GENERAL-PURPOSE SYNCHRONOUS MOTORS

NEW "900 SERIES"

DECIDED advances in construction details, appearance, and flexibility for possible mechanical and electrical modifications have been incorporated in this new line of general-purpose synchronous motors.

Consult the General Electric office nearest you for complete information.

Typical views of the new G-E "900 Series" synchronous motors for general-purpose application

The production of many millions of horsepower of synchronous motors over a period of more than fifty years has familiarized General Electric with every aspect of research and engineering in connection with this subject—every detail of manufacture and application—that would assist in rendering the greatest possible service to industry. Not otherwise could G-E synchronous motors have been so improved year by year as to meet in every respect the numerous and growing demands that have been made upon them.

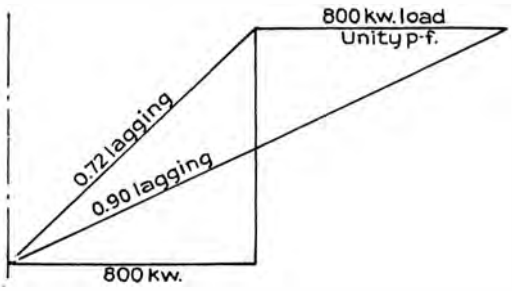


Diagram indicating improvement in power factor resulting from the use of a unity-power-factor synchronous motor, which furnishes no reactive kva

In this catalog is listed General Electric's new "900 Series" line of general-purpose, high-speed synchronous motors. A high-speed synchronous motor is regarded as one operating at a speed of 514 rpm or higher. The motors listed include both unity-power-factor motors, in sizes 25 hp at 1200 rpm up to and including 200 hp at 514 rpm, and 0.8-power-factor motors, sizes 20 hp at 1200 rpm up to and including 150 hp at 514 rpm.

These new G-E general-purpose synchronous motors were developed to fill the need for a synchronous motor which could be recommended for most general-purpose applications in the same way that a standard squirrel-cage motor is recommended—that is, without a detailed study of the requirements of the application. For this reason, General Electric general-purpose high-speed synchronous motors have incorporated in their design high starting torque, overload capacity, mechanical simplicity, and the reliability of general-purpose squirrel-cage motors. Since the exciter is direct-connected and overhung on the motor end shield, general-purpose synchronous motors form complete compact units which, like squirrel-cage induction motors, simply require connection to an a-c power supply.

In addition to their ability to operate at unity or leading power factor, G-E high-speed synchronous motors in the larger sizes have higher efficiencies than squirrel-cage motors in corresponding ratings. This is of particular importance where the motor must operate continuously or a large percentage of the time.

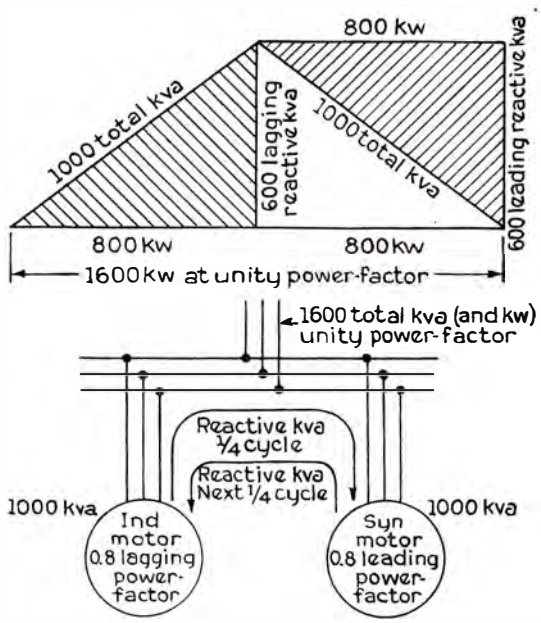


Diagram illustrating the interchange of reactive kva between induction motors and leading-power-factor synchronous motors

GENERAL-PURPOSE HIGH-SPEED SYNCHRONOUS MOTORS

Type TS (3-phase) and Type QS (2-phase)

20 to 200 Hp, 60 Cycles

1.0-power-factor—40 C Stator by Thermometer, 50 C Rotor by Resistance

0.8-power-factor—40 C Stator by Thermometer, 60 C Rotor by Resistance

Hp	Speed, Rpm	Volts	1.0-power-factor			0.8-power-factor		
			FRAME	PRICE Motor Only	PRICE Exciter †	FRAME	PRICE Motor Only	PRICE Exciter †
20	1200	220	....	....	....	934	$570	$149
	1200	440–550 2200	....	....	....	934	599	149
25	1200	220	934	$570	$149	934	583	149
	1200	440–550 2200	934	599	149	934	612	149
	900	220	....	....	....	944	670	252
	900	440–550 2200	....	....	....	944	704	252
30	1200	220	934	583	149	935	610	149
	1200	440–550 2200	934	612	149	935	641	149
	900	220	944	670	252	944	712	252
	900	440–550 2200	944	704	252	944	748	252
	720	220	....	....	....	953	837	288
	720	440–550 2200	....	....	....	953	879	288
40	1800	220	....	....	....	* 945S	1065	128
	1800	440–550 2200	....	....	....	* 945S	1118	128
	1200	220	935	610	149	944	645	173
	1200	440–550 2200	935	641	149	944	677	173
	900	220	944	712	252	945	758	252
	900	440–550 2200	944	748	252	945	796	252
	720	220	953	837	288	953	887	323
	720	440–550 2200	953	879	288	953	931	323
	600	220	....	....	....	954	1000	363
	600	440–550 2200	....	....	....	954	1050	363
50	1800	220	* 945S	1065	128	* 953S	1120	128
	1800	440–550 2200	* 945S	1118	128	* 953S	1176	128
	1200	220	944	645	173	945	690	173
	1200	440–550 2200	944	677	173	945	725	173
	900	220	945	758	252	953	805	289
	900	440–550 2200	945	796	252	953	845	289
	720	220	953	887	323	954	936	323
	720	440–550 2200	953	931	323	954	983	323
	600	220	954	1000	363	955	1060	363
	600	440–550 2200	954	1050	363	955	1113	363
60	1800	220	* 953S	$1120	$128	* 953S	$1195	$128
	1800	440–550 2200	* 953S	1176	128	* 953S	1195	128
	1200	220	945	690	173	945	760	173
	1200	440–550 2200	945	725	173	945	760	173
	900	220	953	805	289	954	875	289
	900	440–550 2200	953	845	289	954	875	289
	720	220	954	936	323	955	1000	384
	720	440–550 2200	954	983	323	955	1000	384
	600	220	954	1060	363	963	1150	427
	600	440–550 2200	954	1113	363	963	1150	427
75	1800	220	* 953S	1195	128	* 954S	1317	128
	1200	440–550 2200	945	760	173	953	876	252
	900		954	875	289	954	985	289
	720		955	1000	323	963	1115	384
	600		963	1150	427	963	1270	427
100	1800	220	* 953S	1317	128	* 954S	1432	128
	1200	440–550 2200	* 953	876	252	* 954S	996	252
	900		954	985	289	955	1095	329
	720		963	1115	323	963	1220	384
	600		963	1270	427	964	1380	427
	514		964	1430	485	972	1530	613
125	1800	220	* 954S	1432	128	* 963S	1549	146
	1200	440–550 2200	* 954S	996	252	* 955S	1105	292
	900		955	1095	289	963	1210	329
	720		963	1220	323	964	1330	384
	600		964	1380	427	965	1480	543
	514		972	1530	485	973	1620	613
150	1800	220	* 954S	1549	128	*....	1742	146
	1200	440–550 2200	* 955S	1105	252	* 963	1310	292
	900		* 963S	1210	289	* 964	1410	329
	720		964	1330	323	965	1530	480
	600		965	1480	427	972	1670	543
	514		973	1620	485	974	1800	613
200	1800	220	* 963S	1742	146	‡	‡	‡
	1200	440–550 2200	* 963S	1310	252	‡	‡	‡
	900		* 964S	1410	329	‡	‡	‡
	720		965	1530	384	‡	‡	‡
	600		972	1670	427	‡	‡	‡
	514		* 974S	1800	485	‡	‡	‡

* For direct connection only. Not recommended for belt drive.
† Exciter price includes a CR8000-B1, back-of-board, exciter-field rheostat, with its operating mechanism.
‡ For prices and other information on these ratings, refer to the Company.
For descriptive information, see GEA-3434.
For weights and dimensions, see GEM-1101, -1102, noting that the letter S following frame number denotes motor for direct coupling without base.

For control, see page 75

SINGLE-PHASE MOTORS

Motors for the Home and Farm—Motors for Industry

MOST homes have many single-phase fractional-hp motors performing the little services that make life more convenient and pleasant—driving electric clocks, appliances, washing machines, fans, water pumps, oil burners, stokers, refrigerators, etc. General Electric makes motors for practically every use and co-operates with manufacturers in applying the best and most economical motor to their devices. It pays to look for and to furnish G-E fractional-hp motors.

G-E motors can be ordered by mail, as well—general-purpose motors for home workshops, for toys, for hobbies, for replacements on washing machines, for motorizing many duties on the farm and in the home. Motors for such purposes are listed in this catalog.

Industry uses many single-phase motors on lighting circuits, and on feeder lines where single-phase is more economical. Office devices and business machines use and depend on electric-motor drive. Fans and unit heaters, air conditioning and room coolers, pumps and small machines are other uses. Many of these motors are exactly matched to the requirements of the driven machine through co-operation between G.E. and the manufacturer. Others can be ordered direct for general-purpose use.

Select and order one of the following G-E single-phase motors the next time you need a new or replacement motor. (Ask our nearest sales office about the G-E Exchange and Service Plan.)

FOR SMALL HOME-WORKSHOP MACHINES AND SIMILAR DEVICES

Dripproof—Sleeve Bearings—50 C Rise

Single-phase, Constant-speed

TYPE KH, SPLIT-PHASE, SPECIAL SERVICE

Prices include the following:

1. Eight-foot rubber-covered cord and molded rubber plug assembled to the motor.
2. "On-Off" toggle switch mounted on the terminal box as shown.
3. Solid base with slots for mounting.
4. Shaft extension 1½ in. long by ½ in. diameter, with flat out one end of motor as shown, or out both ends of motor. See prices below.

Workshop motor with single shaft extension

TYPE KH: Split-phase, 60 Cycles (Starting current in excess of 20 amperes)

Frame	Hp, 50 C	Rated Full-load Speed, Rpm	Volts	Approx Full-load Amperes	Shaft Extension Brought Out	Model No.	Price, Including Accessories Listed
45	* ¼	1725	115	4.8	One end	5KH45AB1793	**$8.05**
45	⅓	1725	115	5.6	One end	5KH45AB1647	**11.20**
45	⅓	1725	115	5.6	Both ends	5KH45AB1948	**11.80**

* ¼ hp rated 40 C temperature rise, continuous.

For dimensions, see page 80.

GENERAL-PURPOSE SINGLE-PHASE MOTORS, TYPE KH, SPLIT-PHASE

These motors, in different speeds and ratings, constitute the general-purpose line of G-E fractional-hp single-phase motors.

The Type KH split-phase motor is a constant-speed, moderate-torque motor for general use. It is designed to meet the requirements of a great variety of applications, such as oil burners, ironers, office appliances, instruments, food-preparation machinery, pumps, small compressors for paint spraying, fans, blowers, etc. It is quiet-running, economical, and is suitable for applications where high starting torque is not a requisite. Where high starting torque is required, use Type KC.

General-purpose single-phase Type KH motor equipped with resilient base

The basic motor listed has the following desirable features.

1. Solid, drawn-steel rigid base with bolt-hole slots for belt-tightening adjustment.
2. Dripproof construction, 40 C rise in all but the "20 Series" frame (which is open).
3. Conduit box cast in end shield opposite pulley end for quick connection ("20 Series" frame has conduit box on frame, which can be ordered).
4. Terminal board permits easy connection.
5. Sleeve bearings are of the filtered-oil-return type with large oil capacity, requiring only occasional oiling.

The following accessories are available at moderate price additions.

1. Resilient, Neoprene cushion ring base for quiet vibration-free operation (see page 39).
2. Ball bearings, grease-seal type, for applications requiring thrust.
3. Thermo-Tector, for either automatic- or manual-reset thermal-overload protection of the motor (see page 62).
4. Motor-mounted toggle switch for convenient starting (see page 63).
5. Cord and plug sets (see page 63).
6. Many other special features, including explosion-proof construction, etc.

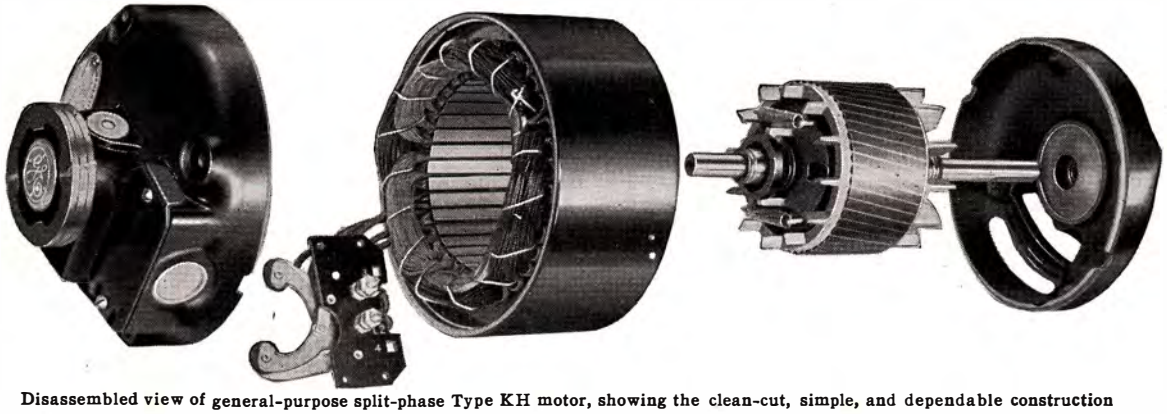
In addition to the standard general-purpose line of Type KH motors, many lines for special application are made.

Fractional-hp—General-purpose—Constant-speed Single-phase

Open, 40 C Rise, Sleeve-bearing, Solid-base, 115 Volts, Types KH and KC*

Hp	Rpm	Class	60 cycles			†50 cycles		
			Frame	Price, KH	Price, KC	Frame	Price, KH	Price, KC
1/20	1725	B	23	$8.50	...	23	$9.35	...
	1140	B	35	10.30	...	35	11.15	...
	860	B	45	12.30	...	45	13.15	...
1/12	3450	B	23	13.00	...	23	13.85	...
	1725	B	35	8.50	...	35	9.35	...
	1140	B	43	12.00	...	43	12.85	...
	860	B	47	14.20	...	47	15.05	...
1/8	3450	B	33	13.00	...	33	13.85	...
	1725	B	43	8.50	$11.00	‡43	9.35	$11.85
	1140	B	45	12.30	15.85	‡45	13.15	16.70
	860	B	49	18.50	23.25	‡49	19.35	24.10
1/6	1725	B	‡43	8.75	11.00	‡45	9.60	11.85
	1140	B	47	14.20	17.80	49	15.05	18.65
	860	C	63	...	30.00	65	...	31.65
1/4	3450	B	47	13.00	16.00	47	13.85	16.85
	1725	B	‡45	10.00	12.25	‡47	10.85	13.10
	1140	B	48	...	23.25	48	...	24.10
	860	C	67	...	*36.00	77	...	37.35
1/3	3450	B	47	15.00	*18.00	47	15.85	*18.85
	1725	B	47	13.85	*17.50	49	...	*18.35
	1140	C	65	...	*30.00	65	...	*31.35
	860	C	77	...	*45.00	...	...	...
1/2	3450	B	49	...	*23.00	49	...	*23.85
	1725	C	63	...	*25.00	63	...	*26.35
	1140	C	77	...	*36.00	77	...	*37.35
3/4	3450	C	67	...	*32.00	67	...	*33.35
	1725	C	73	...	*32.00	73	...	*33.35
1	3450	C	67	...	*40.00	67	...	*41.35

*See page 39 for description of Type KC motors.



Disassembled view of general-purpose split-phase Type KH motor, showing the clean-cut, simple, and dependable construction

ADDITIONAL INFORMATION

1. ***115/230 volts** instead of 115 volts.

2. †**50-cycle Speeds** — Speeds differ from those listed as follows:

Instead of 3450, use 2875
Instead of 1725, use 1425
Instead of 1140, use 960
Instead of 860, use 715

3. ‡**Frames:** Listed frames are for KH motors. KC frames differ as follows:

Instead of 43, use 45
Instead of 45, use 47
Instead of 47, use 49
Instead of 49, use 48

4. **Special Features:** Price additions for special features:

	Class B	Class C
230 volts	**$0.85**	None
Totally enclosed	**1.00**	**$1.50**
Explosion-proof (Class I, Group D)	**8.00**	**12.00**
Ball bearings	**3.75**	**4.00**
Resilient base	**.50**	**.90**

In totally enclosed construction, the frame size may differ from that listed for the open motor. All totally enclosed motors are rated 55 C rise.

5. **Other Modifications:** See page 62.
6. **Control:** See page 72.
7. **Dimensions:** See page 79.
8. **Descriptive Publications:**
   Type KH—GEA-1276
   Type KC—GEA-2969.

GENERAL-PURPOSE SINGLE-PHASE CAPACITOR-MOTORS

General-purpose, single-phase fractional-hp capacitor-motor, Type KC

The truly modern single-phase motor (for medium-horsepower ranges, or high-torque applications in the ratings where Type KH normal-torque motors are available) is the capacitor-motor.

Of particular importance are the following advantages which are obtained because of the cast rotor and absence of brushes or commutator.

1. Dependability inherent with the simplicity of the capacitor design.
2. Quiet operation.
3. Freedom from radio interference.

There are types available to start and run all single-phase applications.

Fractional-horsepower Capacitor-motors, Type KC

These motors are designed to meet high-starting-torque requirements. They are of the capacitor-start, induction-run type and have a compact, long-lived, G-E capacitor mounted on the frame. They are particularly suited for air conditioning, commercial refrigeration, belt-driven fans, etc.

All the many features and accessories listed for the Type KH motor are equally applicable to the fractional-horsepower Type KC motor.

Integral-hp Tri-Clad Capacitor-motor, Types KC and KCJ

These motors have a completely new mechanical design which features triple protection against physical damage, electrical damage, and operating wear and tear. They have completely new electrical designs which provide torque characteristics suited to different types of applications.

Tri-Clad capacitor-motors have that versatility of application which assures the right motor for the right job because:

(a) Tri-Clad protection makes them suitable for a wide variety of applications.
(b) Their attractive appearance harmonizes with modern equipment.
(c) All Type KC motors are furnished dual-voltage, 115/230 volts.
(d) All motors can be operated in either direction of rotation.
(e) A choice of torques permits right selection for the job.

The *Type KC motor* is designed for fans, blowers (direct-connected and belt-driven), centrifugal pumps, and other applications requiring moderate starting torques.

The *Type KCJ motor* is designed for applications requiring high starting torque; such as compressors, loaded conveyors, reciprocating pumps, etc.

In applying these two types of motors, it is highly important that the application be carefully checked, and the motor selected which will best meet the purchaser's requirements.

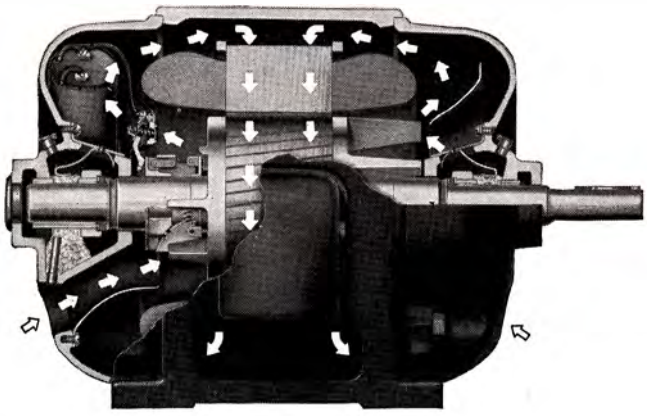
Fans or blowers, if used with a high-starting-torque motor, may be brought up to speed too quickly, resulting in noise, vibration, or belt slippage. This is less likely to happen when normal-torque motors are used. Further, the capacitors for normal-torque motors are mounted inside the end shield, avoiding restriction of air flow on fan applications.

Comparison of Types KC and KCJ Motors

	Type KC, Normal-torque	Type KCJ, High-torque
Starting Torque	Approximately 185 per cent for 4-pole motors	Approximately 300 per cent for 4-pole motors
Voltage	Dual-voltage, 115/230 volts, except 5-hp, 3600-rpm, which is 230 volts only.	1-hp, 1800-rpm, 115/230 volts. Others are single-voltage, 230 volts.
Frequency	On most applications, 60-cycle KC motors provide adequate starting torque on 50-cycle circuits. Starting and pull-up torques are slightly reduced. 50-cycle speed will be 5/6 of 60-cycle speed. Heating will not be injurious on 50 cycles.	Single-frequency, 60 or 50 cycles. Most high-starting-torque applications require full rated starting torque. Therefore, a 50-cycle winding must be used on 50-cycle circuits to meet the torque requirements of the load and provide the same starting torque as a 60-cycle motor.
Location of Capacitors	Inside end shield (opposite pulley end)	1-hp, 1800-rpm, inside end shield. Others in case on top of motor.

Typical Type KC normal-starting-torque motor

Typical Type KCJ high-starting-torque motor



Tri-Clad capacitor-motor, Type KC, showing the compact arrangement and the protection afforded by this design

Integral-hp, Sleeve-bearing, Single-phase Capacitor-motors — **Constant-speed—Open—Horizontal 60 and †50 Cycles—115/230 Volts**

Frame	Hp, Continuous, 40 C Rise	Sync Speed, Rpm	MOTOR PRICE: Normal-starting-torque, Type KC	MOTOR PRICE: High-starting-torque, Type KCJ
224	½	900	**$70**	....
203	¾	1200	**49**	....
225		900	**89**	....
203	1	1800	**37**	**$37**
224		1200	**64**	....
203	1½	3600	**51**	....
204		1800	**49**	***49**
225		1200	**82**	....
204	2	3600	**67**	....
224		1800	**64**	***64**
224	3	3600	**89**	....
225		1800	**82**	***82**
225	5	3600	***144**	....

ADDITIONAL INFORMATION

1. ***Volts:** 230 volts, instead of 115/230.

2. **Ball Bearings:** For ball-bearing motors, add **$4** to the price of the sleeve-bearing motors. (Exception—For the 5-hp, add **$7.**)

3. **Resilient Bases:** Addition (for resilient base):
   Frames 203 and 204 ..... **$1.00**
   Frame 224 ..... **1.50**
   Frame 225 ..... **2.00**

4. **†50-cycle operation:** Type KC. Two- and four-pole Type KC motors (except 5-hp) will operate on 50 cycles at 5/6 of the 60-cycle speed without injurious heating, at rated voltage, with slightly reduced starting and pull-up torques. Six- and eight-pole Type KC motors are for 60-cycle operation only. Type KCJ. Prices of 50-cycle, 40 C rise, continuous-rated, Type KCJ motors are the same as those of corresponding 60-cycle motors. Special windings are required; refer to the Company for data. Standard 60-cycle motors should not be used on 50-cycle circuits without checking characteristics and application with the Company.

5. **Thermo-Tectors:** Add for Thermo-Tectors—115/230 volts (2 hp—230 volts only)
   ½, ¾, and 1 hp. **$1.35**
   1½ and 2 hp. **2.00**

6. **Modifications:** Other than standard. These motors are available in face- and flange-type end shields, round frame, and special shaft only. See page 31.

7. **Dimensions:** See page 81. —KC, GEM-1091
   —KCJ, GEM-1094

8. **Descriptive Bulletin:** GEA-3603.

9. **Control:** See page 74.

SINGLE-PHASE, INTEGRAL-HP REPULSION-INDUCTION MOTORS, TYPES SCR AND SCA

The General Electric repulsion-induction motor combines the high starting torque of the repulsion motor with the constant-speed characteristics of the induction motor.

It is recommended for use as follows:

1. For the larger single-phase general-purpose ratings—Type SCR.
2. For reversing duty on cranes, hoists, machines, etc.—Type SCA.
3. For totally enclosed, fan-cooled, standard and explosion-proof constructions of integral-horsepower single-phase design.

Motors to meet these conditions are listed below.

Single-phase, integral-hp, totally enclosed, fan-cooled, repulsion-induction motor, Type SCR

Single-phase, Repulsion-induction, Open, Horizontal, Constant-speed, 60 and 50 Cycles, 115/230 Volts

†Hp, 40 C, Continuous	Sync. Speed, Rpm	Type SCR ‡60-cycle Frame	Type SCR ‡ PRICE Sleeve-bearing	Type SCR ‡ PRICE Ball-bearing	Type SCA Reversible ‡60-cycle Frame	Type SCA Reversible ‡ PRICE Sleeve-bearing	Type SCA Reversible ‡ PRICE Ball-bearing
½	900	....	....	....	224	$81	$85
¾	1200	....	....	....	204	56	60
	900	....	....	....	225	102	107
1	1800	....	....	....	204	43	47
	1200	....	....	....	224	74	78
	900	254	$105	$110	254	121	127
1½	3600	....	....	....	204	59	63
	1800	....	....	....	224	56	60
	1200	....	....	....	225	94	99
	900	254	132	139	254	152	160
2	3600	....	....	....	224	77	81
	1800	....	....	....	A225	74	78
	1200	254	120	126	254	138	145
	900	255	157	165	255	181	190
3	3600	....	....	....	224	102	107
	1800	....	....	....	A225	94	99
	1200	255	145	152	225	167	175
	900	324	200	210	324	230	242
5	3600	....	....	....	225	166	174
	1800	254	120	126	324	138	145
	1200	324	169	177	324	194	204
	900	326	279	293	326	321	337
*7½	3600	....	182	191	....	....	....
	1800	324	169	177	324	194	204
	1200	....	240	252	326	276	290
*10	3600	326	....	260	....	....	....
	1800	326	224	235	326	258	271

ADDITIONAL INFORMATION

1. ***Voltage:** 7½- and 10-hp motors rated at 230/460 volts instead of 115/230 volts.
2. **†SCA Rating:** Type SCA motor is given an intermittent rating of 50 C rise, 1 hr, instead of the 40 C continuous rating listed, which is for the Type SCR.
3. **‡50 Cycles:** Prices of the 50-cycle motors are the same as those of corresponding 60-cycle motors, although the frame sizes may be different. Speeds will be 5/6 of 60-cycle speeds. Special windings are required. Refer to the Company for data.
4. **Special Shafts**
   See Modifications, page 66.
5. **Dimensions.** See page 83.
   Sleeve-bearing, GEM-600.
   Ball-bearing, GEM-601.
6. **Descriptive Publication**—GEA-560.
7. **Control**—See page 74.

Single-phase Totally Enclosed, Type SCR, Standard and Explosion-proof, Horizontal, Constant-speed, 60 and 50 Cycles, 115/230 Volts

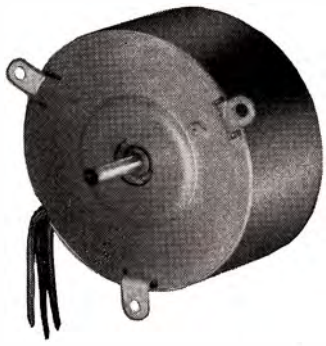
Frame	Hp Continuous 55 C Rise	¶60-cycle Sync Speed	60-CYCLE PRICE Standard	60-CYCLE PRICE Explosion-proof Class I, Group D, Conditions	50-CYCLE PRICE Standard	50-CYCLE PRICE Explosion-proof Class I, Group D, Conditions
224	½	900	§ $79	§ $97	....	...
224	¾	1200	§ 74	§ 92	§ $74	§ $92
225		900	116	134	...	...
224	1	1800	§ 59	§ 77	§ 59	§ 77
224		1200	91	109	91	109
3		900	137	159	...	...
224	1½	3600	§ 77	§ 95	78	96
224		1800	76	94	76	94
225		1200	109	127	109	127
3		900	164	186	...	...
224	2	3600	94	112	94	112
225		1800	91	109	91	109
3		1200	152	174	152	174
324		900	217	...	...	...
224	3	3600	116	134	† 116	† 134
225		1800	109	127	109	127
324		1200	205	...	205	...
326		900	260	...	...	...
3	5	3600	171	189	171	189
3		1800	152	174	152	174
324		1200	229	...	‡ 229	...
326	*7½	3600	242	...	242	...
324		1800	229	...	‡ 229	...
326		1200	300	...	...	...
326	*10	3600	308	...	...	...
326		1800	284	...	...	...

ADDITIONAL INFORMATION

1. ***Voltage:** The 7½- and 10-hp motors are rated 220/440 volts instead of 110/220 volts.
2. **Frames**
   †Frame 225 instead of 224
   ‡Frame 326 instead of 324
3. **§Not Fan-cooled:** These motors are totally enclosed (not fan-cooled).
4. **¶50 Cycles:** 50-cycle synchronous speeds are 5/6 of the 60-cycle synchronous speeds listed.
5. **Class II, Group G:** All the motors listed above can be obtained for Class II, Group G, conditions. Prices are the same as for standard totally enclosed and totally enclosed, fan-cooled motors.
6. **Dimensions:** See page 82.
   GEM-1074.

SINGLE-PHASE SYNCHRONOUS INDUCTOR TORQUE MOTORS, TYPE SMY

Self-starting synchronous inductor motor, 50 Frame



Compact self-starting synchronous inductor motor, 20 Frame

No gears, no direct current—only the single-phase lighting circuit. Yet, here are motors which run at *low* speed, at *synchronous* speed, and with a *constant* torque. The reason: the motors are designed around the remarkable G-E permanent magnet—alnico.

Many uses have been found already for these motors —office machines, stokers, scanning disks, mixers, etc. There are almost unlimited possibilities for future applications.

One feature the motors have may be advantageous for some applications and may require that special precautions be taken if they are used: when the load exceeds the maximum for the motor, or the drive is stalled, the motor instantly reverses rotation without switch change and keeps on running in reverse.

The best precaution against such reversal is to build on some sort of mechanical nonreverse ratchet. On one stoker application, the backstop was set so that the motor would continue to reverse, back and forth, until the obstruction, which generally was a piece of coal, was broken through.

Perhaps this motor will make possible carrying out ideas you may have had for motorizing some function on a machine or around the plant or home.

Self-starting Synchronous Inductor Motors

1 to 100 Rpm, 110 Volts, 60 Cycles, 2 to 75 Oz-In. Torque

Model No. (See Motor Data Below)	RATING		Price	Quantity Net Price Applying to Firm Orders as Below						
				90-DAY ORDER		180-DAY ORDER			1-YEAR ORDER	
	Torque, Oz-In.	Speed, Rpm	Lots 1–49	Lots 50	Lots 100	Lots 250	Lots 500	Lots 1000	Lots 2500	Lots 5000
SMY20J9	2	100	**$11.35**	**$7.29**	**$6.43**	**$5.93**	**$5.50**	**$5.25**	**$5.00**	**$4.75**
* SMY20J16	12	4	**14.85**	**9.66**	**8.66**	**8.03**	**7.50**	**7.25**	**7.00**	**6.75**
* SMY20J15	24	2	**15.85**	**10.37**	**9.34**	**8.67**	**8.10**	**7.85**	**7.60**	**7.35**
* SMY20J14	48	1	**15.85**	**10.37**	**9.34**	**8.67**	**8.10**	**7.85**	**7.60**	**7.35**
SMY50L6	20	75	**18.00**	**12.00**	**10.85**	**10.10**	**9.50**	**9.00**	**8.75**	**8.55**
SMY50H18	40	75	**21.00**	**14.30**	**13.65**	**13.05**	**12.40**	**12.40**	....	....
SMY54H16	75	75	**26.75**	**18.20**	**17.40**	**16.60**	**15.80**	**15.80**	....	....

For 220 volts, add **$1.00 net** to 110-volt prices.
For 25 and 50 cycles, refer to the Company for prices and available speeds and torques.
* Available by means of built-in gear reduction.

Motor Data

Model No.	Bearings	Gear Ratio	Torque, Oz-In.	Speed, Rpm	Volts	Cycles	Dimensions
SMY20J9	Sleeve	None	2	100	110	60	Refer to the Company
SMY20J16	Sleeve	25:1	12	4	110	60	
SMY20J15	Sleeve	50:1	24	2	110	60	
SMY20J14	Sleeve	100:1	48	1	110	60	
SMY50L6	Sleeve	None	20	75	110	60	
SMY50H18	Sleeve	None	40	75	110	60	
SMY54H16	Ball	None	75	75	110	60	

Rotation: All motors listed above are reversible, SMY 20-frame motors have 3 leads, and the SMY 50- and SMY 54-frame motors have 4 leads as standard. SMY 50- and SMY 54-frame, 3-lead reversible motors can be furnished to order, and should be priced by adding 15 per cent to above prices.

DIRECT-CURRENT MOTORS

WHERE D-C POWER IS AVAILABLE

IN certain localities, and in many plants or mines, direct current is available. G-E direct-current motors of all sizes will drive equipment and loads as dependably as their companion polyphase motors. In such instances, d-c motors give additional advantage because of the ability to utilize the motor speeds best suited to the application, or of a value which minimizes or eliminates belt or gear costs. Constant speed for maintained production is obtained with shunt- or compound-wound units.

WHEN SPEED ADJUSTMENT IS ADVANTAGEOUS

Varying-speed Motors

Speed change is desired for street cars, locomotives, cranes, and other transportation equipment after the initial inertia has been overcome. In many cases, this speed change is obtained in whole or in part by a series-wound or series-compounded d-c motor. With such a motor, speed increases automatically as the original starting load drops off. These are known as varying-speed motors.

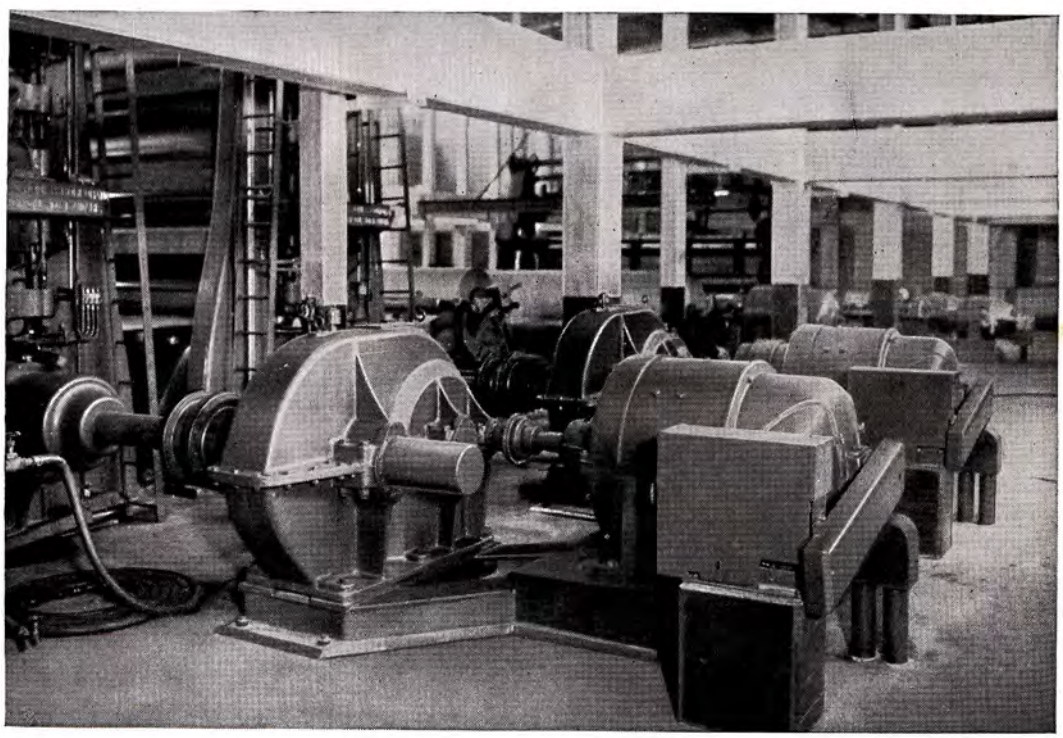
Constant-speed Motors

Most applications require a constant speed, one which holds relatively the same speed, despite load changes. Speed adjustment may be controlled, though sometimes only a moderate amount of speed adjustment or change is desired. Such may be obtained over a speed range of less than 3:1 with the standard integral-horsepower constant-speed motor by adjusting the motor field current with rheostats.

Standard adjustable-speed d-c motors, on the other hand, permit speed changes over a range of 3:1 or higher with field-current change.

These motors are used where a constant-voltage source of d-c power is available or is supplied by motor-generator sets for different drives. Many continuous-process industries obtain advantages from being able to match the speed of one machine with that of another, or from being able to hold tension or vary the speed on a winding roll.

Most flexible and benefit-producing of all adjustable-speed combinations, however, is the use of adjustable-voltage system. This system includes a "constant-speed" type of motor, driven by a motor-generator set which has an adjustable d-c output voltage. Speed ranges to meet every requirement are available. Control is inexpensive. Many cranes and hoists use this system to increase production. Planers use it for rapid return and reversal of platen. Printing presses, wire-drawing equipment, steel-mill runout tables, and many others also gain benefits from this drive. G-E application engineers can choose the drive best suited to your application. In addition, G.E. has available a "package-power" unit, the Speed Variator, which includes a motor-generator set, control, and a d-c motor. Ask the nearest G-E office for complete details.



Installation of totally enclosed heavy-duty direct-current motors

DIRECT-CURRENT FRACTIONAL-HP GENERAL-PURPOSE MOTORS

A complete line of Type BC motors is available for use where d-c motors with characteristics paralleling those of a-c motors are required. They are interchangeable in frame diameter with G-E a-c motors of corresponding ratings. Ball- and sleeve-bearing designs, and open and totally enclosed constructions, are available.

Desirable features that give these motors the fine reputation they have earned are:

1. Frame protected from falling dirt and water.
2. Rotor with solidly bonded windings and heavy, long-lasting commutator.
3. Bearings that require infrequent lubrication.
4. Sturdy end shields for rigid support.
5. Filter capacitor mounted internally for suppression of radio interference.

Fractional-hp d-c motor having interchangeable mounting dimensions with f-hp d-c motors of corresponding ratings

Open, 40 C Rise, Sleeve-bearing, Solid-base, 115-volt, Full-voltage-start, Constant-speed, Direct-current Motor. Type BC, Compound-wound

Hp	Rpm	Class	Frame	Price
1/20	1725	B	*28	$17.00
	1140	B	*36	18.05
	860	B	42	21.00
1/12	3450	B	*28	18.00
	1725	B	*36	17.00
	1140	B	41	18.70
	860	B	42	21.00
1/8	3450	B	36	20.00
	1725	B	42	20.00
	1140	B	42	21.20
	860	B	44	26.50
1/6	1725	B	42	20.00
	1140	B	44	23.00
	860	C	66	30.00
1/4	3450	B	42	23.00
	1725	B	44	22.00
	1140	B	46	26.50
	860	C	66	37.00
1/3	3450	B	42	27.00
	1725	B	46	25.00
	1140	C	66	31.00
	860	C	74	42.00
1/2	3450	B	44	31.00
	1725	C	66	31.00
	1140	C	74	38.00
3/4	3450	C	66	41.00
	1725	C	74	41.00
1	3450	C	66	45.00

Armature and commutator end shield of fractional-hp Type BC d-c motor, showing compact construction

ADDITIONAL INFORMATION

1. **Note:** *These motors are shunt-wound.
2. **Special Features:** Price additions for special features:

	Class B	Class C
230 or 32 volts	$0.85	$1.35
Totally enclosed	1.00	1.50
Explosion-proof (Class I, Group D)	8.00	12.00
Ball bearings	3.75	4.00

3. **Frames:** In totally enclosed construction and in special voltages, the frame size may differ from that listed for the open, standard-voltage motor. All totally enclosed motors are rated 55 C rise.
4. **Modifications:** See page 62.
5. **Dimensions:** See page 79.
   Open, GEM-852.
   Explosion-proof, GEM-872.
6. **Control:** See page 72.
7. **Descriptive Bulletin:** GEA-3513.

MOTORS FOR INDUSTRIAL AND MACHINE-TOOL DESIGN

The desirable features of the industrial and machine-tool polyphase motor are also available in the direct-current design. Prices are as follows, and dimensions are the same as those indicated on page 24.

DIRECT-CURRENT, 1725 RPM		
Volts	Model No.	Price
115	5BC44AB1358	$26.75
230	5BC44AB1359	27.60
115	5BC46AB558	29.75
230	5BC46AB559	30.60
115	5BC66AB1105	36.50
230	5BC66AB1106	37.85
115	5BC68AB11	46.50
230	5BC68AB12	47.85

HEAVY-DUTY DIRECT-CURRENT INTEGRAL-HORSEPOWER MOTORS

Constant- and Adjustable-speed

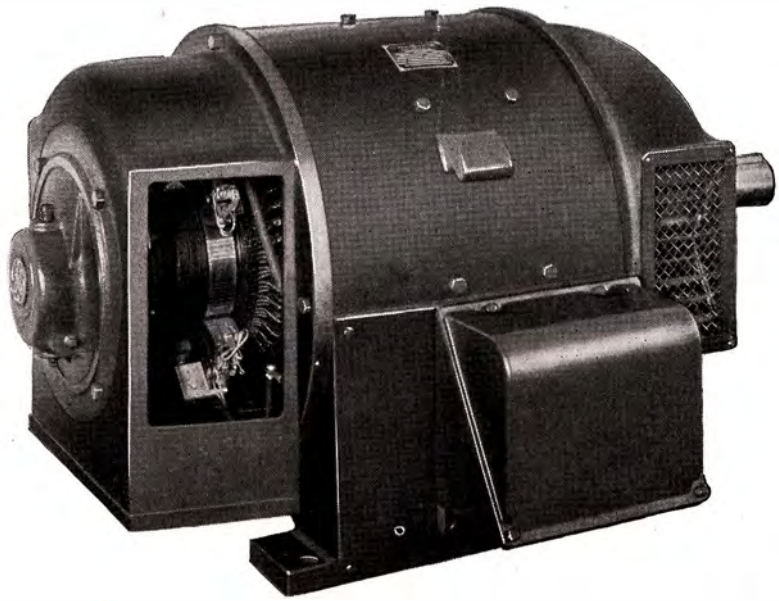
Heavy-duty direct-current open motor, Types B and CD, typical of sizes to 50 hp

Notable among the many outstanding features that are included in one or both of these designs are:

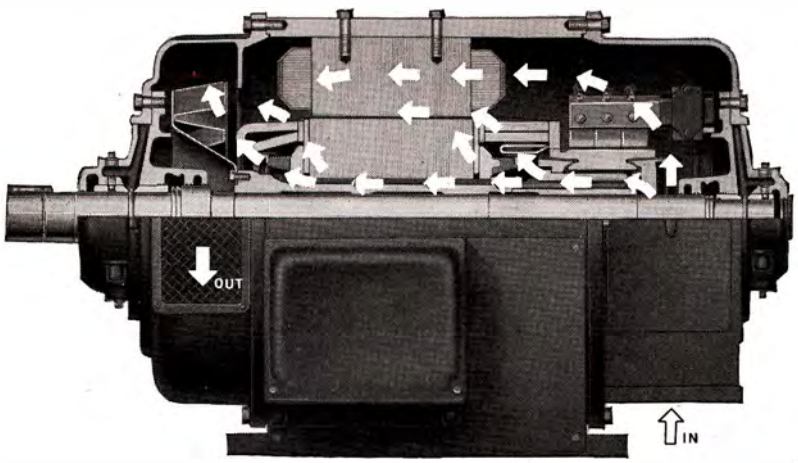
1. Built-up commutators, assembled under tons of pressure, yet a twist of a wrench can disassemble them.
2. Compensating, adjustable-tension brush holders for constant brush pressure under varying conditions.
3. Sturdy rolled-steel frame.
4. Solidly bonded and impregnated armature and field coils, resistant to moisture, acids, oils, and fumes.
5. Efficient fan and scroll of new quiet design.
6. Dust-tight, oil- or grease-tight bearing housings.

New! this past year—a streamline, protected, heavy-duty, reversible d-c motor in a complete line, known as Type CD "1000 Series" motors, rated from 50 hp at 850 rpm, and larger. These motors have sturdiness and strength for the rough service to which they are often put. Mines, quarries, planers, press drives, and many other applications demand this type of motor.

Fit companions to the "1000 Series" line are the compact, sturdy, new Type B (in NEMA frames) and Type CD Motors rated from 1 to 50 hp.



Heavy-duty Type CD direct-current open motor, typical of the new "1000 Series" line



Cutaway view of Type CD "1000 Series" dripproof, fully protected direct-current motor, showing improved ventilating system designed for reversible rotation which gives positive axial ventilation through the motor. This new design gives a motor of less height, reduced weight, and higher rating per frame size than heretofore possible. Compact, sturdy construction gives dependability under heavy-duty conditions prevalent in mines and industry

Integral-horsepower, Constant-speed, Direct-current Motors

General-purpose, Open, Sleeve-bearing, Horizontal, Shunt-wound, Commutating-pole Type— 115, 230 Volts, Type B (Frames 203-284) and Type ¶CD (Frames 66-95 and "1000 Series")

¶ Frame	Hp, Continuous, 40 C Rise	‡ Rated Full-load Basic Speed, Rpm	Max Speed by Field Control, Rpm	§ Volts	*† Sleeve-bearing Shunt-wound Motor Price
204	½	850	1700	115	$91
204		690	1380	230	115
225		575	1150		126
203	¾	1150	2300	115	85
224		850	1700	230	100
225		690	1380		126
254		575	1150		203
203	1	1750	2190	115	82
204		1150	2300	230	96
225		850	1700		110
226		690	1380		137
254		575	1150		209
203	1½	3500	....	115	102
204		1750	2190	230	93
224		1150	2300		110
254		850	1700		188
254		690	1380		209
284		575	1150		231
204	2	3500	....	115	114
224		1750	2190	230	104
225		1150	2300		129
254		850	1700		200
284		690	1380		229
284		575	1150		255
224	3	3500	....	115	136
225		1750	2190	230	128
254		1150	2300		195
284		850	1700		236
73		690	1380		270
73		575	1150		300
225	5	3500	....	115	169
254		1750	2190	230	203
284		1150	2300		247
66		850	1700		298
67		690	1380		336
75		575	1150		381
254	7½	3500	....	115	300
284		1750	2190	230	246
66		1150	1725		300
75		850	1700		358
75		690	1380		415
83		575	1150		466
284	10	3500	....	115	345
66		1750	2190	230	282
67		1150	1725		345
83		850	1700		411
83		690	1380		472
85		575	1150		546
73	15	3500	....	115	421
67		1750	2190	230	344
83		1150	1725		422
85		850	1700		506
93		690	1380		553
95		575	1150		684
75	20	3500	....	115	490
83		1750	2190	230	398
85		1150	1725		492
95		850	1700		598
95		690	1380		674
1129		575	1150		805

¶ Frame	Hp, Continuous, 40 C Rise	‡ Rated Full-load Basic Speed, Rpm	Max Speed by Field Control, Rpm	§ Volts	*† Sleeve-bearing, Shunt-wound Motor Price
75	25	3500	....	115	$836
			....	230	557
85		1750	2190	115	448
93		1150	1725	230	559
95		850	1700		685
1126		690	1380		762
1129		575	1150		924
83	30	3500	....	230	623
85		1750	1925	115	494
95		1150	1725	230	621
1126		850	1700		764
1129		690	1380		857
1133		575	1150		1022
85	40	3500	....	230	726
93		1750	1925		578
95		1150	1440		743
1129		850	1275		912
1133		690	1380		1010
1235		575	1150		1215
93	50	3500	....	230	847
95		1750	1925		702
1130		1150	1440		860
1128					....
1135		850	1275		1051
1131					....
1140		690	1035		1210
1136					....
1242		575	1150		1396
1238					....
95	60	1750	1925	230	756
1129		1150	1440		978
1133		850	1065		1185
1235		690	1035		1361
1337		575	865		1565
1129S	75	1750	1925	230	894
1131		1150	1440		1142
1235		850	1065		1366
1335		690	1035		1591
1441		575	865		1815
1135S	100	1750	1925	230	1117
1239S		1150	1440		1405
1339		850	1065		1655
1444		690	1035		1912
1539		575	865		2160
1137S	125	1750	1925	230	1331
1242S		1150	1325		1655
1345		850	1065		1932
1448		690	865		2160
1546		575	720		2529
1239S	150	1750	1925	230	1538
1341S		1150	1325		1896
1444S		850	1065		2193
1549		690	865		2529
1553		575	720		2892
1344S	200	1750	1925	230	1949
1447S		1150	1325		2361
1549S		850	1065		2691
1556		690	865		3110
1648		575	720		3533

ADDITIONAL INFORMATION

1. ***Compound- or Series-wound motors:** Available at approximately 3% addition, on the average, to the shunt-wound price. Series motors not recommended for belt drive.

2. †**Ball-bearing** motors available at 5% addition to the sleeve-bearing price.

3. ‡**Additional Ratings** available with full-load basic speeds from 500 to 100 rpm. For data, consult the Company.

4. §**Voltages:** 550- or 600-volt motors are available.

5. ¶**Shafts:** If the CD "1000 Series" motors are desired with short shaft for direct connection, specify frame with suffix letter "S."

6. **Modifications:** See page 67.

7. **Dimensions:** See page 82. GEM-550; GEM-920.

8. **Descriptive Bulletins:** GEA-1542; GEA-1868.

9. **Control:** See page 76.

Integral-horsepower, Adjustable-speed, Direct-current Motors

Open, *Sleeve-bearing, Shunt-wound, Horizontal, Commutating-pole Type, ‡115, 230 Volts, Type B (Frames 204-284) and Type ¶CD (Frames 66-95 and "1000 Series")

¶ Frame	Horsepower TAPERED Continuous, 40 C Rise	Horsepower CONSTANT Continuous, 40 C Rise	Horsepower CONSTANT One-hour, 50 C Rise	†§ Basic Full-load Speed, Rpm	* Sleeve-bearing, Shunt-wound Motor Price
204	.....	...	½	690	$101
204	½–¾	½	¾	850	100
224				690	124
225				575	135
				500	150
				450	161
				400	176
				350	190
				300	236
204	¾–1	¾	1	1150	94
224				850	110
225				690	135
225				575	150
				500	176
254				450	230
254				400	238
				350	256
				300	262
224	1–1½	1	1½	1150	106
225				850	121
225				690	147
254				575	225
254				500	233
284				450	250
284				400	258
284				350	280
....				300	290
225	1½–2	1½	2	1150	121
254				850	207
254				690	225
284				575	248
284				500	263
284				450	285
...				400	297
...				350	331
...				300	339
226	2–3	2	3	1150	142
284				850	220
284				690	246
66				575	274
66				500	291
67				450	319
67	2–3	2	3	400	332
...				350	374
...				300	387
284	3–5	3	5	1150	214
66				850	260
66				690	290
67				575	323
67				500	347
75				450	382
75				400	401
83				350	449
83				300	472
67	5–7½	5	7½	690	361
75				575	410
83				500	447
83				450	488
83				400	511
...				350	578
...				300	612
83	7½–10	7½	10	690	446
83				575	501
83				500	549
85				450	603
85				400	631
95				350	718
95				300	756

¶ Frame	Horsepower TAPERED Continuous, 40 C Rise	Horsepower CONSTANT Continuous, 40 C Rise	Horsepower CONSTANT One-hour, 50 C Rise	†§ Basic Full-load Speed, Rpm	* Sleeve-bearing, Shunt-wound Motor Price
85	10–15	10	15	575	$587
93				500	643
95				450	707
95				400	737
....				350	838
1129				300	888
95	15–20	15	20	575	650
95				500	750
....				450	827
1129				400	908
....				350	1017
1133				300	1110
....	20–25	20	25	575	765
1129				500	888
....				450	975
1131				400	1073
....	20–25	20	25	350	1200
1138				300	1304
....	25–30	25	30	575	878
1131				500	1009
....				450	1115
1136				400	1230
....				350	1354
1235				300	1472
....	30–40	30	40	575	971
1136				500	1123
....				450	1242
1138				400	1359
....				350	1499
1337				300	1687
....	40–50	40	50	575	1154
1138				500	1345
....				450	1472
1238				400	1609
....				350	1799
1441				300	1971
1238	50–60	50	60	500	1546
....				450	1684
1341				400	1839
....				350	2041
1445				300	2253
1341	60–75	60	75	500	1736
....				450	1868
1441				400	2046
....				350	2271
1539				300	2495
1441	75–100	75	100	500	1994
....				450	2172
1445				400	2357
....				350	2597
1543				300	2840
1543	100–125	100	125	400	2793
....				350	3006
1550				300	3356
1553	125–150	125	150	400	3202
....				350	3437
1645				300	3793
1645	150–200	150	200	400	3524
....				350	3828
1653				300	4230
....	.....	200	200	400	4236
....				350	4570
....				300	5012

ADDITIONAL INFORMATION

1. **Maximum Speeds.** By means of field control, certain maximum speeds may be obtained. There are two fundamental ratios of maximum to basic speed that may be obtained. These are 3:1 to 4:1, and either may be had at the prices listed. In some ratings, by paying a 10% price addition, it is possible to obtain a maximum speed by field control in excess to the 4:1 ratio. For details, consult the Company.

2. ***Ball-bearing** motors available at 5% addition to the sleeve-bearing price.

3. †**Additional ratings** available with full-load basic speeds of 250, 200, 150, or 100 rpm. For data, consult the Company.

4. ‡**Voltages:** Types CD "1000 Series" motors are standard at 230 volts only, instead of the 115, 230 volts listed. For Type CD "1000 Series" at 115 volts, and all types at 550 or 600 volts, consult the Company.

5. §**Speed Changes:** From basic speeds upwards to 150 per cent, temperature will not exceed 50 C rise; above 150 per cent basic speed, temperature will not exceed 40 C rise. For prices of motors rated 40 C rise over the entire speed range, add 10 per cent.

6. ¶**Shafts:** If the CD "1000 Series" motors are desired with short shaft for direct connection, specify frame with suffix letter "S."

7. **Modifications:** See page 67.

8. **Dimensions:** See page 82.
GEM-550; GEM-920.

9. **Control:** See page 76.

10. **Descriptive Bulletins:**
GEA-1542; GEA-1868.

DIRECT-CURRENT MOTOR ENCLOSURES

Protection of personnel in a factory is important. So too, is protection of the direct-current motor, from the many different adverse installation conditions which exist. Hence, all d-c motors are made so they can readily be equipped with different kinds of covers.

(1) Dripproof

With solid covers on all top ventilating openings for protection from dripping liquids.

(2) Dripproof Protected

Protection from dripping, bouncing objects, accidental entrance of hands or clothes, vermin, etc. with solid top-half covers and perforated bottom-half covers.

Dripproof, fully protected Type B or CD motors. Note solid covers on all top ventilating openings for dripproof construction and perforated protective covers for all other openings

(3) Protected

Protection of personnel and motor with perforated cover on all openings.

(4) Splashproof

Protection from hosing down or where wetness is a factor—with solid covers on all top and louver covers on all bottom openings.

(5) Self-(pipe-)ventilated Motors

For obtaining cool, clean, ventilating air. These motors are equipped with totally enclosed end shields with provision for connection of pipe for conveying air to the motor. The frame provides for discharge of air into the surrounding atmosphere, or provision may be made for connection to an exhaust air duct.

The motor fan will circulate sufficient air if relatively straight pipe of ample section, and not more than 25 ft long, is used. Pipes or ducts are not included in price addition.

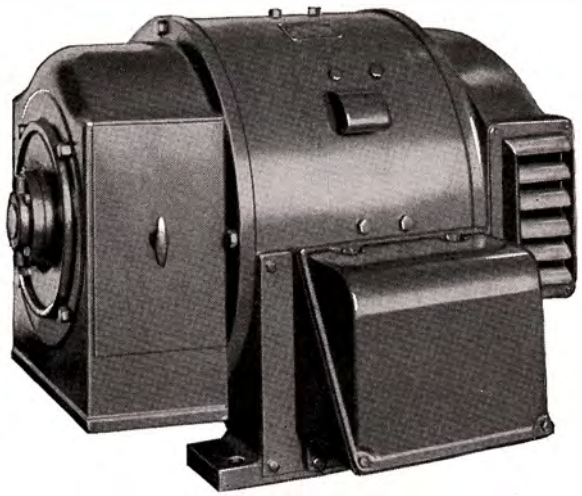
This enclosure may be used on a motor rated 40 C without increase in temperature rise.

(6) Separately (Forced) Ventilated Motors

These motors are similar to the self-ventilated motors, but depend upon a separate, forced air supply for ventilation. The end shields provide for pipe connection, and the frame provides for the discharge of air into the surrounding atmosphere.

Pipes or blowers are not included in price addition.

Motors rated 40 C with this type of enclosure will operate without increase in temperature rise.



Direct-current splashproof motor, Type CD, typical of "1000 Series" construction

Price Additions for Enclosures—D-c Motors

		Price of Motor (after all adjustments for electrical modifications have been made)								
		$109 and Below	$110 to $157	$158 to $242	$243 to $424	$425 to $575	$576 to $1029	$1030 to $1815	$1816 to $2662	Above $2662
		* Price Additions								
Dripproof—50 C—Front end	Add	$1	$2	$3	$5	$7	$11	$19	$27	1½%
Both ends	Add	2	3	5	8	11	19	32	45	2%
Dripproof, protected—55 C—Front end	Add	2	4	6	10	14	22	38	54	3%
Both ends	Add	4	6	10	16	22	38	64	90	4%
Protected (semienclosed)—50 C—Front end	Add	2	4	6	10	14	22	38	54	3%
Both ends	Add	4	6	10	16	22	38	64	90	4%
Self-(pipe-)ventilated—40 C	Add	22	33	47	76	97	164	260	355	15%
† Separately (forced) ventilated—40 C	Add	9	14	22	37	50	87	152	215	9%
Splashproof—50 C—Front end	Add	8	12	16	25	33	52	85	126	5%
Both ends	Add	11	16	23	36	47	78	129	178	8%

* Price additions are to be based on the price of the open, sleeve-bearing motor, but should be added to the price of the open, sleeve- or ball-bearing motor required.

† Blower not included.

TOTALLY ENCLOSED DIRECT-CURRENT MOTORS

Standard and Explosion-proof

Just as for polyphase a-c motors, the totally enclosed construction gives real protection from adverse conditions. In addition to the standard enclosure, and the explosion-proof motor for Class I, Group D, hazardous gas conditions, General Electric builds and has had inspected and tested by the Bureau of Mines, a line of

Totally enclosed, fan-cooled d-c motor, typical of Type B

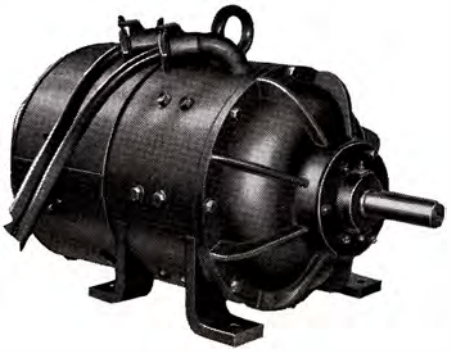
motors that is eligible, without further tests, for application to an approved power-using assembly in mines.

The smaller sizes are made in compact nonventilated construction. All the openings are covered with solid covers, so that there is no deleterious exchange of air between the inside and outside of the motor.

The totally enclosed, fan-cooled motors have a system of dual ventilation. The internal fan, located on the pulley end, draws the warm air over the windings and core and circulates it around the interior so that internal heat is given up to the frame and end shields.

The external fan draws cool air through the mesh openings in the fan guard on the commutator end and directs it over the surface of the end shield and magnet frame. Cast-iron conduit boxes, nonsparking fans, and compact, sturdy construction are used throughout.

The explosion-proof motors have extra-heavy magnet frames and special end shields of strong design. The motors for Class I, Group D, conditions have dual ventilation and special conduit boxes. The Class B motors are provided with suitable stuffing box and 10 feet of mine-type rubber-covered cable and air hose.



Totally enclosed motor of construction that has passed the inspection and test of the Bureau of Mines and is designated as Class BM

Integral-horsepower, Direct-current, Totally Enclosed Motors

Standard or Explosion-proof, Totally Enclosed, Fan-cooled Motors. Shunt-wound, Constant-speed, Commutating-pole, Horizontal, Ball-bearing. Types B (Frames 204 to 284) and CD (Frames 66 to 173)

Hp, Continuous, 55 C Rise	¶ Speed, Rpm	Volts	Totally Enclosed, Fan-cooled, Ball-bearing, Shunt-wound Motors			
			STANDARD		EXPLOSION-PROOF	
			Frame	Price	Frame	Price
½	850	†	*224	$130	*224	‡§
¾	1150	†	*224	125	*224	‡§
	850	†	*225	143	*225	‡§
1	1750	†	*204	121	*224	‡§
	1150	†	*224	143	*224	‡§
	850	†	225	160	225	‡§
1½	3500	†	*204	148	*224	‡§
	1750	†	*225	135	*225	‡§
	1150	†	224	160	224	‡§
	850	†	254	272	226	‡§
2	3500	†	*224	177	*224	‡§
	1750	†	225	151	225	‡§
	1150	†	225	187	225	‡§
	850	†	254	300	226	‡§
3	3500	†	224	197	224	‡§
	1750	†	225	186	225	‡§
	1150	†	254	293	66	‡
	850	†	284	354	66	‡
5	3500	†	225	245	225	‡§
	1750	†	254	305	66	‡
	1150	†	284	371	66	‡
	850	†	75	447	67	‡
7½	3500	†	254	450	66	‡
	1750	†	284	369	66	‡
	1150	†	67	450	67	‡
	850	†	83	573	83	‡
10	3500	†	284	518	...	
	1750	†	66	423	67	‡
	1150	†	83	552	83	
	850	†	85	658	85	
15	3500	†	75	632	...	
	1750	†	83	550	83	‡
	1150	†	85	675	85	
	850	†	95	810	95	‡
20	3500	†	85	784	...	
	1750	†	85	637	85	
	1150	†	93	787	93	
	850	†	95	999	95	‡
25	3500	230	...	891	...	
	1750	†	...	748	95	‡
	1150	†	95	934	95	‡
	850	†	...	1144	...	
30	3500	230	...	997	...	
	1750	230	95	825	95	‡
	1150	230	103	1037	...	
	850	230	113	1276	...	
40	1750	230	105	1156	...	
	1150	230	113	1241	...	
	850	230	123	1523	...	
50	1750	230	115	1404	...	
	1150	230	123	1436	...	
	850	230	135	1755	...	
60	1750	230	123	1512	...	
	1150	230	135	1633	...	
	850	230	173	1979	...	

Refer to the Company

ADDITIONAL INFORMATION

1. ***Totally Enclosed Motors:** These motors are furnished totally enclosed (not fan-cooled) instead of totally enclosed, fan-cooled. Practically all of the motors up to and including 15 hp may be obtained in the totally enclosed (not fan-cooled) construction, if desired. However, in all cases where frames and prices are listed for the totally enclosed, fan-cooled motors, both frames and prices will be higher for the totally enclosed (not fan-cooled) construction.
2. **†Voltages:** These ratings are 115, 230 volts in the standard type and 230 volts only in the explosion-proof type. All motors are available in other standard voltages at increased prices.
3. **‡Bureau of Mines:** These motors have passed the inspection and tests of the Bureau of Mines and are listed as Class BM. They may be offered as eligible for ultimate approval without further test as a part of a complete power-using assembly. All other motors of the explosion-proof type are manufactured under the same standards and are of the same construction, but are offered subject to further inspection and tests.
4. **§Class I—Group D:** These motors are for Class I, Group D, hazardous gas conditions—tested and listed by Underwriters' Laboratories.
5. **¶Speed Ranges:** All motors listed have speed ranges comparable to the constant-speed, open motors in the previous section.
6. **△Special Windings:** Compound- and series-wound motors also available. Consult the Company for complete information.

PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

THE Pacific, General Electric Motorized, Speed Reducer—often the most economical means of obtaining a dependable source of power for the operation of many types of machinery at low speeds — consists of a normal-speed motor in combination with a built-in reduction gear. This combination results in an integral, self-contained unit that is highly efficient, extremely compact, and sturdily built.

General Electric offers a complete line of motorized speed reducers in this design, in listed ratings from 1/6 to 50 horsepower. In practically all of these ratings, Pacific, General Electric Motorized, Speed Reducers are obtainable in polyphase, single-phase, or direct-current types. A wide choice of output-shaft speeds between 780 and 13.5 rpm is available.

NOMENCLATURE
(Integral-hp Speed Reducers)

Standard construction, horizontal mounting
Type MS: Single-reduction speed reducer
Type MR: Double-reduction speed reducer
Type MT: Triple-reduction speed reducer

Standard construction, vertical mounting
Type SV: Single-reduction speed reducer
Type DV: Double-reduction speed reducer

How the Pacific, General Electric Motorized, Speed Reducer Benefits You

It Reduces Power Costs—Pacific, General Electric Motorized, Speed Reducers have a higher operating efficiency than any other type of low-speed drive of comparable installation cost—the motor, running at 1800 rpm, operates at maximum efficiency and power factor; and motor and gear are closely connected, minimizing mechanical losses.

It Saves Space—The gear design used permits a compact, balanced arrangement of parts and a housing of small physical proportions. Pacific, General Electric Motorized, Speed Reducers require only slightly more mounting space than standard motors.

It Minimizes Shutdowns—The simple design, careful workmanship, adequate lubrication, and ample factors of safety in all parts mean long, reliable service and freedom from production delays.

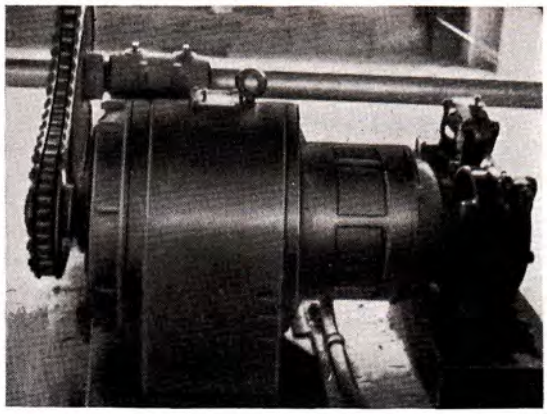
It Reduces Maintenance Costs—The inherent smoothness of operation and the sturdiness of the Pacific, General Electric Motorized, Speed Reducer permits it to operate dependably with no more attention than an infrequent change of lubricant.

It Is Unusually Quiet—All gears running in oil, and a balanced distribution of load, eliminate the noises usually associated with geared speed reduction.

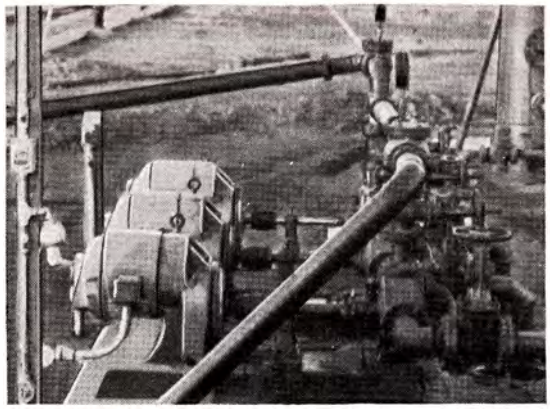
It Is Easy to Install—The integrally cast base and overhanging motors contribute to lower installation costs. Problems of leveling bases, and of providing safety devices for couplings and external spur gears are greatly simplified.

It Promotes Safety in Your Plant—The reduction or elimination of external chains, gears, or belts by a completely self-contained Pacific, General Electric Motorized, Speed Reducer means added safety for your workers.

It Is Available in a Complete Line—Practically any desired speed between 780 and 13.5 rpm can be obtained in all standard ratings—polyphase, single-phase or direct-current.



Lumber unstacker requiring frequent starting, stopping, and braking, driven by Type MR double-reduction speed reducer with high-slip motor



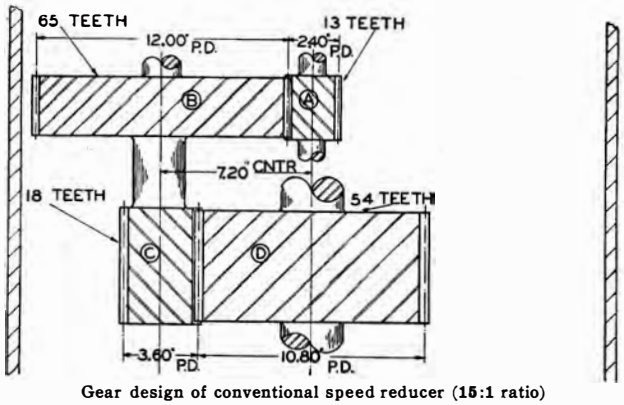
Positive-displacement rotary transfer pumps driven by Type MS single-reduction motorized speed reducers, handling crude oil

Analysis of Gear Designs, Type MR

A study of the two gear trains illustrated readily shows the advantage of the gear design used in the Pacific, General Electric Motorized, Type MR Speed Reducers.

Both the Type MR and the conventional-type reducer-gear plans include an over-all ratio of 15 to 1.

Note that the over-all ratio, the distance between shafts, the gear centers, and the diameter of the enclosing case are, as shown by both plans, identical. Yet, the pitch diameters of the driving pinions, E and G, of the Type MR design are considerably larger than the corresponding pinions, A and C, of the conventional design.



Gear design of conventional speed reducer (15:1 ratio)

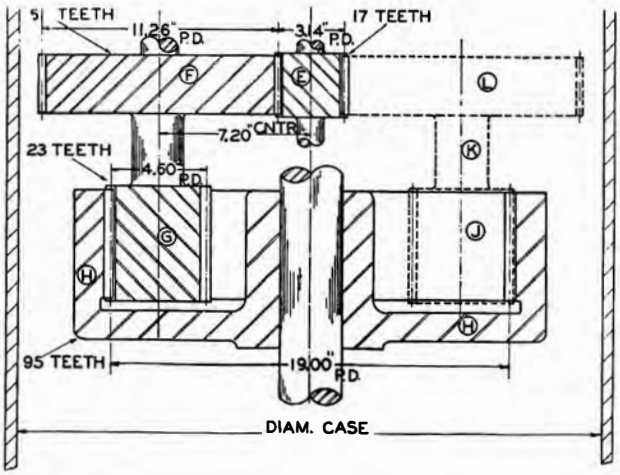
Note also that the pitch diameter of the MR internal gear, H, is 75 per cent larger than the final gear, D, of the conventional type.

This demonstrates the huge gain in available torque on the low-speed shaft of the Type MR unit.

Now, compare the capacities of the two systems under identical conditions, with similar pitches and face lengths. Any accepted gear formula used in both cases will prove definitely that the over-all capacity of the Type MR is more than 45 per cent greater than that of the conventional type.

The internal gear set offers distinct advantages over the external gear. The tooth contact is over a longer arc than with the external set. The larger-size internal gear engages a greater number of pinion teeth; it "wraps" around the pinion instead of arcing away from it.

Hence, more pinion teeth of G assume the total load of gear H, minimizing the individual tooth load of G. This resists tooth wear on pinion G—and tooth wear is the main measure of success or failure of a gear set.



Gear design of Pacific, General Electric Motorized, Speed Reducer (15:1 ratio)

The internal-gear-set tooth shape lends itself to better rolling action and less sliding action than the external set. The result: Less friction and heating; greater efficiency.

The Pacific, General Electric Motorized, Type MR Speed Reducer goes a step further.

A second countershaft, JKL, is added, shown by the dotted line on the diagram of the Type MR design.

Note that this system utilizes the opposite side of the initial pinion, A, which side is idle in the conventional type. The total load, which is carried on one or more teeth on A, is now carried on E by twice the number of teeth. The individual tooth load is reduced one-half.

Likewise, the total gear load of gear D on pinion C of the conventional type is now transmitted from internal gear H to two pinions, G and J, with the same result as above.

Also, the high-speed pinion bearings for E and the low-speed-shaft bearings of H are required to assume only the outside load. Gear loads are eliminated on them because of the opposite directions of the tooth-load reactions.

CLASS I MOTORIZED SPEED REDUCERS

Selection of Motorized Speed Reducers

A motorized speed reducer differs from a standard motor in that the gearing inserts a mechanical link of limited strength in the conversion of electric power from the source of supply to mechanical power in the output shaft. The safe limits for the duty required of motor and gear are quite dissimilar; and, in determining the safe limits for motorized-speed-reducer duty, this fact must be recognized. In a motorized speed reducer properly designed for continuous duty with a specified maximum variation of load, the gear is subject to abuse by excessive loads of any duration, whereas the continued operation of the motor is not greatly affected, except by excessive duration of overloads. Therefore, gear elements must be selected to meet safely the working stress based on peak overloads, rather than on the normal full-load torque of the motor.

The speed reducers that are listed in this catalog are Class I motorized reducers, designed to handle a wide range of applications where the speed and load are reasonably constant and do not exceed the normal rating of the motor and where the length of service does not exceed 8 to 10 hours daily. For applications that impose more severe service conditions, Pacific, General Electric Motorized, Speed Reducers are available in Class II and Class III designs.

On normal applications, motorized speed reducers can be operated in either direction of rotation, but if they are to be thus operated, it should be so specified in ordering, to permit the assembly of the gears for minimum backlash and minimum end play in the bearing assembly. The type of connection must be specified, because minimum sprocket, pulley, and pinion diameters have been established and must be observed in selecting a motorized speed reducer for connection to a given load. As regards ambient conditions, a motorized speed reducer should be selected with the same care that is used in selecting a motor.

The rules for selecting the type of motor on a motorized speed reducer (K, KH, totally enclosed, etc.) are the same as given elsewhere in this catalog for each specific type of regular motor. In general, applications requiring Types KG, KR, and M motors should be analyzed thoroughly, to decide on the proper gear type, since applications which justify such motor characteristics as these types possess usually also demand Class II or Class III gears.

FRACTIONAL-HORSEPOWER MOTORIZED SPEED REDUCERS

The line of fractional-horsepower Pacific, General Electric Motorized, Speed Reducers covers a range of standard ratings from 1/6 to ¾ hp, in polyphase, single-phase, and direct-current types. Two principal types are available, each giving the advantages of compactness, economy and dependability, and each designed for applications where its particular arrangement of parts is preferable. These types are (1) parallel-shaft, helical-gear type, giving a choice of output speeds between 780 and 125 rpm; and the dual-countershaft type, giving a choice of output speeds between 125 and 13.5 rpm.

Each of these types of motorized speed reducers consists of an efficient, normal-speed motor combined with a sturdy reduction gear, built as a single unit. A complete line of both types is available in open, splash-proof, and totally enclosed construction. Motorized speed reducers for flange mounting or vertical operation are also available.

In fractional-horsepower ratings, all motors are overhung from the gear casing. Feet cast integrally with the casing permit easy mounting and provide the rigidity necessary for high-radial-thrust loads.

All standard listed fractional-horsepower motorized speed reducers are rated for normal 8 to 10 hours' continuous operation per day, with rated motor output to the gears. Listed speeds are based on full-load motor speeds of 1750 rpm.

The listing on page 55 covers Class I, fractional-horsepower units only, and for that reason should be used only in determining prices of motorized speed reducers for standard applications. There are numerous electrical and mechanical modifications available for this Class I line. A partial list of these follows, but for specific details and pricing directions, consult the nearest General Electric office.

Electrical Modifications

1. Special frequencies.
2. Special voltages.
3. Special insulation.
4. Reversing duty.
5. Frequent-starting duty.

Mechanical Modifications

1. Special mounting positions—various types.
2. Nonstandard bearings.
3. Special gear ratios.
4. Motor-mounted brakes.
5. Low-speed shaft out opposite side from standard on right-angle-shaft motorized speed reducers.
6. Special shaft extensions.
7. Special bases.

General Information on Fractional-horsepower Speed Reducers, Types MS, MR, MT, MW, and MHW

Fractional-horsepower units are furnished in three types, these including the MW series with right-angle take-off shaft, MHW series with double-reduction and right-angle shaft, and the parallel-shaft types in MS and MR series.

Strength and Durability

A generous factor of safety is used in design of all housings, gears, shafts, and bearings to give utmost rigidity and the strength necessary to withstand continuous duty. The overhung load is carried by a rigid foundation base cast integrally with the gear housing.

Motors are overhung and carry only the torque loads essential to the required load. Ample oil capacity, with positive lubrication, contributes to long operating life with practically no attention beyond occasional inspection of the oil level.

Over-all size has been minimized by compact gear arrangement, thus adding to strength and rigidity.

Efficiency

Highest transmission efficiency is obtained and maintained by use of precision-cut gears, antifriction bearings, and continuous lubrication. Continuous, low-speed, full-rated capacity is provided with utmost economy and extreme quietness.

Accessibility

Full access to gears and other parts is provided through proper arrangement of cover plates in all housings.

Application

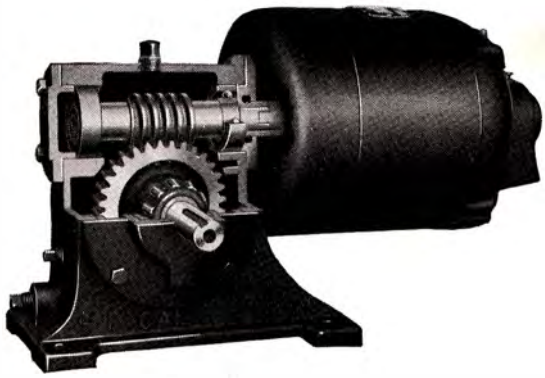
Fractional-horsepower motorized speed reducers have a wide field of application which requires many different, and frequently unique, modifications of standard frames. Often entirely new designs are needed to meet certain conditions. When it is found that requirements cannot be met from available information, refer to the nearest G-E office.

Ratings

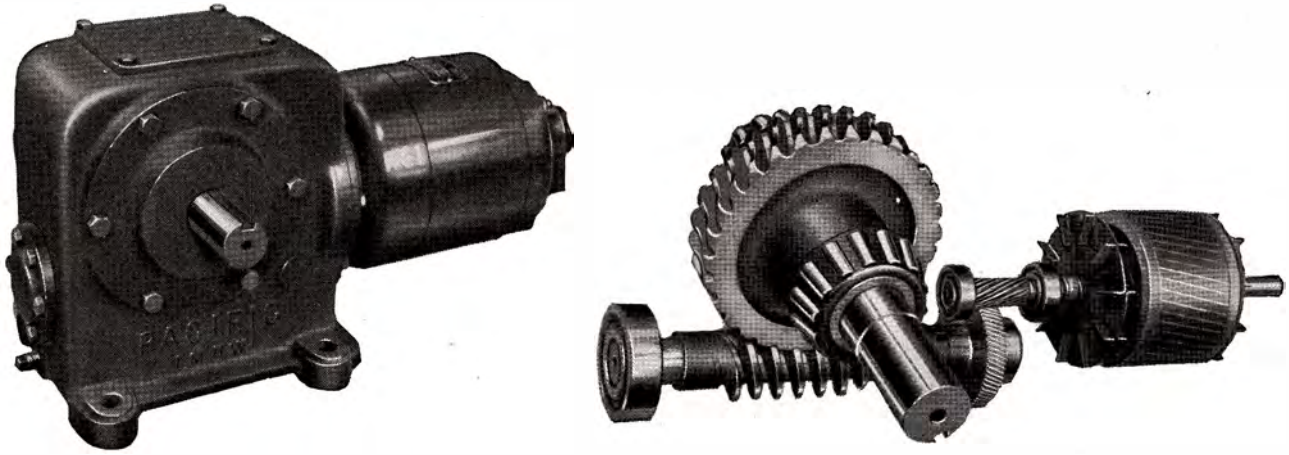
The input rating of fractional-horsepower speed reducers, listed on page 55, is based on the *nominal rating* of the motor to be mounted on the gear frame. The output rating of the speed reducer is the *nominal rating* of the motor minus the gear losses. The listed output ratings may be carried *continuously—24 hours per day—for normal-duty loading.*

Direction of Rotation

Fractional-horsepower motorized speed reducers can be operated in either direction without loss of efficiency or injury to parts. For direct-current and single-phase operation, however, the direction of rotation required should be specified, as the direction of rotation of these motors is not readily changeable.



Type MW—Single-reduction, right-angle shafts



Type MHW—Double-reduction, right-angle shafts

In specifying direction of rotation of motorized speed reducers, the practice is to specify the direction of rotation (clockwise or counterclockwise) when one is looking along the output shaft toward the gear housing.

Nomenclature

Fractional-horsepower, Pacific, General Electric Motorized, Speed Reducers are identified by a complete frame number; as, 1MHW-45—1MHW designating the speed reducer as a Frame 1 of Type MHW, and -45 indicating a Frame 45, Type K, KH, or KC motor. Speed-reducer frame numbers only are listed on page 55.

Gear Types

Type MS: Single-reduction, parallel shafts.
Type MR: Double-reduction, concentric shafts.
Type MT: Triple-reduction, concentric shafts.
Type MW: Single-reduction, right-angle shafts.
Type MHW: Double-reduction, right-angle shafts.

Overhung Loads

Fractional-horsepower motorized speed reducers are designed to carry overhung sprocket, gear, V-belt, or flat-belt loads without outboard bearings, provided the minimum pitch diameter and other limitations, as listed on rating page 55, are adhered to.

Lubrication

Pacific, General Electric Motorized, Speed Reducers are shipped without lubricant. Attached to each unit at the time of shipment is a *Lubrication Chart.*

The grade of lubricant recommended for various temperature conditions, and the approximate required quantity of lubricant for each speed-reducer frame size, are shown on this chart, as well as in the tabulation below. The quantity shown on this chart is in excess of the actual amount required to fill the speed reducer to the proper oil level. No more oil than that actually required to bring the oil level to the gage mark should be put into the speed reducer.

No speed reducer should be placed in service before these recommendations are followed.

Speed-reducer Frame No.	10 to 40	40 to 100	100 to 140
	Ambient Temperature, Degrees F Saybolt Viscosity (Sec at 100 F)		
½MS, 1MS, 3MR, 5MR, 3MT	250–450 SAE 20	450–600 SAE 30	750 SAE 40
½MW, 1MHW	1200–1800 SAE 50	1900–3000 600W	3200–7000
Approximate Amounts of Oil Required (in Gallons)			
½MS–¼ 1MS–¼	3MR–½ 5MR–1¼	3MT–1	½MW–⅛ 1MWH–½

Maintenance

At the time of the initial installation, motorized speed reducers should be filled with the proper lubricant to the gage mark. After 100 hours of operation, the initial lubricant should be completely drained, the housing flushed (with a light flushing oil) and refilled with the proper oil to the gage mark. Therefore, for normal temperature and humidity conditions, *semiannual* draining will be sufficient, except for frequent inspections of the oil level. Where high, varying, or very low temperatures and/or humidity conditions prevail, special maintenance instructions should be obtained from the nearest G-E office. This is extremely important when speed reducers are intermittently in and out of operation.

Type MS—Single-reduction, parallel shaft

Type 3 MR—Double-reduction, single countershaft, concentric

Fractional-hp Pacific, General Electric Motorized, Speed Reducers

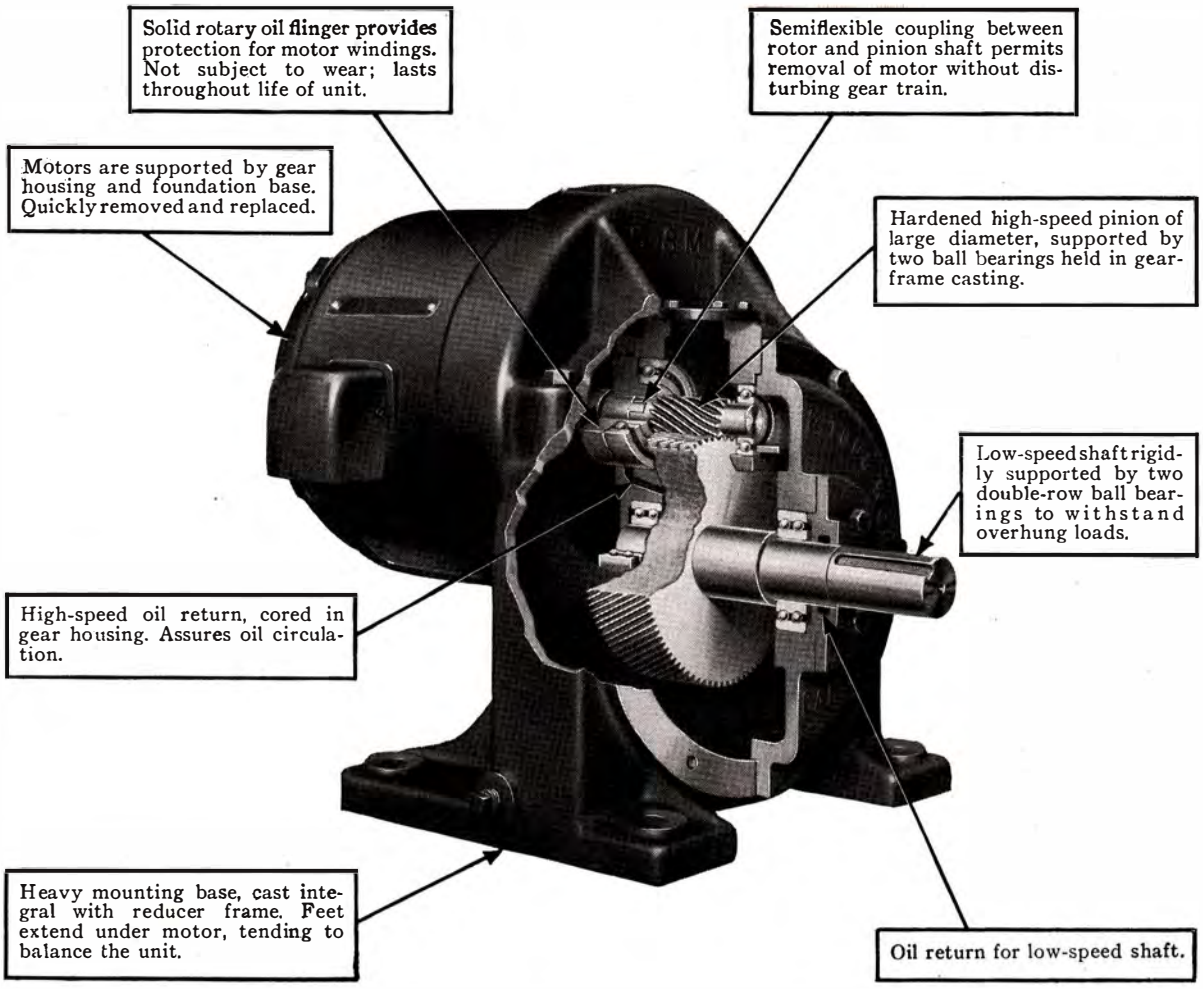
Type K; 3- and 2-phase; 60 Cycles; 110, 220, 440, and 550 Volts
Type KH; Single-phase, 60 Cycles, 115 and 230 Volts
Type KC; Single-phase, 60 Cycles, 115 and 230 Volts
Type BC; Direct Current; 32, 115, and 230 Volts

1/6 to 3/4 HP

Frame No. †	HP Input	HP Output 40 C Rise	Motor Sync Speed, Rpm	Output Full-load Speed (Approximate) Rpm (One Only)	PRICE STANDARD OPEN HORIZONTAL MOTORIZED REDUCERS Type K § 220 or 440 Volts	Type KH ϕ 115 Volts	Type KC 115 or 230 Volts	Type BC ¶ 115 Volts	For Totally Enclosing Add to Price of Open Motorized Reducer	‡ Min. P.D. of Sprocket in Inches	BASE OR RAILS FOR HORIZONTAL MOUNTING △ No.	Add to Price of Motorized Reducer
For Motor Frame Numbers, Refer to the Company												
½MS-	1/6	0.16	1800	780, 640, 520	$38	$32	...	$41	$4	1½	02	$7
½MS-		.16	1800	420, 350, 280	38	32	...	41	4	1½	02	7
½MS-		.16	1800	230,190	45	39	...	48	5	1½	02	7
½MW-		.12	1800							1¾	....	....
½MW-		.10	1800		Refer to the Company		...	Refer to the Company	Refer to the Company	1¾	....	....
½MW-		.09	1800							1¾	....	....
1MHW-		.13	1800	Refer to the Company						2¼	....	....
1MHW-		.12	1800							2¼	....	....
1MHW-		.11	1800							2¼	....	....
1MHW-		.11	1800							2¼	....	....
½MS-	1/4	.24	1800	780, 640, 520	39	...	$34	44	4	1½	02	7
½MS-		.24	1800	420, 350, 280	39	...	34	44	4	1½	02	7
½MS-		.24	1800	230, 190	47	...	42	52	4	1½	02	7
½MW-		.18	1800							1¾	....	....
½MW-		.15	1800		Refer to the Company	..	Refer to the Company		Refer to the Company	1¾	....	....
1MHW-		.19	1800	Refer to the Company						2¼	....	....
1MHW-		.18	1800							2¼	....	....
1MHW-		.18	1800							2¼	....	....
1MHW-		.17	1800		111	...	111	116	14	2¼	....	....
1MHW-		.16	1800		114	...	114	119	14	2¼	....	....
½MS-	1/3	.32	1800	780, 640, 520	41	...	41	47	4	1½	02	7
½MS-		.32	1800	420, 350, 280	41	...	41	47	4	1½	02	7
½MS-		.32	1800	230, 190	51	...	51	57	5	1½	02	7
½MW-		.26	1800							1¾	....	....
½MW-		.23	1800		Refer to the Company	...	Refer to the Company		Refer to the Company	1¾	....	....
1MHW-		.25	1800	Refer to the Company						2¼	....	....
1MHW-		.24	1800							2¼	....	....
1MHW-		.22	1800		103	...	103	109	11	2¼	....	....
1MHW-		.22	1800		125	...	125	132	15	2¼	....	....
1MS-	1/2	.49	1800	780, 640, 520	52	...	52	58	6	2	204	7
1MS-		.49	1800	420, 350, 280	52	...	52	58	6	2	204	7
1MS-		.49	1800	230	61	...	61	67	7	2	204	7
1MS-		.49	1800	190	61	...	61	67	7	2	204	7
						...	61	67	7	2	204	7
1MS-		.49	1200	155, 125	71	...	71	77	8	2	204	7
3MR-		.48	1800	100	71	...	71	77	8	2¼	254	7
3MR-		.48	1800	84	71	...	71	77	8	2¼	254	7
3MR-		.48	1800	68	83	...	83	89	9	2¼	254	7
3MR-		.48	1800	56	83	...	83	89	9	2¼	254	7
						...	83	89	9	2¼	254	7
3MR-		.48	1800	45	100	...	100	106	10	2¼	254	7
3MR-		.48	1800	37, 30	100	...	100	106	10	2⅞	254	7
5MR-		.48	1200	25, 20	111	...	111	117	11	3¼	254	7
3MT-		.47	1800	16.5, 13.5	135	...	135	141	12	3¼	2	12
3MT-		.47	1800			...	195	204	15	3¼	2	12
1MS-	3/4	.73	1800	780, 640, 520	62	...	62	69	8	2	204	7
1MS-		.73	1800	420, 350, 280	62	...	62	69	8	2	204	7
1MS-		.73	1800	230	73	...	73	80	8	2	204	7
1MS-		.73	1800	190	73	...	73	80	8	2	204	7
						...	...	...	8	2	204	7
1MS-		.73	1200	155	89	...	...	...	8	2	204	7
3MR-		.72	1800	125	89	...	89	96	8	2¼	254	7
3MR-		.72	1800	100	89	...	89	96	8	2¼	254	7
3MR-		.72	1800	84	89	...	89	96	8	2¼	254	7
3MR-		.72	1800	68	102	...	102	109	10	2⅜	254	7
3MR-		.72	1800	56	102	...	102	109	10	2¾	254	7
3MR-		.72	1800	45	120	...	120	127	12	3¼	254	7
5MR-		.72	1800	37, 30	120	...	120	127	12	3¼	254	7
5MR-		.72	1200	25, 20	137	...	...	...	12	3¼	254	7
3MT-		.70	1800	16.5, 13.5	156	...	156	163	15	3¼	2	12

† Reducer frame number only is shown; for frame number of complete unit add the motor frame number to reducer frame number.
‡ Minimum pitch diameters are based on radial load applied at center of shaft extension. For other than sprocket drives, use the following multipliers on values of minimum diameters listed: 1.25 for gear drive; 1½ for V-belt drive; 2.5 for flat-belt drive.
§ For 550 volts, add **$2.00** in ratings 1/6 to 1/3 hp incl; no addition on ½ and ¾ hp.
¶ For 32 or 230 volts, add **$1.00.**
△Numbers 02 and 204 to 254 are sliding bases; Number 2 are sliding rails.
ϕ Price for 230 volts same as for 115 volts.

Design Features—Integral-hp Single-reduction Unit, Type MS



Gear Assembly

In referring to the sectional view above, of a Type MS Pacific, General Electric Motorized, Speed Reducer, observe that the high-speed pinion and the low-speed output gear and shaft are mounted in the vertical center line of the gear housing, with the gear directly below the pinion. Each shaft—that is, the high-speed pinion shaft and the low-speed output shaft—is supported by two correctly selected and fitted ball bearings.

This method of gear assembly is unusually advantageous, since it permits:

(a) Inspection of tooth surfaces through the top-sight cover plate.

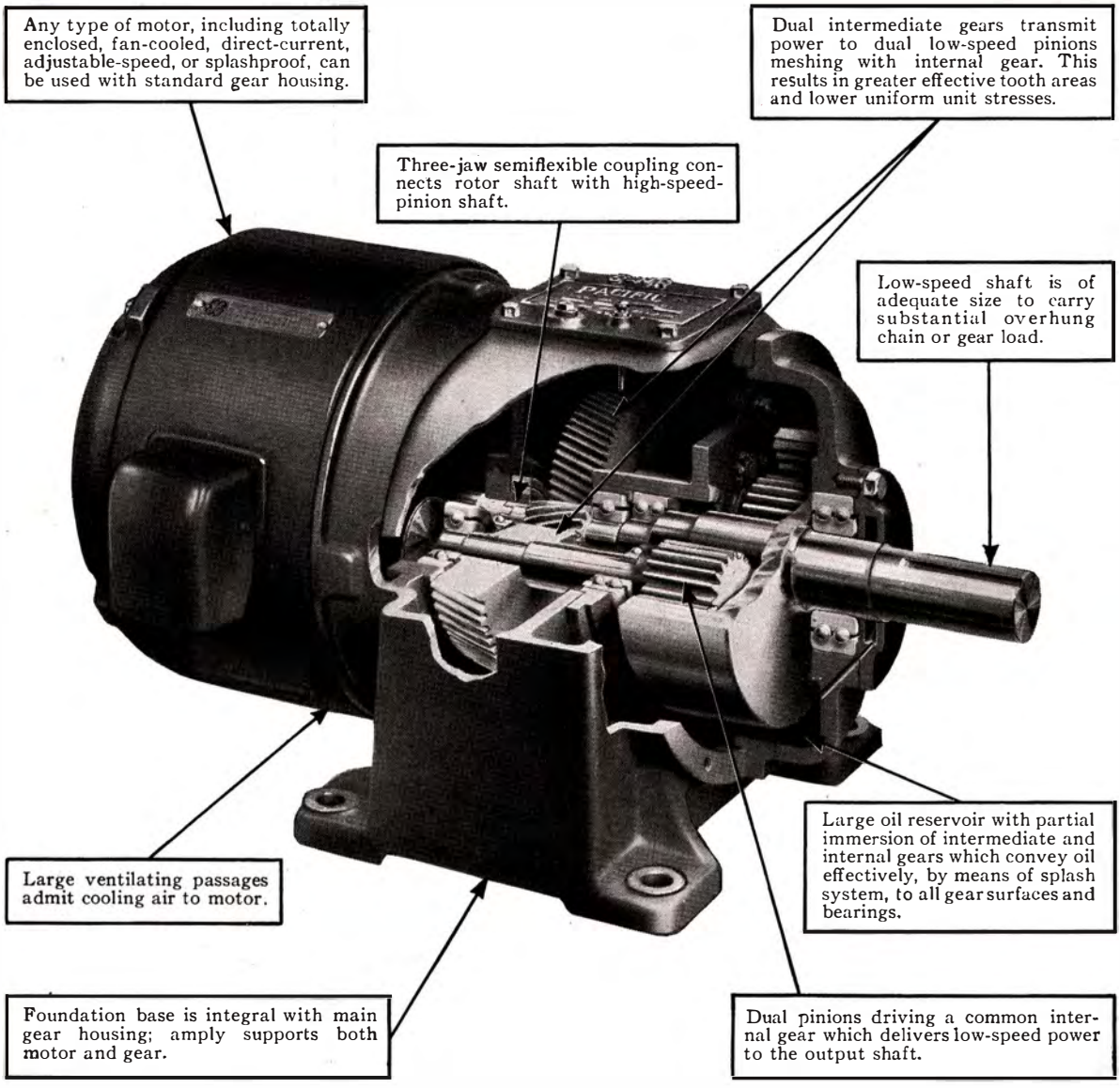
(b) Removal of pinion and gear without disturbing rotor or stator.

(c) Substantial overhung loads on the output shaft, because the load center is close to the foundation base.

Lubrication

The bottom of the Type MS gear housing is inclined downward and toward the motor, thus providing a large oil reservoir. Also note that ample oil-return passages are cored in the gear housing, providing for adequate oil circulation through and around all bearings. The low-speed gear, partially submerged in the lubricant, becomes an oil flinger, spraying oil over the entire housing. In this manner, a continuous flow of lubricant is maintained over all working parts.

Design Features—Integral-hp Double-reduction Unit, Type MR



Type MR, double-reduction, Pacific, General Electric Motorized, Speed Reducers are designed with great care and consideration of the important factors in the production of a power transmission having high efficiency, ample capacity at all ratings, adequate life, compactness, rigidity, and accessibility.

Standard construction is with motor connected to, and supported by, the gear housing. The rotor shaft and the high-speed-pinion shaft are connected by a three-jaw semiflexible coupling machined as an integral part of these two rotating elements. Therefore,

(a) Stators can be quickly serviced or replaced with spare stators with or without feet, independently of rotor, gearing, or connection to driven machine.
(b) High-speed pinion, bearings, or other gear-housing parts can be serviced without interference with rotor or stator.
(c) Motor-frame stresses are minimum, as high-torque stresses of output shaft are *not* transmitted to motor frame.

The high-speed pinion, integral with the pinion shaft, is supported by two carefully selected ball bearings. This method of mounting driving pinions assures:

(a) Minimum gear vibration.
(b) Limited possibility of shaft deflection caused by bending movement; and
(c) Uniform contact of teeth over full width of pinion.

Class I Integral-hp Speed Reducers—3- and 2-phase; 60 Cycles; 110 (326 Frame and Smaller), 208, 220, 440, and 550 Volts

TYPE K

1 HP

Output Speed, Rpm	Horizontal: Open	Horizontal: Totally Enclosed Only: Standard	Horizontal: Totally Enclosed Only: Explosion-proof	Vertical: Open
	Frame 1MSA203 *			
780	$ 81	$ 89	$105	Refer to Company
640	82	90	106	
520	83	91	107	
420	84	93	109	$103
350	86	95	111	105
280	88	97	113	108
230	91	100	116	111
	Frame 2MSA203 *			
190	94	104	120	115
	Frame 2MSA204 †			
155	98	108	124	120
	Frame 3MRA203 *			
125	103	113	129	126
100	112	123	139	137
84	114	126	142	139
68	120	132	148	146
	Frame 5MRA203 *			
56	127	140	156	155
45	136	150	166	165
37	144	159	175	175
	Frame 5MRA204 †			
30	154	170	186	187
	Frame 3MTA203 *			
25	164	181	197	203
20	176	194	210	217
16.5	189	208	224	233
13.5	202	222	238	249

1½ HP

Output Speed, Rpm	Horizontal: Open	Horizontal: Totally Enclosed Only: Standard	Horizontal: Totally Enclosed Only: Explosion-proof	Vertical: Open
	Frame 2MSA204 †			
780	$ 95	$105	$123	Refer to Company
640	97	107	125	
520	99	109	127	
420	102	113	131	$123
350	104	115	133	126
280	107	118	136	129
230	113	125	143	136
190	115	127	145	139
	Frame 2MSA224			
155	120	132	150	145
	Frame 3MRA204 †			
125	126	139	157	152
100	134	148	166	162
	Frame 5MRA204 †			
84	140	154	172	169
68	144	159	177	174
56	157	173	191	189
45	163	180	198	196
37	174	192	210	210
	Frame 5MRA224			
30	186	205	223	238
	Frame 5MTA204 †			
25	198	218	236	242
20	213	235	253	260
16.5	229	252	270	287
13.5	243	268	286	303

2 HP

Output Speed, Rpm	Horizontal: Open	Horizontal: Totally Enclosed, Fan-Cooled: Standard	Horizontal: Totally Enclosed, Fan-Cooled: Explosion-proof	Vertical: Open
	Frame 2MSA224 ‡			
780	$110	$139	$157	Refer to Company
640	112	141	159	
520	114	143	161	
420	116	145	163	$143
350	120	150	168	147
280	124	154	172	152
230	130	161	179	159
190	133	164	182	163
	Frame 2MSA225			
155	140	172	190	170
	Frame 5MSA225			
125	147	179	197	180
	Frame 5MRA224 ‡			
100	160	194	212	195
84	163	197	215	199
68	171	206	224	209
56	181	217	235	221
45	188	225	243	229
	Frame 9MRA224 ‡			
37	201	239	257	245
	Frame 9MRA225			
30	215	254	272	261
	Frame 5MTA224 ‡			
25	228	269	287	284
20	248	291	309	308
16.5	266	310	328	336
13.5	283	329	347	356

3 HP

Output Speed, Rpm	Totally Enclosed, Fan-Cooled: Open	Totally Enclosed, Fan-Cooled: Standard	Totally Enclosed, Fan-Cooled: Explosion-proof	Totally Enclosed, Fan-Cooled: Vertical, Open
	Frame 2MSA225			
780	$127	$157	$175	Refer to Company
640	129	159	177	
520	131	161	179	
420	133	163	181	$162
350	135	166	184	164
280	138	169	187	168
	Frame 5MSA225			
230	145	177	195	176
190	147	179	197	179
	Frame 5MSA254			
155	156	189	207	189
125	166	200	218	201
	Frame 5MRA225			
100	177	212	230	215
84	186	222	240	225
68	199	236	254	241
56	211	249	267	255
	Frame 9MRA225			
45	226	266	284	273
37	241	282	300	291
	Frame 9MRA254			
30	259	302	320	320
	Frame 5MTA225			
25	274	319	337	344
20	296	343	361	369
16.5	321	370	388	407
	Frame 9MTA225			
13.5	341	392	410	431

5 HP

Output Speed, Rpm	Totally Enclosed, Fan-Cooled: Open	Totally Enclosed, Fan-Cooled: Standard	Totally Enclosed, Fan-Cooled: Explosion-proof	Totally Enclosed, Fan-Cooled: Vertical, Open
	Frame 5MSA254			
780	$157	$194	$216	Refer to Company
640	159	196	218	
520	162	199	221	
420	165	202	224	$205
350	168	206	228	208
280	171	209	231	212
230	175	213	235	217
190	183	222	244	226
	Frame 5MSA284			
155	194	234	256	240
	Frame 5MRA254			
125	206	248	270	254
100	221	264	286	272
84	233	277	299	286
	Frame 9MRA254			
68	247	293	315	303
56	263	310	332	322
45	283	332	354	346
37	301	352	374	368
	Frame 9MRA284			
30	323	376	398	400
	Frame 5MTA254			
25	346	402	424	435
	Frame 9MTA254			
20	361	418	440	456
16.5	403	464	486	503
13.5	421	484	506	525

7½ HP

Output Speed, Rpm	Totally Enclosed, Fan-Cooled: Open	Totally Enclosed, Fan-Cooled: Standard	Totally Enclosed, Fan-Cooled: Explosion-proof	Totally Enclosed, Fan-Cooled: Vertical, Open
	Frame 5MSA284			
780	$198	$248	$272	Refer to Company
640	201	251	275	
520	205	255	279	
420	210	261	285	$261
350	214	265	289	265
	Frame 10MSA284			
280	218	270	294	270
230	222	274	298	275
190	232	285	309	287
	Frame 10MSA324			
155	247	302	326	305
	Frame 9MRA284			
125	262	318	342	323
100	282	340	364	347
84	296	355	379	364
68	309	370	394	379
56	335	398	422	411
	Frame 15MRA284			
45	359	425	449	439
37	382	450	474	467
	Frame 15MRA324			
30	404	474	498	500
	Frame 9MTA284			
25	440	514	538	544
20	457	533	557	564
16.5	512	593	617	643
	Frame 15MTA284			
13.5	525	607	631	659

* For totally enclosed units, motors are built in Frame 204.
† For totally enclosed units, motors are built in Frame 224.
‡ For totally enclosed fan-cooled units, motors are built in Frame 225.

Class I Integral-hp Speed Reducers—3- and 2-phase; 60 Cycles; 110 (326 Frame and Smaller), 208, 220, 440, and 550 Volts

TYPE K

10 HP

Output Speed, Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 10MSA324			
780	$241	$307	$338	Refer to Company
640	245	312	343	
520	249	316	347	
420	253	321	352	$314
350	257	325	356	319
280	262	330	361	325
230	267	336	367	331
190	278	348	379	344
	Frame 10MSA326			
155	295	367	398	364
	Frame 9MRA324			
125	313	387	418	386
100	234	410	441	411
84	350	427	458	430
	Frame 15MRA324			
68	373	453	484	458
56	395	477	508	484
45	428	513	544	524
37	448	535	566	548
	Frame 9MTA324			
30	483	574	605	590
25	513	607	638	639
	Frame 15MTA324			
20	553	651	682	687
16.5	598	700	731	752
13.5	633	739	770	794

15 HP

Output Speed, Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 10MSA326			
780	$291	$359	$390	Refer to Company
640	296	365	396	
520	301	370	401	
420	306	376	407	$373
350	308	378	409	375
	Frame 20MSA326			
280	316	387	418	385
230	329	401	432	401
190	336	409	440	409
	Frame 20MSA365			
155	356	431	462	433
	Frame 15MRA326			
125	381	458	489	463
100	409	489	520	497
84	424	505	536	515
68	451	535	566	547
56	481	568	599	583
	Frame 35MRA326			
45	511	601	632	619
37	546	640	671	661
	Frame 35MRA365			
30	586	684	715	722
25	616	717	748	769
	Frame 15MTA326			
20	621	722	753	775
16.5	726	838	869	916
13.5	756	871	902	952

20 HP

Output Speed, Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 20MSA364			
780	$343	$440	$485	Refer to Company
640	348	445	490	
520	353	451	496	
420	360	458	503	$445
350	366	465	510	453
280	373	473	518	461
230	391	492	537	483
190	393	495	540	485
	Frame 20MSA404			
155	418	522	567	515
	Frame 15MRA364			
125	444	551	596	546
100	497	609	654	610
84	500	612	657	613
68	528	643	688	647
	Frame 35MRA364			
56	588	709	754	719
45	598	720	765	731
37	660	788	833	805
	Frame 15MAA364			
30	683	814	859	844
25	758	896	941	949
20	786	927	972	983
	Frame—Refer to Company			
16.5	878	1028	1073	1114
13.5	883	1034	1079	1120

25 HP

Output Speed Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 20MSA365			
780	$387	$484	$529	Refer to Company
640	389	487	532	
520	391	489	534	
420	407	506	551	$497
350	414	514	559	505
280	421	522	567	513
230	432	534	579	527
	Frame 50MSA365			
190	449	553	598	547
	Frame 15MRA365			
155	477	583	628	581
125	504	613	658	613
100	554	668	713	673
84	564	679	724	685
	Frame 35MRA365			
68	604	723	768	733
56	659	784	829	799
	Frame 50MRA405			
45	686	813	858	831
37	739	872	917	895
	Frame—Refer to Company			
30	784	921	966	960
25	844	987	1032	1047
20	904	1053	1098	1119
16.5	989	1147	1192	1242
13.5	1044	1207	1252	1308

30 HP

Output Speed Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 20MSA405			
780	$473	$585	$651	Refer to Company
640	475	587	653	
520	477	589	655	
420	502	617	683	$607
350	512	628	694	619
	Frame 50MSA405			
280	519	635	701	627
230	542	661	727	655
190	557	677	743	673
	Frame 50MSA444			
155	582	705	771	703
	Frame 15MRA405			
125	617	743	809	745
	Frame 35MRA405			
100	691	824	890	834
84	713	849	915	860
68	727	864	930	877
56	839	987	1053	1011
	Frame 50MRA405			
45	847	996	1062	1021
37	944	1103	1169	1137
	Frame—Refer to Company			
30	960	1120	1186	1172
25	1081	1253	1319	1338
20	1116	1292	1358	1380
16.5	1270	1461	1527	1565
13.5	1282	1475	1541	1579

40 HP

Output Speed Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 20MSA444			
780	$539	$692	$783	Refer to Company
640	540	693	784	
520	542	695	786	
	Frame 50MSA444			
420	561	716	807	$682
350	602	761	852	731
280	609	769	860	739
230	622	783	874	755
190	649	813	904	787
	Frame 50MSA445			
155	674	840	931	817
	Frame 35MRA444			
125	732	904	995	887
100	782	959	1050	947
84	817	998	1089	989
	Frame 50MRA444			
68	872	1058	1149	1055
56	957	1152	1243	1157
45	977	1174	1265	1181
	Frame—Refer to Company			
37	1078	1285	1376	1302
30	1142	1355	1446	1400
25	1235	1457	1548	1512
20	1322	1553	1644	1616
16.5	1442	1685	1776	1760
13.5	1542	1795	1886	1916

50 HP

Output Speed Rpm	Horizontal: Open	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Standard	Horizontal: TOTALLY ENCLOSED, FAN-COOLED: Explosion-proof	Vertical: Open
	Frame 20MSA445			
780	$628	$852	$943	Refer to Company
640	629	853	944	
520	631	855	946	
	Frame 50MSA445			
420	657	884	975	$781
350	706	938	1029	840
280	711	943	1034	846
230	736	971	1062	876
190	766	1004	1095	912
	Frame—Refer to Company			
155	801	1042	1133	954
	Frame 50MRA445			
125	861	1108	1199	1026
100	921	1174	1265	1098
84	966	1224	1315	1152
68	1031	1295	1386	1230
56	1129	1403	1494	1348
	Frame—Refer to Company			
45	1181	1460	1551	1410
37	1276	1565	1656	1524
30	1371	1669	1760	1659
25	1471	1779	1870	1779
20	1601	1922	2013	1935
16.5	1736	2071	2162	2115
13.5	1881	2230	2321	2307

INDUCTION MOTOR-GENERATOR SETS

*3-bearing, 40 C, Continuous-rated
SLEEVE BEARINGS

60 Cycles—3- or 2-phase Induction Motor, Shunt- or Compound-wound D-c Generator

Kw	Speed, Rpm	Generator Type and Frame	MOTOR Hp	MOTOR Type and Frame	MOTOR Volts	Prices Set with Generator Field Rheostat Only — GENERATOR VOLTS 125	250	125/-250
0.050	1725	BC-42	..	K-43	110, 220	**$63**	† **$65**	.....
					440, 550	**65**	† **67**	.....
0.100	1725	BC-42	..	K-43	110, 220	**65**	† **67**	.....
					440, 550	**67**	† **69**	.....
0.150	1725	BC-44	..	K-45	110, 220	**72**	† **74**	.....
					440, 550	**74**	† **76**	.....
0.200	1725	BC-46	..	K-45	110, 220	**86**	† **88**	.....
					440, 550	**89**	† **91**	.....
0.300	1725	BC-66	..	K-63	110, 220, 440	**105**	† **108**	.....
					550	**109**	† **112**	
0.500	1725	BC-74	..	K-73	110, 220, 440	**132**	† **135**	.....
					550	**132**	† **135**	
0.750	1800	B-204Y	1½	K-204	110,220, 440, 550	**197**	**197**	.....
1		B-204Y	2	K-224		**223**	**223**	.....
1½		B-224Y	3	K-225		**254**	**254**	**$324**
2		B-225Y	3	K-225		**277**	**277**	**355**
3		B-254Y	5	K-254		**370**	**370**	**460**
5	1800	B-284Y	7½	K-284	220, 440, 550	**460**	**460**	**562**
7½		CD-73Y	15	K-326		**559**	**559**	**688**
10		CD-73Y	15	K-326		**617**	**617**	**753**
15	1800	CD-75Y	25	K-364S	220,440, 550	**782**	**782**	**925**
20	1800	CD-83Y	30	K-365S		**930**	**930**	**1080**
25	1800	CD-85Y	40	K-404S	220, 440, 550	**1085**	**1085**	**1241**
					2200	**1241**	**1241**	**1397**

Kw	Speed, Rpm	Generator Type and Frame	MOTOR Hp	MOTOR Type and Frame	MOTOR Volts	Prices Set with Generator Field Rheostat Only — GENERATOR VOLTS 125	250	125/-250
30	1800	CD-93Y	50	K-405S	220, 440, 550	**$1282**	**$1242**	**$1403**
					2200	**1438**	**1398**	**1559**
40	1800	CD-95Y	60	K-444S	220, 440, 550	**1500**	**1453**	**1622**
					2200	**1643**	**1596**	**1765**
40	1200	△CD-1129	60	K-505S	220, 440, 550	**1814**	**1756**	**1925**
					2200	**1956**	**1898**	**2067**
50	1800	△CD-1126	75	K-455S	220, 440, 550	**1740**	**1635**	**1817**
					2200	**1879**	**1774**	**1956**
50	1200	△CD-1131	75	K-542S	220, 440, 550	**2138**	**2007**	**2189**
					2200	**2291**	**2160**	**2342**
60	1200	△CD-1133	100	K-544S	220, 440, 550	**2522**	**2375**	**2587**
					2200	**2661**	**2514**	**2726**
75	1200	△CD-1235	125	K-546S	220, 440, 550	**2937**	**2768**	**3008**
				K-548S	2200	**3065**	**2896**	**3136**
100	1200	△CD-1242	150	K-557S	220, 440, 550	**3506**	**3300**	**3584**
					2200	**3624**	**3418**	**3702**
125	1200	△CD-1345	200	K-559S	220, 440, 550	**4344**	**4096**	**4420**
					2200	**4410**	**4162**	**4486**
150	1200	△CD-1444	250	K-559AS	440, 550	**5004**	**4717**	**5074**
					2200	**5004**	**4717**	**5074**

60 Cycles—Single-phase A-c Motor, D-c Generator

Kw	Speed, Rpm	Generator Type and Frame	MOTOR Hp	MOTOR Type and Frame	MOTOR Volts	Prices Set with Generator Field Rheostat Only — GENERATOR VOLTS 125	250	Approx Ship. Wt of Set in Lb
0.050	1800	BC-42	....	KH-43	110	**$58**	† **$60**	80
					220	**59**	† **61**	80
0.100	1800	BC-42	....	KH-47	110	**61**	† **63**	89
					220	**62**	† **64**	89
0.150	1800	BC-44	....	KC-47	110/220	**72**	† **74**	105
0.300	1800	BC-66	....	KC-63	110/220	**105**	† **108**	184
0.500	1800	BC-74	....	KC-75	110/220	**134**	† **137**	235
0.750	1800	B-204Y	1 1/2	SCR-224	110/220	**206**	**206**	330
1	1800	B-204Y	2	SCR-A225	110/220	**243**	**243**	350
1½	1800	B-224Y	3	SCR-A225	110/220	**291**	**291**	390
2	1800	B-225Y	3	SCR-A225	110/220	**314**	**314**	450
3	1800	B-254Y	5	SCR-254	110/220	**436**	**436**	580
5	1800	B-284Y	7 1/2	SCR-324	220/440	**561**	**561**	640

* Sets with Type BC generators are 2-unit, 4-bearing.
If speed-limiting device is wanted on set rated 100 kw or less, add **$75** to the price of the set. Speed-limiting device is included in prices of 125- and 150-kw sets.
Prices include CR8000-B1 rheostat with operating mechanism for back-of-board mounting, except for sets smaller than 1 kw, which should have **$7.00** added for price of rheostat.
Prices of 3-wire generator sets include autotransformer for 10 per cent unbalanced current in the neutral.
† Price also applies to 36-volt generators.
△These frame sizes are for 250-volt generators only. 125-volt and 125/250-volt generator frame sizes will be larger.

General Electric can supply practically any kind of unit or group of units to meet unusual requirements. However, the user can often directly benefit by selecting standard listed equipment, in the design and manufacture of which standard motors and generators are employed as far as possible. A selection of the most popular standard sets is listed on this page.

A typical small induction motor-generator set

DIRECT-CURRENT GENERATORS AND EXCITERS

For Belt Drive or †Direct Connection

Shunt- or Compound-wound—△Commutating Poles
Horizontal, Open Type—Two Sleeve Bearings

Type BC (Frames 42 to 74)
Type B (Frames 202 to 284)
Type CD (Frames 73 to 175)

0.050 to 75 Kw

Frame	Kw Continuous, 40 C Rise	¶Speed, Rpm	Prices: Generator with Field Rheostat, 125 Volts	Prices: Generator with Field Rheostat, 250 Volts	Price Additions, 125/250 Volts	Full-load Amp at 125 Volts
42	**0.050** *	1725	**$25**	**†$27**	....	0.4
42	**0.100**	1725	**25**	**†27**	....	0.8
44	**0.150**	1725	**28**	**†30**	....	1.2
46	**0.200**	1725	**31**	**†33**	....	1.6
66	**0.300**	1725	**39**	**†42**	....	2.4
74	**0.500**	1725	**51**	**†54**	....	4
‡202	**1**	3600	**100**	**100**	....	8
204		1750	**116**	**116**	....	8
224		1450	**121**	**121**	....	8
224		1150	**136**	**136**	....	8
226		850	**208**	**208**	....	8
‡204	**1½**	3600	**115**	**115**	....	12
224		1750	**133**	**133**	....	12
225		1450	**144**	**144**	....	12
226		1150	**157**	**157**	....	12
284		850	**229**	**229**	....	12
‡204	**2**	3600	**129**	**129**	....	16
225		1750	**150**	**150**	....	16
254		1450	**215**	**215**	....	16
254		1150	**229**	**229**	....	16
284		850	**252**	**252**	....	16
‡224	**3**	3600	**174**	**174**	....	24
254		1750	**229**	**229**	....	24
254		1450	**247**	**247**	....	24
284		1150	**265**	**265**	....	24
66		850	**299**	**299**	....	24
73		700	**348**	**348**	....	24
‡254	**5**	3600	**296**	**296**	....	40
284		1750	**280**	**280**	....	40
284		1450	**300**	**300**	....	40
66		1150	**332**	**332**	....	40
67		850	**378**	**378**	....	40
83		700	**437**	**437**	....	40
85		575	**494**	**494**	....	40
85		500	**558**	**558**	....	40
‡284	**7½**	3600	**393**	**393**	**$97**	60
66		1750	**332**	**332**	**109**	60
66		1450	**362**	**362**	**109**	60
67		1150	**402**	**402**	**109**	60
83		850	**466**	**466**	**109**	60
85		700	**535**	**535**	**109**	60
93		575	**600**	**600**	**109**	60
93		500	**678**	**678**	**109**	60
‡284	**10**	3600	**436**	**436**	**100**	80
67		1750	**380**	**380**	**136**	80
67		1450	**414**	**414**	**136**	80
75		1150	**465**	**465**	**136**	80
83		850	**538**	**538**	**136**	80
93		700	**626**	**626**	**136**	80
95		575	**697**	**697**	**136**	80
1126		500	**784**	**784**	**136**	80
‡73	**15**	3600	**506**	**506**	**117**	120
75		1750	**467**	**467**	**143**	120
83		1450	**511**	**511**	**143**	120
85		1150	**578**	**578**	**143**	120
93	**15**	850	**$674**	**$674**	**$143**	120
1126		700	**770**	**770**	**143**	120
1129		575	**863**	**863**	**143**	120
1133		500	**968**	**968**	**143**	120
‡83	**20**	3600	**835**	**589**	**124**	160
83		1750	**538**	**538**	**150**	160
85		1450	**594**	**594**	**150**	160
93		1150	**673**	**673**	**150**	160
95		850	**794**	**794**	**150**	160
1129		700	**904**	**904**	**150**	160
1133		575	**1008**	**1008**	**150**	160
1138		500	**1134**	**1134**	**150**	160
‡83	**25**	3600	**933**	**659**	**137**	200
85		1750	**616**	**616**	**156**	200
93		1450	**675**	**675**	**156**	200
95		1150	**768**	**768**	**156**	200
1129		850	**901**	**901**	**156**	200
1133		700	**1019**	**1019**	**156**	200
1138		575	**1139**	**1139**	**156**	200
1235		500	**1273**	**1273**	**156**	200
†85	**30**	3600	**1047**	**718**	**147**	240
†93		1750	**709**	**675**	**161**	240
95		1450	**788**	**750**	**161**	240
1126		1150	**892**	**849**	**161**	240
1133		850	**1048**	**998**	**161**	240
1136		700	**1195**	**1139**	**161**	240
1235		575	**1337**	**1273**	**161**	240
1238		500	**1504**	**1433**	**161**	240
‡93	**40**	3600	**1271**	**830**	**169**	320
‡95		1750	**835**	**795**	**169**	320
1129		1150	**1048**	**998**	**169**	320
1136		850	**1252**	**1193**	**169**	320
θ1235		700	**1428**	**1360**	**169**	320
1337		575	**1608**	**1532**	**169**	320
1341		500	**1804**	**1718**	**169**	320
‡93	**50**	3600	**1422**	**938**	**182**	400
θ1126		1750	**992**	**901**	**182**	400
θ1131		1150	**1264**	**1150**	**182**	400
θ1138		850	**1517**	**1379**	**182**	400
1238		700	**1730**	**1573**	**182**	400
1438		575	**1943**	**1767**	**182**	400
1441		500	**2194**	**1994**	**182**	400
θ‡1129	**60**	1750	**1140**	**1036**	**212**	480
θ§1133		1150	**1414**	**1286**	**212**	480
θ1235		850	**1694**	**1540**	**212**	480
1337		700	**1942**	**1765**	**212**	480
1441		575	**2180**	**1982**	**212**	480
1539		500	**2436**	**2214**	**212**	480
θ‡1131	**75**	1750	**1375**	**1250**	**240**	600
θ§1235		1150	**1626**	**1479**	**240**	600
θ1337		850	**1953**	**1775**	**240**	600
1441		700	**2228**	**2026**	**240**	600
θ1539		575	**2494**	**2268**	**240**	600
θ1543		500	**2795**	**2541**	**240**	600

* Price also applies to 36-volt generators.
† 3600-rpm generators listed on this page are not suitable for use as direct-connected exciters with synchronous motors or a-c generators.
‡ For direct connection only. Not recommended for belt drive.
◊ Not recommended for 2-bearing belt drive.
¶ The speeds listed are those recommended for belt drive, except ratings marked (‡). However, when machines are direct-connected, either listed speed or nearest synchronous speed may be used.
△Generators listed below 1 kw do not necessarily have commutating poles.
Price includes generator and Type CR8000-B1 rheostat with operating mechanism for back-of-board mounting (on generators rated 1 kw and larger only). For generators smaller than 1 kw, add **$7.00** for price of rheostat.
Prices of 3-wire generators include autotransformer for 10 per cent unbalanced current in the neutral.
ϕ Generator price includes solid base with slotted holding-down-bolt holes. For dimensions, see pages 82, 87, and 88.
θ Frames listed are for 250 volts; frames for 125-volt generators are slightly larger.

MODIFICATIONS AND ACCESSORIES

Fractional-hp Motors and Gear-motors

Apply only to motors listed on pages 23, 24, 38, 39, and 44.

Orders Less Than 200 Units

In order to make *quicker shipments* to purchasers from factory or warehouse stocks of motors, motor parts, generators, or motor-generator sets, ordered in less than 200-lot quantities, the Company will, at its own option, make substitutions of stock models under the following conditions:

1. Orders received for motors of one rotation when the opposite rotation is in stock, and when rotation can be readily changed externally, will be filled using motors with stock rotation. (Motors, are normally connected for counterclockwise rotation facing end opposite shaft extension.)
2. Orders received for plain, round-frame motors, or for motors with resilient or belt-tightener bases, which can be filled from stock by supplying motors equipped with Neoprene rings with the proper base shipped separately, will be filled in this manner.
3. Orders received for stock motors with cord sets, toggle switch, Thermo-Tectors, or a combination of these accessories, will be filled by shipping the accessories separately.
4. Stock motors arranged for horizontal operation will be furnished on orders calling for side-wall or ceiling mounting, when such motors can be readily changed for side-wall or ceiling mounting.
5. Orders for motors in 40-diameter frames with built-in overload device, may be supplied with externally mounted Thermo-Tector when models with built-in overload devices are not available.

Many kinds of special motors are made by General Electric. While standard G-E motors are generally considerably lower in price, many times the quantities involved or benefits gained from their use will justify the purchase of special motors.

1. THERMO-TECTORS

Automatic-reset and Manual-reset Thermal Overload Switches

Built-in Overload Protection for G-E Fractional-hp, Single-phase Motors

To provide a satisfactory means of protecting single-phase fractional-hp motors from overloads, General Electric can furnish either automatic-reset or manual-reset thermal overload switches. These switches are built inside the motor end shield where they can closely follow the winding temperature of the motor. When the motor-winding temperature becomes excessive, the switch opens and removes the motor from the line.

Illustrating location of Thermo-Tector in motor end shield

If the motor is equipped with the automatic-reset type of overload switch, the motor is automatically restored to the line when the windings cool to a safe operating temperature. If the motor is equipped with the manual-reset type of overload switch, it is necessary to reset the switch manually before motor service is restored.

The Company reserves the right to furnish externally mounted Thermo-Tectors, instead of the built-in type, at the same price.

	* Class B	† Class C
Single-voltage		
Automatic-reset	**$0.50**	**$0.85**
Manual-reset	**.70**	**1.10**
Dual-voltage		
Automatic-reset	**.70**	**.85**
Manual-reset	**.85**	**1.10**

* For ½-hp, 3450-rpm; ⅓-hp, 1725-rpm; ¼-hp, 1140-rpm; ⅛-hp, 860-rpm; 60-cycle, and smaller.

† For ¾-hp, 3450-rpm; ½-hp, 1725-rpm; ⅓-hp, 1140-rpm; ⅙-hp, 860-rpm; 60-cycle, and larger.

What built-in overload protection will do for motorized machines:

1. Protect the driving motors against burnouts caused by sustained overloads, low voltage, etc.
2. Maintain maximum performance of machines up to the danger point without premature service interruptions.
3. Eliminate service expense—the cost of one service call or for one motor burnout will pay for overload protection on many motors.
4. Automatic-reset type returns the motor to the line when it cools to a safe temperature—no attention by the operator is required to restore a machine to service.

Facts you should know about the built-in overload switches.

1. Complete overload protection is provided.
2. Automatic reset means minimum lost time and service interruption.
3. Positive snap action, and pure-silver contact tips assure long, dependable operating life.

ERRATA

For "Modifications and Accessories" Section, Pages 64-69

Pages 64-69: Open motors, Frames 364-445, listed on page 27, have modifications based on the following frame sizes, instead of the frame sizes listed on that page.

Hp	SPEED, RPM: 3600	1800	1200	900
	FRAME SIZE			
10	Use Frame Sizes Listed on Page 27		365	365
15				404
20			404	405
25		365	405	444
30	365	405	444	445
40	404	444	445	504
50	405	445	504	
60	444	504		
5	445	505	Use Frame Sizes Listed on Page 27	
100	505			

Page 66: Additions for dynamic balancing, page 66, apply to squirrel-cage motors only.

Page 67: Prices for bases and pulleys, page 67, should be as follows.

Price Additions to Motor Only

Integral-horsepower Motors

ALTERNATING-CURRENT		
Motor Frame	Price of Base	Price of Pulley
203–204	$6	$2
224–225	6	2
254	6	2
284	10	4
324	13	4
326	13	5
364–365	13	5
404–405	15	5
444	17	7
445	19	7
504	19	8
505	22	16
Larger Sizes	Refer to Company	

Page 69: The price additions for face-type and flange-type end shields on d-c motors, page 69, should be corrected as follows.

Motor Frame or Price	NEMA Style B Flange with Machining — NO. OF MOTORS: 1	2–4	5–24	25 or More	Face-type End Shield with Machining — NO. OF MOTORS: 1	2–4	5–24	25 or More
203, 204	$9	$8	$6	$5	$3	$3	$2	$2
224, 225, 226	12	10	8	7	4	3	3	2
254	16	14	11	9	5	4	4	3
284	20	17	13	11	6	5	5	4
$261–340	24	20	15	12	8	7	6	5
$341–424	32	25	18	18	10	9	7	7
$425–575	38	30	21	21	12	11	8	8
$576–750	46	36	36	36	15	13	13	13
$751–1250	56	46	46	46	18	15	15	15

7 789

2. TWO-CONDUCTOR CORD AND PLUG

Cord Sets—Including Plug

A. Addition for Standard 8-foot (or less) Length (Shipped separately on lot 249 or less) (Shipped attached on lot 250 up)	TYPE SJ SPECIAL 40% RUBBER JACKET		TYPE S 40% RUBBER JACKET
	No. 18 Awg	No. 16 Awg	No. 14 Awg (½ Hp Up)
2-conductor with plug	$0.40	$0.40	$1.50
3-conductor with 2-prong plug. Tip on ground lead	.75	.75	....
3-conductor with 3-prong plug	....	.90	2.00

B. Cord Sets Less than Eight Feet in Length—Use price additions above.

C. Cord Sets More than Eight Feet in Length—Standard cord sets are made up in large-quantity lots in eight-foot lengths. However, where cord sets longer than eight feet are required, they must be made up for each order. Refer to the Company for price.

3. SPLASHPROOF ENCLOSURE—$3.00

4. TUMBLER SWITCH

Features

1. Easily mounted on standard motor.
2. Positive snap-action mechanism.
3. Completely mounted in substantial steel case.
4. Replaces standard terminal-box cover plate.
5. Simple to install—no solder connections or additional wiring.

4A. PRICE ADDITIONS FOR TUMBLER SWITCH (ITEM 4 ABOVE)

	CLASS B Ratings Only See "Class" column motor price pages LOTS			CLASS C Ratings Only See "Class" column motor price pages LOTS		
	1	2–4	5–24	1	2–4	5–24
(Shipped separately) For mounting on terminal box or conduit box, a-c and d-c:						
Single-pole: ¼-hp, 1725-rpm and smaller	$0.80	$0.80	$0.80	....	....	....
⅓-hp, 1725-rpm; ½-hp, 3450-rpm and larger	1.00	1.00	1.00	$1.00	$1.00	$1.00
Double-pole	1.35	1.35	1.35	1.35	1.35	1.35

5. SPECIAL SHAFT LENGTH

	For CLASS B Ratings Only See "Class" column motor price pages LOTS			For CLASS C Ratings Only See "Class" column motor price pages LOTS		
	1	2–4	5–24	1	2–4	5–24
In ordering, give complete details—preferably by sketch or drawing. Long shafts subject to engineering approval.						
(a) No longer than standard	$7.00	$4.00	$3.00	$7.00	$4.00	$3.00
(b) Up to 2 inches longer than standard	9.00	5.00	4.00	9.00	5.00	4.00
(c) Up to 5 inches longer than standard	9.00	5.00	4.00	9.00	5.00	4.00
(d) Up to 10 inches longer than standard	12.00	8.00	6.00	12.00	8.00	6.00
(e) Up to 15 inches longer than standard	30.00	20.00	12.00	18.00	12.00	8.00

6. SPECIAL SHAFT FEATURES

	For CLASS B Ratings Only See "Class" column motor price pages LOTS			For CLASS C Ratings Only See "Class" column motor price pages LOTS		
	1	2–4	5–24	1	2–4	5–24
The following additions are to be added only in connection with the proper additions for special-length shaft.						
(a) Extension on both ends of motor—includes (e)	$1.00	$1.00	$0.65	$1.00	$1.00	$0.65
(b) Free-machining stainless steel	3.00	2.50	2.00	6.00	5.00	4.00
(c) Taper	3.00	2.00	1.50	3.00	2.00	2.00
(d) Threads, per set	1.00	1.00	1.00	1.00	1.00	1.00
(e) Extra rectangular keyway or flat	1.00	1.00	.65	1.00	1.00	.65
(f) Woodruff keyway	1.00	1.00	.65	1.00	1.00	.65
(g) Drilling—per hole	1.00	1.00	.65	1.00	1.00	.65
(h) Chromium-plated extension	3.50	2.00	1.50	4.00	2.50	2.00
(i) Oversize-diameter shaft	....	....	....	....	....	....

7. BRAKES, MOTOR-MOUNTED—FRAMES 40, 60, AND 70

Frame	Torque Lb-ft Cont.	A-c CR9522-Form	D-c CR9522-Form	A-C AND D-C PRICE ADDITIONS A-c	A-C AND D-C PRICE ADDITIONS D-c	
40	.75	A1H	B1B	$29	$31	For vertical, hand-release, special enclosures, refer to Company.
60 & 70	3	A2C	F2H	33	35	

MODIFICATIONS AND ACCESSORIES

Integral-hp A-c Induction Motors and Gear-motors

1. GENERAL

All price additions for electrical modifications for integral-horsepower motors are cumulative, each addition being added to the motor price before the next addition is figured.

All price additions for mechanical modifications for integral-horsepower motors are additive, the total amount of all additions being added to the motor price.

Each price addition is figured separately to the nearest dollar. (Fifty cents and above becomes the next higher dollar.)

All price additions are based on the price of the open, horizontal, sleeve-bearing, 40 C continuous-rated motor of the same type and rating, except that, where motors are listed enclosed or with ball bearings only, the prices of such motors are used as the base. Additions for mechanical modifications are based on the price of the motor after all adjustments for electrical modifications, if any, have been made.

All price additions for modifications are subject to the same discount classification as the motors to which they apply.

For your convenience, electrical modifications are listed here alphabetically by electrical change desired.

Mechanical modifications are also listed first alphabetically by motor part and secondly alphabetically by type of accessory.

2. ELECTRICAL MODIFICATIONS

(a) Frequency or Voltage—Special

Standard frequencies are: 60, 50, 40, 30, and 25 cycles.

Standard voltages 110, 208, 220, 440, 550, and 2200 volts.

Add 5 per cent to motor price if special frequency or voltage is desired.

Caution: Add 5 per cent for 110 volts in Frames 364 and 365. Special prices prevail for 110-volt motors in larger frames.

(b) Overload

25 per cent for 2 hours at 55 C rise—add 5 per cent to price of 40 C continuous-rated motor of same type and rating.

(c) Quiet Operation

In most cases, the standard G-E motor is suitable for locations requiring quiet operation. Special motors can be made that have been designed and tested for quiet operation.

Quiet operation
Frames 505 and smaller—
Squirrel-cage.....Add 15 per cent (minimum addition **$10**) to price of standard motor of same type and rating
Wound-rotor.....Add 25 per cent (minimum addition **$25**) to price of standard motor of same type and rating
Frames larger than 505.....Refer to Company, giving complete application details

(d) Rating

Nonstandard. Use next-larger standard-hp motor.

(e) Speed Changes

The Company has a complete line of multispeed motors available—2-speed, 3-speed, and 4-speed polyphase induction motors. Prices and information will be furnished immediately upon request.

(f) Temperature Ratings

Open motors

50 C rise cont (except 50-cycle).....Use price of 40 C rise open motor of same rating and frequency.
50 C rise cont, 50-cycle.....Use price of 40 C rise 60-cycle motor of same rating.
40 C rise cont, 50-cycle.....Add 5 per cent to price of 60-cycle, 40 C, continuous, open motor of same type and rating.
30 C rise cont, all frequencies.....Add 5 per cent to price of next-larger hp 40 C motor of same frequency.
25 C rise cont, all frequencies.....Add 5, and then 10 per cent to price of next-larger-hp 40 C motor of same frequency.

*Totally Enclosed (Not Fan-cooled)**

60-cycle—40 C.....Add 5 per cent to price of next-larger listed, 55 C rise, totally enclosed (not fan-cooled) motor of same type, number of poles, and frequency.
50-cycle—55 C.....Add 5 per cent to price of listed 60-cycle, 55 C rise, totally enclosed (not fan-cooled) motor of same type, hp, and number of poles.
50-cycle—40 C.....Add 5 per cent to price of next-larger listed 60-cycle, 55 C rise, totally enclosed (not fan-cooled) motor of same type and number of poles.

*Totally Enclosed, Fan-cooled**

60-cycle—40 C.....Add 5 per cent to price of next-larger listed, 55 C rise, totally enclosed, fan-cooled motor of same type, number of poles, and frequency.
50-cycle—55 C.....Use price of next-larger listed 60-cycle, 55 C rise, totally enclosed, fan-cooled motor of same type and number of poles.
50-cycle—40 C.....Add 5 per cent to price of second-larger listed 60-cycle, 55 C rise, totally enclosed, fan-cooled motor of same type and number of poles.

(g) Time Ratings

* Intermittent ratings (constant-speed, open motors)
Types K, KF, KG, and M

60-minute, 50 C rise.....Add 7½ per cent
30- or 15-minute, 50 C rise.....Add 5 per cent

} to price of next-smaller continuous-duty, 40 C, constant-speed motor of same type

(h) Torque Changes

High-starting-torque Type KG Motors

Where not listed....Add to price of normal-starting-current motor (Type K) of same rating as follows:
Frames 254 to 326, add 5%; Frames 364 to 405, add 7½%; Frames 444 and larger, add 15%.

* Classified as mechanical modification.

3. MECHANICAL MODIFICATIONS

(a) Bearings

Ball or roller—grease-lubricated.

Single-bearing motors. . . . Add 2½ per cent (min **$2**)
Two-bearing motors. . . . . Add 5 per cent (min **$4**)

} Base the percentage addition on price of motor with two sleeve bearings after adjustments for all required electrical modifications have been made. Make further adjustments for single- and three-bearing motors as listed under "sleeve" bearings.

(b) Conduit Box

Standard boxes can be located on either side of the motor by reversing the stator. Or they may be directed in any one of four positions. The correct conduit opening for the conduit generally used is furnished. Also, the correct type of box for the type of motor is furnished. Some modifications of these can be obtained on request.

(c) Connections

Differential protection, add 5 per cent.

Dual-voltage (i.e. 220/440), add 5 per cent in frames larger than 505.

Y-delta connection (i.e. 220/380), add 5 per cent, based on price of motor at higher voltage.

(d) Enclosures (See Definitions, page 140.)

Frames	203 204	224 225	254	284	324 326	364 365	404 405	444 445	504 505
Splashproof, 50 C	4	5	7	9	12	18	24	33	46
Protected	Order splashproof motor								
Self-(pipe-)ventilated, 40 C	Add 40% to open sleeve-bearing motor price								
Separately(forced)ventilated, 40 C	Add 20% to open sleeve-bearing motor price								

(e) Face and Flange End Shields—See page 31.

(f) Finish Special

Paint furnished by G.E., **$4**+2 per cent of motor price.

Paint furnished by purchaser, **$4** per motor.*

* When two or more identical motors are ordered for unit shipment, the basic **$4** addition need be made but once.

(g) Insulation

Classification of Special or Extreme Conditions

No. 1002. Steam, excessive moisture from vapor, splashing, dripping or flooding. (Parts of dye houses, bleacheries, packing plants, etc., involve this condition.)

No. 1003. Excessive amounts of acid or alkali vapors, fumes, or dusts. (Chemical, fertilizer, and similar plants usually have this condition.)

No. 1005. Excessive ambient temperature—where windings are subject to observable temperatures (ambient plus rise) above 90 C, but not exceeding 110 C for open motors, or above 95 C, but not exceeding 115 C for totally enclosed motors. (Class B.)

No. 1006. Conducting or abrasive dusts, such as cast-iron dust, carbon, graphite, coke, etc. Even small amounts of such dusts may be extremely harmful.

No. 1007. A combination of conducting or abrasive dusts (such as carbon, coke, coal, etc.), with sulphur fumes, moisture, etc., as is often encountered in *power-plant boiler rooms* around fans, and coal-pulverizing and ash-handling equipment.

Prices are available on request.

(h) Leads

Where leads longer than those furnished as standard are required, make the following additions per motor for each extra foot or fraction thereof of lead beyond standard.

No. of Leads	15 hp and Smaller	20 to 50 hp	60 to 100 hp	125 to 200 hp
4 or less	**$0.25**	**$0.50**	**$0.75**	**$1.00**
5 to 8	**.50**	**1.00**	**1.50**	**2.00**
9 to 14	**.75**	**1.50**	**2.25**	**3.00**

NOTE.—Minimum charge is **$1** per motor.

(i) Mounting

Motor Frame	Price Additions for Mechanical Modifications				
	Item 1	Item 2	Item 3		Item 4
			Pressing-on Purchaser's Half-coupling		
	End Thrust (Horizontal Ball-bearing Motors)	Motor Feet Planed (Sides), Splined, or Slotted	Rigid *	Flexible †	Round Frame (Omission of Feet)
203–204	**$2**	**$6**	**$15**	**$8**	No charge
224–225	**3**	**6**	**15**	**8**	No charge
254	**3**	**6**	**15**	**8**	**$3**
284	**4**	**7**	**15**	**8**	**4**
324–326	**6**	**7**	**16**	**8**	**6**
364–365	**9**	**7**	**16**	**8**	**9**
404–405	**12**	**11**	**16**	**8**	**12**
444–445	**16**	**13**	**16**	**8**	**16**
504–505	**23**	**13**	**24**	**13**	**23**
$750 and below	....	....	**24**	**13**	5%
751 to **$1000**	....	....	**24**	**13**	5%
1001 to **1500**	....	....	**24**	**13**	5%
1501 to **2500**	....	....	**32**	**16**	5%
2501 to **3500**	....	....	**32**	**16**	5%

* Additions apply also for pressing-on pinions.
† Additions apply also for pressing-on V-belt sheaves.

(j) Operation

End Play—Horizontal sleeve-bearing motors, Frames 203-445, add 1 per cent for end play within limits of 0.005 to 0.010 in.

Dynamic Balancing—All G-E integral-hp induction motors are dynamically balanced to close limits as standard.

For dynamic balancing to extreme precision limits, add:

Frame	
203–254	**$14**
284–364	**20**
365–445	**26**
504–505	**32**

(k) Overspeed

0–25% overspeed—no addition
26–100% overspeed—add 10%

(l) Shafts

Where shaft extensions in excess of standard lengths (as shown on standard dimension prints) are used without outboard bearings or in any manner that would place abnormal stress on the bearings, refer to the Company.

Any deviation from standard shaft will increase the motor price according to the following price additions. For any modifications of shafts not listed, refer to the Company.

When pricing special shaft for brake, determine if straight or tapered shaft is required.

Modification of Shaft	Number of Motors *	Motor Frame: 203 204 N6212	224 225 6203 6204 N6213 N6214	254 6205 N6215	284 N6206 N6216	324 326 N6207 N6208 N6217 N6218	364 365 N6301 N6302	404 405 N6303 N6304	444 445 N6305 N6306	504 N6307	505 N6308	Motor Price (for motors in frames larger than 505 or N6308): $750 and Below	$751 to $1000	$1001 to $1500	$1501 to $3500
		Price Additions													
Special shaft with standard metal		Make further price additions for any items listed under "special shaft features," if required—SEE NOTE													
Standard length or †shorter	1	$6	$6	$6	$7	$9	$10	$12	$15	$17	$17	$18	$20	$22	$24
	2 to 4	4	5	5	6	7	8	10	12	14	14	14	16	18	19
	5 to 24	3	4	4	4	5	6	7	12	14	14	14	16	18	19
	25 or more	1	2	2	3	4	6	7	12	14	14	14	16	18	19
5 in. longer than standard	1	8	8	8	8	10	11	14	17	19	19	21	23	26	29
	2 to 4	5	6	6	7	8	9	12	14	16	16	17	19	22	24
	5 to 24	4	5	5	5	6	7	9	14	16	16	17	19	22	24
	25 or more	2	3	3	4	5	7	9	14	16	16	17	19	22	24
10 in. longer than standard	1	10	10	10	10	11	12	16	19	21	21	24	26	30	34
	2 to 4	7	7	7	8	9	10	14	16	18	18	20	22	26	29
	5 to 24	5	6	6	6	7	8	11	16	18	18	20	22	26	29
	25 or more	3	4	4	5	6	8	11	16	18	18	20	22	26	29
15 in. longer than standard	1	15	15	15	15	15	16	18	21	23	23	27	29	34	39
	2 to 4	10	10	10	10	10	11	16	18	20	20	23	25	30	34
	5 to 24	6	7	7	7	8	9	13	18	20	20	23	25	30	34
	25 or more	4	5	5	6	7	9	13	18	20	20	23	25	30	34
‡ Each additional 5 in. (or less) in excess of 15 in. longer than standard	1 or more	...	...	...	...	2	2	2	2	3	3	3	3	4	5
Special shaft features		These price additions must be combined with the price additions listed above for special shaft of the length and type of metal required—SEE NOTE													
Double shaft extension	1 or more	$1	$1	$1	$1	The price additions for special shafts listed above (Frames 324 and larger) permit special shaft extension on either or both ends of motor without further charge.									
Tapered shaft—one end (includes threads, nut and lock washer)	1	3	3	3	3.50	$4.50	$5	$6	$7.50	$8.50	$8.50	$9	$10	$11	$12
	2 to 4	2	2.50	2.50	3	3.50	4	5	6	7	7	7	8	9	9.50
	5 to 24	1.50	2	2	2	2.50	3	3.50	6	7	7	7	8	9	9.50
	25 or more	.50	1	1	1.50	2	3	3.50	6	7	7	7	8	9	9.50
Threads—per set.. Drilling and/or tapping—per holes Knurling—Each... § Keyway—special (all types)—each	1	1.20	1.20	1.20	1.40	1.80	2	2.40	3	3.40	3.40	3.60	4	4.40	4.80
	2 to 4	.80	1	1	1.20	1.40	1.60	2	2.40	2.80	2.80	2.80	3.20	3.60	3.80
	5 to 24	.60	.80	.80	.80	1	1.20	1.40	2.40	2.80	2.80	2.80	3.20	3.60	3.80
	25 or more	.20	.40	.40	.60	.80	1.20	1.40	2.40	2.80	2.80	2.80	3.20	3.60	3.80
Parkerizing, plating, etc.	1	6	6	6	7	9	10	12	15	17	17	18	20	22	24
	2 to 4	4	5	5	6	7	8	10	12	14	14	14	16	18	19
Splined shaft—one end	5 to 24	3	4	4	4	5	6	7	12	14	14	14	16	18	19
	25 or more	1	2	2	3	4	6	7	12	14	14	14	16	18	19
Omitting keyway from standard shaft	.....	Make price addition for special shaft of standard length.													

* Motors are to be identical electrically and mechanically, for shipment on specified dates within a period of 90 days from date of first shipment.

† For motors in frames larger than 505, no charge is made for shafts shorter than standard.

‡ Maximum length of shaft beyond standard is 15 in. for Frames 284 and smaller, and 72 in. for Frames 324 and larger.

§ When addition is made for special shaft, one straight, rectangular keyway will be furnished for each shaft extension without further charge.

NOTE.—The price additions for special shafts and any required special shaft features should be combined and their total figured to the nearest dollar for each motor (50 cents becoming the next-higher dollar).

Example—Price addition for a 284 Frame motor with 4-in. straight shaft extension and Woodruff keyway on each end is **$12**, figured as follows:

Standard shaft extension is 3½ in. Extra length is 4½ in.

Special shaft (standard metal) 4½ in. longer than standard	**$8**
Double shaft extension	**1**
Woodruff keyways (**$1.40—2**)	**2.80**
	$11.80 (Use **$12**)

4. ACCESSORIES

(a) Bases and Pulleys

A complete line of sliding bases is available for General Electric motors. For motors built in standard mounting dimensions, each base bears the number of the frame size of the motor for which it is designed. The design of the bases shows the same forethought and knowledge of operating conditions which are evident in the construction of the motors themselves.

The following features of a G-E sliding base facilitate installation and provide unusually satisfactory operation.

1. The motor can be moved in either direction by a single adjusting screw.
2. Alignment of the motor and belt is maintained in all positions by guide washers, sliding in accurately machined grooves.
3. The four holding-down bolts are secured on the under side of the base so that they cannot turn or drop down; this permits the installation of the motor without lifting or tipping up the base.
4. Accident hazards are avoided, since there are no projecting bolts or studs on which to trip or catch the clothing.
5. Ample strength is provided by heavy cast-iron construction for floor, side-wall, or ceiling mounting.
6. Neat appearance and uniformity of castings are assured by the use of metal patterns.

A line of standard flat-face paper pulleys is also available for G-E motors at the following prices:

Price Additions to Motor Only

Integral-horsepower Motors

ALTERNATING-CURRENT		
Motor Frame	Price of Base	Price of Pulley
203–204	**$6**	**$2**
224–225	**6**	**3**
254	**8**	**3**
284	**10**	**4**
324	**13**	**5**
326	**13**	**7**
364–365	**15**	**9**
404–405	**17**	**10**
444–445	**20**	**13**
504	**24**	**16**
505	**24**	**24**
"500 Series" Motors		
542	**$30**	**$30**
546	**30**	**40**
552	**40**	**40**
556	**40**	**55**
558	**55**	**55**
564–566	**75**	**115**
568	**100**	**115**

(b) Brakes

Information covering a complete line of brake-motors is available on request.

(c) Bearing Temperature Relays

$40 net for each sleeve bearing above 505 Frame.

(d) Oil Sight Gage

Add **$2** per bearing.

(e) Plugging Switch, Motor-mounted

Add **$15** to price of CR2962 for mounting on motor. (CR2962 price **$41**—GO-10.)

MODIFICATIONS

Integral-hp Direct-current Motors

ELECTRICAL MODIFICATIONS

Voltage

For the purpose of pricing, 115 and 230 volts are considered as standard within the following horsepower ranges:

Volts	115	230
Hp	30 (except 3500 rpm)	200 and smaller

For 115-volt motors above this range, and for 550- or 600-volt motors, price additions must be made as shown in the following table:

Hp	UP TO 1150 RPM		ABOVE 1150 TO 1750 RPM		ABOVE 1750 TO 3600 RPM	
	115 Volts	550 and 600 Volts	115 Volts	550 and 600 Volts	115 Volts	550 and 600 Volts
Up to 20	0	*5% †15% or ‡25%	0	*5% †15% or ‡25%	0	* 5% †15% or ‡25%
21 to 30	0		0		50%	
31 to 50	5%		5%		50%	
51 to 60	5%		5%		§	
61 to 125	10%		10%			
126 to 200	40%		60%			

* 5% applies only to motors with speed range as listed on constant-speed-motor price pages.

† 15% applies to motors having a speed range of less than 3:1, but more than listed on constant-speed-motor price pages after proper adjustment is made for speed range.

‡ 25% applies for motors having a speed range of 3:1 to 4:1 inclusive as listed on adjustable-speed-motor price pages.

§ Refer to the Company.

For voltages of 100 to 172 inclusive, except 115 volts, add 5 per cent to the 115-volt-motor price.

For voltages of 173 to 390 inclusive, except 230 volts, add 5 per cent to the 230-volt motor price.

For voltages of 391 to 750 inclusive, except 550 and 600 volts, add 5 per cent to the 550-volt motor price.

Constant-torque Motors

With constant-torque load, the horsepower output varies in direct proportion to the speed.

To price constant-torque motors having a speed range of less than 3:1, use price of constant-horsepower 40 C continuous-rated motor of same horsepower as required at maximum speed, and with the same speed range. Frame sizes may be different.

For constant-torque motors having a speed range of 3:1 or more, refer to the Company.

NOTE: Orders must specify motors are for constant-torque duty.

Pump Motors

Motors for driving centrifugal pumps should have speed characteristics which differ from those of standard general-purpose motors. If the speed of the motor is less than rated pump speed, the pump output is less than rated output. And if the motor speed is greater than rated pump speed, the motor is liable to become dangerously overloaded. This is because the power required to drive a centrifugal pump varies directly as the cube of the speed. Therefore, a d-c motor applied to such a pump should have a speed, when hot, within ± 3 per cent of the rated pump speed.

These motors are priced the same as constant-horsepower or constant-torque motors. When ordering motors for centrifugal-pump drive, the application should be specified on the order so that the correct motor will be furnished.

Fan-duty Motors (Variable-torque)

These motors are priced the same as constant-horsepower or constant-torque motors. Frame sizes may be different.

NOTE: Orders must specify motors are for fan duty.

Quiet Operation

Add 25 per cent; minimum charge, **$25.**

MECHANICAL MODIFICATIONS

Bearings, Ball or Roller

Same as for polyphase induction motors.

Special Shafts

Where shaft extensions in excess of standard lengths (as shown on standard dimension prints) are used without outboard bearings or in any manner that would place abnormal stress on the bearings, refer to the Company.

Any deviation from standard shaft will increase the motor price according to the following price additions. For any modifications of shafts not listed, refer to the Company.

When pricing special shaft for brake, determine if straight or tapered shaft is required.

Modification of Shaft	Number of Motors *	Motor Frame: 203 204	224 225 226	254	284	Motor Price (For motors in frames larger than 284): $261 to $340	$341 to $424	$425 to $575	$576 to $750	$751 to $1000	$1001 to $1250	$1251 to $1500	$1501 to $2000	$2001 to $2500	$2501 to $4500
		Price Additions													
		Make further price additions for any items listed under "special shaft features," if required —SEE NOTE													
Special shaft with standard metal†															
Standard length or ‡shorter	1	$6	$6	$6	$7	$9	$10	$12	$15	$17	$17	$18	$20	$22	$24
	2 to 4	4	5	5	6	7	8	10	12	14	14	14	16	18	19
5 in. longer than standard	1	8	8	8	8	10	11	14	17	19	19	21	23	26	29
	2 to 4	5	6	6	7	8	9	12	14	16	16	17	19	22	24
10 in. longer than standard	1	10	10	10	10	11	12	16	19	21	21	24	26	30	34
	2 to 4	7	7	7	8	9	10	14	16	18	18	20	22	26	29
15 in. longer than standard	1	15	15	15	15	15	16	18	21	23	23	27	29	34	39
	2 to 4	10	10	10	10	10	11	16	18	20	20	23	25	30	34
§Each additional 5 in. (or less) in excess of 15 in. longer than standard	1 or more	....	....	....	....	2	2	2	2	3	3	3	3	4	5
Special shaft features		These price additions must be combined with the price additions listed above for special shaft of the length and type of metal required—SEE NOTE.													
Double shaft-extension	1 or more	$1.00	$1.00	$1.00	$1.00	The price additions for special shafts listed above (larger than 284 Frame) permit special shaft extension on either or both ends of motor without further charge.									
Tapered shaft—one end (includes threads, nut, and lockwasher)	1	3.00	3.00	3.00	3.50	$4.50	$5.00	$6.00	$7.50	$8.50	$8.50	$9.00	$10.00	$11.00	$12.00
	2 to 4	2.00	2.50	2.50	3.00	3.50	4.00	5.00	6.00	7.00	7.00	7.00	8.00	9.00	9.50
Threads—per set Drilling and/or tapping—per hole Knurling—each ¶Keyway—special (all types) each	1	1.20	1.20	1.20	1.40	1.80	2.00	2.40	3.00	3.40	3.40	3.60	4.00	4.40	4.80
	2 to 4	.80	1.00	1.00	1.20	1.40	1.60	2.00	2.40	2.80	2.80	2.80	3.20	3.60	3.80
Parkerizing, plating, etc.	1	6.00	6.00	6.00	7.00	9.00	10.00	12.00	15.00	17.00	17.00	18.00	20.00	22.00	24.00
Splined shaft—one end	2 to 4	4.00	5.00	5.00	6.00	7.00	8.00	10.00	12.00	14.00	14.00	14.00	16.00	18.00	19.00
Omitting keyway from standard shaft		Make price addition for special shaft of standard length.													

* Motors are to be identical electrically and mechanically, for shipment on specified date within a period of 90 days from date of first shipment.
† For shafts of special metals, refer to the Company.
‡ For motors in frames larger than 284, no charge is made for shafts shorter than standard.
§ Maximum length of shaft beyond standard is 15 in. for Frames 284 and smaller, and 72 in. for frames larger than 284.
¶ When addition is made for special shaft, one straight, rectangular keyway will be furnished for each shaft-extension without further charge.

NOTE—The price additions for special shafts and any required special shaft features should be combined and their total figured to the nearest dollar for each motor (50 cents becoming the next-higher dollar).

EXAMPLE.—Price addition for a 284 Frame motor with 4-in. straight shaft-extension and Woodruff keyway on each end is **$12,** figure as follows:
Standard shaft-extension is 3½ in. Extra length is 4½ in.

Special shaft (standard metal) 4½ in. longer than standard	$8.00
Double shaft-extension	1.00
Woodruff keys ($1.40 x 2)	2.80
	$11.80 (Use $12)

Price Additions for Mechanical Modifications

Motor Price (After Adjusting for All Required Electrical Modifications)	Item 1	Item 2		Item 3	Item 5	Item 6		Item 7
		INSULATION Condition 1005 (Class B)				‡ PRESSING ON PURCHASERS		
	Compound Windings	Armature and Fields	Armature Only	*Machining Motor Field Frame (Includes Omission of Feet)	Planed Feet (Sides)	Rigid Half-coupling or Pinion ¶	Flexible Half-coupling, Chain Sprocket, or V-belt Sheave △	Round Frame (Omission of Feet)
$109 and below	$2	$61	$30	$10	$6	$15	$8	†
110 to $157	4	73	36	12	7	15	8	†$5
158 to 242	6	85	42	15	8	15	8	7
243 to 424	10	151	48	21	11	15	8	10
425 to 575	16	188	67	....	13	16	8	14
576 to 1029	30	224	91	....	16	16	8	20
1030 to 1815	39	260	109	....	18	24	13	30
1816 to 2662	67	363	182	....	21	32	16	45
2663 and above	3%	18%	9%	....	24	§		2%

* Applies only to motors in Frames 203 to 284 inclusive. Field-frame dimension "P" may be reduced not more than ⅛ in.
† No charge for round frame for Frames 203, 204, 224, and 225.
‡ Price additions do not include transportation.
§ Up to 0.4 hp per rpm **$32**, over 0.4 to 1 hp per rpm **$50**; over 1 to 2.5 hp per rpm **$65**.
Up to 0.4 hp per rpm **$16**; over 0.4 to 1 hp per rpm **$25**; over 1 to 2.5 hp per rpm **$33**.
¶To be shipped to our Works rough-bored. We will finish-bore and keyseat.
△To be shipped to our Works finish-bored and keyseated to our dimensions. If we are to finish-bore and keyseat, the same price additions as listed for rigid half-couplings will apply.

Price Additions (or Deductions, Where Indicated) for Mechanical Modifications

Motor Price (After Adjusting for All Required Electrical Modifications)	Item 8	Item 9			Item 10		Item 11	Item 12	Item 13
		VERTICAL SOLID-SHAFT MOTORS			SPLIT END SHIELD AND SPLIT SLEEVE BEARING				
	Belt-tightener Attachment	With Base and Drip Cover †	Deduct for Omission of				Water-tight Conduit Box *	End-thrust, Horizontal Ball-bearing Motors	Special Finish, Filled and Rubbed
			Drip Cover	Base	Front End	Rear End			
$109 and below	....	$24	$5	$8	....	.....	$4	$3	$5
110 to $157	....	31	8	8	.....	.....	5	4	7
158 to 242	$52	42	13	11	$18	$12	6	5	10
243 to 424	63	67	13	11	28	18	8	6	12
425 to 575	79	97	25	15	36	24	10	12	25
576 to 1029	97	151	36	19	54	36	14	23	32
1030 to 1815	....	242	47	27	73	48	19	.....	42
1816 to 2662	....	15%	59	42	109	No add'n	23	.....	52
2663 and above	....	15%	3%	3%	No add'n		1%	.....	2%

* Navy-type bushing can be furnished at same price.
† Price additions are made to price of sleeve-bearing motor.

Price Additions for Mechanical Modifications*†

Motor Frame or Price	NEMA Standard Style B End Shield with Machining and Finishing	FACE-TYPE END SHIELD, WITH MACHINED FACING AND FINISHING				SPECIAL MACHINING OF STANDARD END SHIELD	
		Number of Motors				‡Number of Motors	
		1	2–4	5–24	25 or More	1	2 to 4
203, 204	$5	$4	$4	$3	$3	$2	$2
224, 225, 226	7	5	5	4	4	3	2
254	9	7	6	5	5	3	2
284	11	8	7	6	6	3	2
$261–340	14	12	10	8	8	5	4
$341–424	18	15	12	10	10	6	5
$425–575	24	18	14	14	14	7	6
$576–750	36	22	18	18	18	9	7
$751–1250	46	30	25	25	25	11	8

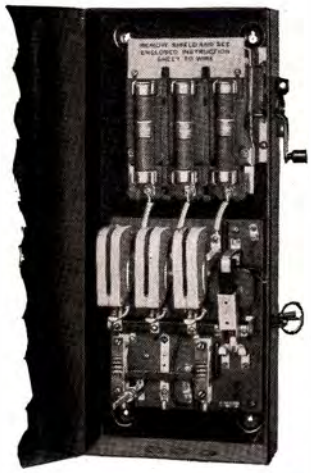
* Price additions should be made to price of ball-bearing motor.
† If motor without feet is required, make regular addition for "round frame" (Item 7 above).
‡ Motors must be identical electrically and mechanically, and the Company must be permitted to complete shipment within 90 days following the initial shipment.

PICTORIAL SELECTOR

MAGNETIC CONTROLS

CR7006 magnetic full-voltage starter

This full-voltage starter consists of a 3-pole magnetic contactor and two temperature overload relays cased in a metal enclosure. May be operated from a push button mounted in the cover of the case or from a remotely located push button. Available in a number of ratings, to satisfy any requirement.



CR7008 magnetic full-voltage combination starter

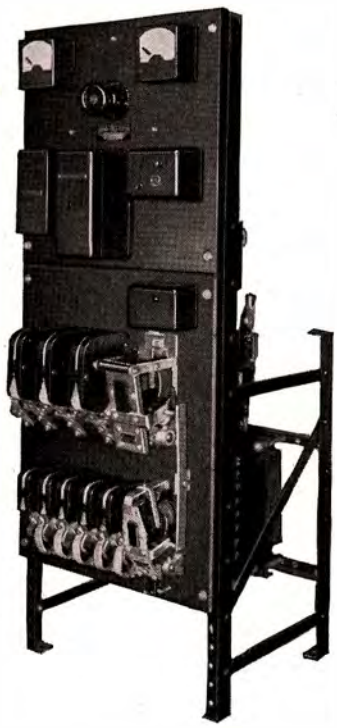
This starter combines a CR7006 with an externally operated manual fusible or nonfusible safety switch or circuit breaker. For safety to operators, enclosing cover locks closed when safety switch is closed.

CR7009 magnetic full-voltage reversing starter

In this starter, two mechanically interlocked contactors are combined. Operated by a 3-button push button, or other equivalent pilot control, it provides "Forward-Reverse-Stop" control for a motor. It also affords overload and undervoltage protection.

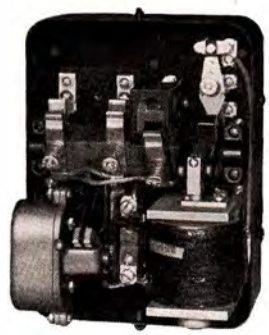
CR7051 magnetic reduced-voltage starter

This reduced-voltage starter controls a motor from push-button stations or pilot controls—automatically, after a definite time applies full voltage to motor when it approaches full speed. Provides overload and undervoltage protection.



CR7061 and CR7065 synchronous-motor starters

Control for all types of synchronous motors—semi-magnetic or full-magnetic, and full- or reduced-voltage starting. Field application and removal always accomplished automatically. Complete overload protection by suitable relays during starting and running periods.



CR4065 magnetic starters for d-c motors

Magnetic starters for d-c motors are available in a variety of forms for constant- or adjustable-speed motors. Such features as reversing dynamic braking and jogging are provided, where they are required by the application. Complete protection is afforded to the motor and machine by temperature overload relays.

FOR MOTOR CONTROLS

MANUAL CONTROLS

CR1061 manual full-voltage starter

This compact, hand-operated starting switch for fractional-hp motors is available in general-purpose, dust-tight and hazardous-gas or -dust enclosures. A flip of the handle starts or stops the motor, provides overload protection. The handle is trip free, that is, it cannot be held in the closed position to prevent the switch opening on overload. Rating: 1 hp, 110 or 220 volts, a-c.

CR1062 manual full-voltage starter

This starter is similar to the CR1061 switch, but is for use with 3-phase motors up to 5 hp, 220 volts; 7½ hp, 600 volts. Available in general-purpose, dust-tight and hazardous-gas or -dust enclosures. Two overload relays provide complete protection to the motor and driven machine.

CR1034 manual reduced-voltage starter (autotransformer type)

This starter is operated by a handle on the side—push to start motor, then pull back to operating position. To stop, push the "Stop" button in front cover. Temperature relays protect motor against overload; undervoltage protection is also provided.

PILOT CONTROLS

CR2943 push-button station

CR2943-A200A two-button push-button station for use with nonreversing magnetic starters. Buttons marked "Start-Stop." Heavy-duty stations with two buttons are available. Similar to CR2940 station illustrated. Publications GEA-2473 and GEA-3469 give further details.

CR2940 push-button station

CR2940-3A1 heavy-duty three-button push-button station for use with reversing magnetic starters. General-purpose station similar to above illustration at the left, but with three buttons. Large, accessible buttons clearly marked "Forward-Reverse-Stop."

CR2931 float switch

CR2931 Form P float switch maintains level of liquid in an open tank or reservoir or in a sump tank. Can be used to control small motors directly, or as a pilot device for any nonreversing magnetic starter. See Publication GEA-67 for further details.

CR2927 pressure switch

CR2927 pressure switch for maintaining a predetermined pressure in any enclosing tank. Can be used to control small motors directly or as a pilot device for any nonreversing magnetic starter. See Publication GEA-821 for further data.

MOTOR CONTROL

Manual Control for Fractional-horsepower Motors

Single-pole; 1 hp, 110 to 220 Volts
Double-pole; 1 hp, 110 to 220 Volts
} A-c = Maximum Ratings = D-c {
Single-pole; ½ hp, 115 to 230 Volts
Double-pole; ¾ hp, 115 to 230 Volts

Thermal Overload Protection

Listed by Underwriters' Laboratories

Power Supply	No. of Poles	Nomenclature	Cat. No.	* Price	Approx Ship. Wt in Lb
OPEN TYPE—†Also for Flush Mounting					
A-c	1	CR1061-C1C	4983952	**$1.85**	1
A-c	2	CR1061-C2C	4983960	**2.10**	1
D-c	1	CR1061-C1G	4983956	**1.85**	1
D-c	2	CR1061-C2G	4983964	**2.10**	1
ENCLOSED TYPE—For Surface Wall Mounting					
A-c	1	CR1061-C1A	4983950	**$2.25**	2
A-c	2	CR1061-C2A	4983958	**2.50**	2
D-c	1	CR1061-C1E	4983954	**2.25**	2
D-c	2	CR1061-C2E	4983962	**2.50**	2
DUST-TIGHT AND WEATHER-RESISTING					
A-c	1	CR1061-F1A	4988807A	**$8.10**	10
A-c	2	CR1061-F1B	4988807B	**8.35**	10
D-c	1	CR1061-F1C	4988807C	**8.10**	10
D-c	2	CR1061-F1D	4988807D	**8.35**	10
EXPLOSION-PROOF TYPE—For Class I, Group D, Hazardous Locations					
A-c	1	CR1061-B2A	4986903G1	**$8.10**	11
A-c	2	CR1061-B2B	4986903G2	**8.35**	11
D-c	1	CR1061-B2C	4986903G3	**8.10**	11
D-c	2	CR1061-B2D	4986903G4	**8.35**	11
FLUSH-MOUNTED TYPE—See "Ordering Directions"					

* Prices include one overload-device heater which must be ordered separately. Heater may be omitted or additional heaters may be ordered, at **$0.50** each.
† Open type is adaptable to flush mounting when used with standard (2½-in.-deep) conduit box and flush plate.
Replaceable solder-film-type overload device, Cat. No. 5187946G1. Price **$0.50** each.

ORDERING DIRECTIONS

Flush-mounted Type

1. Order an open-type switch by nomenclature designation and Cat. No.
2. For a single switch, order from a local dealer the material indicated below.
   1—Flush plate: Textolite, Cat. No. GE2316, or brass, Cat. No. GE1701.
   1—Conduit box, 2½ in. deep, Cat. No. SP6971 for rigid conduit.
   Cat. No. SP6972 for "BX" or flexible conduit.
   For gang mounting, specify flush plate and/or conduit box "similar to Cat. No. . . . . ," and state number of switches to be included in gang.

All Other Types

1. Order switch by nomenclature designation and Cat. No.
2. Order one heater for overload device.

Enclosed-type Control for Squirrel-cage and Wound-rotor Induction Motors

3- and ▣2-phase, ¶ 3-wire—60 and 50 Cycles

Hp	Volts	For Squirrel-cage Induction Motors, Constant-speed — MANUAL: Full-voltage Starting Switch CR1062 (3-pole) ¶	Reduced-voltage Starter (auto-transformer type) CR1034	Primary-resistor Starter ▣CR1042 ¶	MAGNETIC: Reduced-voltage Starter (auto-transformer type) ⊕ Push-button Included CR7051	Primary-resistor Starter ▣CR7056 ϕ	Used with Either Squirrel-cage or Wound-rotor Motors ◉: Magnetic Full-voltage Starter or Primary Switch CR7006 (3-pole) ¶	COMBINATION MAGNETIC FULL-VOLTAGE STARTER OR PRIMARY SWITCH CR7008 (3-POLE): □ α Fusible (*Fuse-clip amp shown in italics*)	Non-fusible	Magnetic Reversing Full-voltage Starter or Primary-Switch CR7009 (3-pole)	For Wound-rotor Induction Motors Constant-or Adjustable-varying-speed — MANUAL: Starting Rheostat ◈CR1028	Speed-regulating Rheostat ◈CR1263 for Machine Service CR1264 for Fan Service	Drum Switch and Cast-grid Resistor for Starting Duty ◈CR3204	Drum Switch and Cast-grid Resistor for Speed-regulating Duty ◈CR3204	MAGNETIC: Non-reversing Controller ▣CR7022	Reversing Controller ▣CR7029
		PRICES														
¼ to 1½	110, 220	**$7.50**	....	....	....	....	*$14	*$28 (30)	*$25	‡$30	$33	$46	....	....	....	....
	440, 550		....	....	....	....	14	31 (30)	25	30	33	46	....	....	....	....
2	110	9.50	....	....	....	....	*16	*30 (30)	*27	‡35	33	53	....	....	....	....
	220	7.50	....	....	....	*$128	*14	*28 (30)	*25	‡30	33	53	....	....	....	....
	440, 550	7.50	....	....	....	*128	*14	*31 (30)	*25	‡30	33	53	....	....	....	....
3	110	9.50	....	....	....	....	*16	*30 (30)	*27	‡35	33	53	....	....	....	....
	220	9.50	....	....	....	*128	*16	*30 (30)	*27	‡35	33	53	....	....	....	....
	440, 550	9.50	....	....	....	*128	*16	*33 (30)	*27	‡35	33	53	....	....	....	....
5	110	....	....	....	....	....	*30	51 (60)	46	‡67	36	74	$110	$121	....	....
	220	9.50	$101	$63	$171	*128	*16	*30 (30)	*27	‡35	36	74	110	121	*$139	‡$198
	440, 550	9.50	101	63	171	*128	*16	*33 (30)	*27	‡35	36	74	110	121	*139	‡ 198

For footnotes, see following page

Enclosed-type Control for Squirrel-cage and Wound-rotor Induction Motors

3- and ▣2-phase, ¶3-wire—60 and 50 Cycles

Hp	Volts	For Squirrel-cage Induction Motors, Constant-speed — MANUAL: Full-voltage Starting Switch CR1062 (3-pole) ¶	MANUAL: Reduced-voltage Starter (autotransformer type) CR1034	MANUAL: Primary-resistor Starter ▣ CR1042 ¶	MAGNETIC: Reduced-voltage Starter (autotransformer type) ⊕ Push-button Included CR7051	MAGNETIC: Primary-resistor Starter ▣ CR7056 φ	Used with Either Squirrel-cage or Wound-rotor Motors ◉: Magnetic Full-voltage Starter or Primary Switch CR7006 (3-pole) ¶	COMBINATION MAGNETIC FULL-VOLTAGE STARTER OR PRIMARY SWITCH CR7008 (3-POLE): □ α Fusible (*Fuse-clip amp shown in italics*)	COMBINATION MAGNETIC FULL-VOLTAGE STARTER OR PRIMARY SWITCH CR7008 (3-POLE): Non-fusible	Magnetic Reversing Full-voltage Starter or Primary Switch CR7009 (3-pole)	For Wound-rotor Induction Motors Constant- or Adjustable-varying-speed — MANUAL: Starting Rheostat ◈ CR1028	MANUAL: Speed-regulating Rheostat ◈ CR1263 for Machine Service CR1264 for Fan Service	MANUAL: Drum Switch and Cast-grid Resistor for Starting Duty ◈ CR3204	MANUAL: Drum Switch and Cast-grid Resistor for Speed-regulating Duty ◈ CR3204	MAGNETIC: Non-reversing Controller ▣ CR7022	MAGNETIC: Reversing Controller ▣ CR7029
		PRICES														
7½	110	....	....	....	....	....	*$30	$51 (60)	$46	‡$67	....	$87	$112	$124	....	....
	220	....	$101	$63	$171	*$128	*30	*51 (30)	*46	‡67	$63	87	112	124	*$139	‡$198
	440, 550	$9.50	101	63	171	*128	*16	*33 (60)	*27	‡35	63	87	112	124	*189	‡198
10	110	....	....	....	....	....	*50	80 (100)	77	‡105	....	95	112	124	....	....
	220	....	101	φ71	171	*134	*30	*51 (60)	*46	§67	63	95	112	124	*139	‡198
	440, 550	....	101	φ71	171	*134	*30	*53 (60)	*46	‡67	63	95	112	124	*139	‡198
15	110	....	....	....	....	....	*50	....	....	‡105	....	116	119	155	....	....
	220	....	101	φ71	171	*139	*30	*51 (60)	*46	‡67	90	116	119	155	*139	‡198
	440, 550	....	101	φ71	171	*189	*30	*53 (60)	*46	‡67	90	116	119	155	*139	‡198
20	110	....	....	....	....	....	*112	....	....	‡263	....	132	149	184	....	....
	220	....	105	....	200	*181	*50	*80 (100)	*77	‡105	90	132	149	184	*261	‡355
	440, 550	....	105	....	187	*151	*30	*53 (60)	*46	‡67	90	132	149	184	*261	‡320
25	220	....	105	....	200	*187	*50	*80 (100)	*77	‡105	....	160	150	214	*261	‡355
	440, 550	....	105	....	187	*157	*30	*53 (60)	*46	‡67	....	160	150	214	*261	‡320
	2200	....	△417	....	△306	....	† △389	....	....	§ △693	....	160	150	214	† △737	....
30	220	....	109	....	207	....	*50	*89 (200)	*77	‡105	....	....	151	228	*261	‡355
	440	....	109	....	207	*193	*50	*83 (100)	*77	‡105	....	....	151	228	*261	‡355
	550	....	109	....	207	*193	*50	*83 (100)	*77	‡105	....	....	151	228	*261	‡355
	2200	....	△417	....	△806	....	† △389	....	....	§ △693	....	....	151	228	† △737	....
40	220	....	185	....	423	421	*112	*200 (400)	*161	‡263	....	....	162	243	*489	‡634
	440, 550	....	115	....	224	*204	*50	*83 (100)	*77	‡105	....	....	162	243	*296	‡380
	2200	....	△422	....	△813	....	† △389	....	....	§ △693	....	....	162	243	† △763	....
50	220	....	191	....	423	421	*112	*200 (100)	*161	‡263	....	....	167	274	*489	‡634
	440, 550	....	115	....	224	*222	*50	*83 (100)	φ*77	‡105	....	....	167	274	*286	‡380
	2200	....	△422	....	△813	....	† △389	....	....	§ △693	....	....	167	274	† △763	....
60	220	....	198	....	649	....	†226	....	....	§483	....	....	170	304	†541	§772
	440	....	198	....	429	....	*112	....	....	‡263	....	....	170	304	*509	‡654
	550	....	198	....	429	....	*112	....	....	‡263	....	....	170	304	*509	‡654
	2200	....	△437	....	△827	....	† △389	....	....	§ △693	....	....	170	304	† △763	....
	4000	....	△1029	....	△1608	....	† △522	....	....	§ △952	....	....	170	304	....	....
75	220	....	205	....	649	....	†226	....	....	§483	....	....	172	363	†541	§772
	440	....	205	....	429	....	*112	....	....	‡263	....	....	172	363	*509	‡654
	550	....	205	....	429	....	*112	....	....	‡263	....	....	172	363	*509	‡654
	2200	....	△437	....	△827	....	† △389	....	....	§ △693	....	....	172	363	† △763	....
	4000	....	△1029	....	△1608	....	† △522	....	....	§ △952	....	....	172	363	....	....
100	220	....	279	....	713	....	†226	....	....	§483	....	....	189	424	†662	§893
	440	....	205	....	429	....	*112	....	....	‡263	....	....	189	424	*577	‡722
	550	....	205	....	429	....	*112	....	....	‡263	....	....	189	424	*577	‡722
	2200	....	△445	....	△834	....	† △389	....	....	§ △693	....	....	189	424	† △839	....
	4000	....	△1085	....	△1664	....	† △522	....	....	§ △952	....	....	189	424	....	....

* Add CR2943-A200A push-button station at **$2.**
† Add CR2940-2A1 push-button station at **$6.**
‡ Add CR2943-A300A push-button station at **$6.**
§ Add CR2940-3A1 push-button station at **$8.**
△Includes control-circuit transformer. As an alternative for 2200-volt CR7006, use CR1035-FK20 oil circuit breaker.
◈For secondary control only. Requires separate primary switch, but no push-button station.
φ Not suitable for 3600-rpm motors; shows 7½ hp, except on high-reactance motors driving centrifugal pumps.
□These prices apply only for starters with fuse clips of the size indicated. Starters with larger fuse clips are available at a higher price. Select fuses in accordance with the National Electrical Code.
α Prices do not include fuses.
⊕Push-button stations included in prices can be omitted as follows:
30 hp and below, 220 volts, and 50 hp and below, 440 or 550 volts—CR2943-A200A at **$2.**
All other ratings—CR2940-2A1 at **$6.**
▣CR1042, CR7022, CR7029, and CR7056 as listed are for 3-phase only.
◉When these switches are used with wound-rotor motors, a secondary control must also be used; such as CR1264, CR3204, etc.
¶ **2-PHASE, 4-WIRE CIRCUITS**
CR1062—Use 4-pole, CR1038 switch, price **$13.50.**
CR1034—All sizes up to and including 50 hp, 220, 440, and 550 volts only, can be obtained to open all four lines at the price listed,
CR7006—Four-pole switches are available in four sizes only:
Where price of 3-pole switch is **$14,** price of 4-pole switch is **$17.**
Where price of 3-pole switch is **$16,** price of 4-pole switch is **$19.**
Where price of 3-pole switch is **$30,** price of 4-pole switch is **$36.**
Where price of 3-pole switch is **$50,** price of 4-pole switch is **$61.**
All other primary control listed above, for 2-phase, 4-wire service will open three lines only, it being necessary to run one line directly to the motor.

Enclosed-type Control for Single-phase Induction Motors

60 and 50 Cycles

Type of Control / Type of Motor		MANUAL			MAGNETIC			
		SCR	SCR, SCA, BSR, KC, or KCJ	SCA	SCR, SCA, BSR, KC, or KCJ	SCR, SCA, BSR, KC, or KCJ		SCA
Hp	Volts	Reduced-voltage Starting Rheostat, CR1026	Full-voltage Starting Switch, CR1062 ¶2-pole	Full-voltage Rotating-cam Switch for Reversing Service, CR3300	Full-voltage Starting Switch, CR7006 ¶2-pole	COMBINATION FULL-VOLTAGE STARTING SWITCH, CR7008 (3-POLE) □‡ Fusible (*Fuse-clip amp shown in italics*)	COMBINATION FULL-VOLTAGE STARTING SWITCH, CR7008 (3-POLE) Nonfusible	Full-voltage Reversing Switch, CR7009 (3-pole)
½	115	$22	$6.50	$12	* $12	$28 (30)	$25	† $30
	230	22	6.50	12	* 12	* 28 (30)	* 25	† 30
	460	..	6.50	22	* 12	* 31 (30)	* 25	† 30
¾	115	22	6.50	12	* 12	28 (30)	25	† 30
	230	22	6.50	12	* 12	* 28 (30)	* 25	† 30
	460	..	6.50	22	* 12	* 31 (30)	* 25	† 30
1	115	22	6.50	12	* 12	28 (30)	25	† 30
	230	22	6.50	12	* 12	* 28 (30)	* 25	† 30
	460	..	6.50	22	* 12	* 31 (30)	* 25	† 30
1½	115	24	8.50	22	* 14	30 (30)	27	† 35
	230	24	6.50	12	* 12	* 28 (30)	* 25	† 30
	460	..	6.50	22	* 12	* 31 (30)	* 25	† 30
2	115	24	....	..	ϕ * 18	51 (60)	46	† 67
	230	24	8.50	22	* 14	* 30 (30)	* 27	† 35
	460	..	8.50	22	* 14	* 33 (30)	* 27	† 35
3	115	24	....	..	ϕ * 18	51 (60)	46	† 67
	230	24	§ 8.50	22	* 14	* 30 (30)	* 27	† 35
	460	..	8.50	22	* 14	* 33 (30)	* 27	† 35
5	115	26	....	..	△ * 50	80 (100)	77	105
	230	26	....	..	ϕ * 18	* 51 (60)	* 46	† 67
	460	..	8.50	22	* 14	* 38 (30)	* 27	† 35
7½	115	49	....	..	△ * 50	80 (100)	77	105
	230	36	....	..	△ * 30	* 51 (60)	* 46	† 67
	460	38	....	..	ϕ * 18	* 53 (60)	* 46	† 67
10	115	50	....	..	..	..	..	..
	230	53	....	..	△ * 50	* 80 (100)	77	105
	460	38	....	..	△ * 30	* 53 (60)	* 46	† 67
15	115	62	....	..	..	..	..	..
	230	56	....	..	△ * 50	80 (100)	77	..
	460	..	....	..	△ * 50	83 (100)	77	..

Type of Control	SCR, Open Motors	SCR, Enclosed Motors	SCA, Open Motors
CR1062	¾ hp, 900 rpm, 115 or 230 volts 1 hp, 1800 rpm, 115 volts	½ hp, 900 rpm, 115 or 230 volts ¾ hp, 1200 rpm, 115 or 230 volts 1 hp, 1800 rpm, 115 or 230 volts 1 hp, 1200 rpm, 115 or 230 volts 2 hp, 1200 rpm, 230 volts	¾ hp, 1200 rpm, 115 or 230 volts
CR7006	¾ hp, 900 rpm, 115 or 230 volts	½ hp, 900 rpm, 115 volts 1 hp, 1800 rpm, 115 volts 1 hp, 1200 rpm, 230 volts	¾ hp, 1200 rpm, 115 volts ¾ hp, 900 rpm, 115 volts 2 hp, 1800 rpm, 115 volts
CR7009	.....	.....	¾ hp, 1200 rpm, 115 volts ¾ hp, 900 rpm, 115 volts 2 hp, 1800 rpm, 115 volts

* Add CR2943-A200A push-button station at **$2.**
† Add CR2943-A300A push-button station at **$6.**
‡ Prices do not include fuses.
§ Except for 900-rpm, SCR and SCA open motors.
¶ Price includes one overload-relay heater unit.
△ These are 3-pole switches and prices include two overload-relay heater units.
ϕ If motor normal full-load amp exceed 30, use price of **$30.**
□ These prices apply only for starters with fuse clips of size indicated. Starters with larger fuse clips are available at a higher price. Select fuses in accordance with the National Electrical Code.

Synchronous-motor Controllers

60 or 50 Cycles, 3- or 2-phase, 3-wire

Interrupting Rating, 10 Times Motor Full-load Current

OPEN—FLOOR-MOUNTED

Undervoltage Protection (Time-delay above 600 volts)
Overload Protection for Stator and Squirrel-cage Windings

Automatic Field Application
Pull-out Protection (Automatic disconnection of motor from line or automatic removal of field)

Rating of Controller			Reduced-voltage Controllers						Full-voltage Controllers					
HORSEPOWER		Voltage Range	MAGNETIC, CR7061			SEMIMAGNETIC, CR7062			MAGNETIC, CR7065			SEMIMAGNETIC, CR7066		
1.0-p-f	0.8-p-f		* Price	Approx Ship. Wt in Lb	Panel No.	* Price	Approx Ship. Wt in Lb	Panel No.	* Price	Approx Ship. Wt in Lb	Panel No.	* Price	Approx Ship. Wt in Lb	Panel No.
25	**20**	220	**$620**	670	111	**$520**	550	121	**$445**	370	131	....	....	....
		440/550	**572**	670	111	**520**	550	121	**425**	370	131	....	....	....
		2000/2500	**1361**	1800	211	**817**	1600	221	**784**	1200	231	**$804**	900	533
30	**25**	220	**620**	670	111	**520**	550	121	**445**	370	131	....	....	....
		440/550	**572**	670	111	**520**	550	121	**425**	370	131	....	....	....
		2000/2500	**1361**	1800	211	**832**	1300	221	**784**	1200	231	**805**	900	533
40	**30**	220	**633**	750	112	**524**	550	123	**445**	420	132	....	....	....
		440/550	**633**	670	111	**524**	550	121	**445**	370	131	....	....	....
		2000/2500	**1379**	1800	211	**832**	1600	221	**784**	1200	231	**805**	900	533
50	**40**	220	**775**	850	112	**600**	750	123	**495**	430	132	....	....	....
		440/550	**642**	750	111	**530**	550	121	**445**	370	131	....	....	....
		2000/2500	**1389**	1800	211	**837**	1600	221	**784**	1200	231	**805**	900	533
60	**50**	220	**775**	850	112	**606**	750	123	**495**	430	132	....	....	....
		440/550	**662**	750	111	**530**	550	121	**445**	370	131	....	....	....
		2000/2500	**1389**	1800	221	**837**	1600	221	**784**	1200	231	**805**	900	533
75	**60**	220	**911**	950	114	**613**	750	123	**605**	625	134	....	....	....
		440/550	**784**	850	112	**613**	750	123	**495**	430	132	....	....	....
		2000/2500	**1409**	1800	211	**852**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**1902**	2800	233	**1323**	2450	....	**1012**	1200	433	**833**	900	533
100	**75**	220	**911**	950	114	**620**	850	124	**605**	625	134	....	....	....
		440/550	**784**	900	112	**620**	750	123	**495**	430	132	....	....	....
		2000/2500	**1409**	1800	211	**852**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**1902**	2800	233	**1323**	2450	....	**1012**	1200	433	**833**	900	533
125	**100**	220	**974**	1000	114	**694**	850	124	**605**	625	134	....	....	....
		440/550	**784**	1000	112	**620**	750	123	**495**	430	132	....	....	....
		2000/2500	**1409**	1800	211	**860**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**1958**	2800	233	**1379**	2450	....	**1012**	1200	433	**833**	900	533
150	....	220	**1463**	1550	116	**1224**	1900	133A	**865**	950	136	....	....	....
		440/550	**941**	1100	114	**638**	750	123	**605**	625	134	....	....	....
		2000/2500	**1460**	1800	211	**866**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**1958**	2800	233	**1379**	2450	333	**1012**	1200	433	**833**	900	533
....	**125**	220	**1463**	1550	116	**1440**	2000	142A	**865**	950	136	....	....	....
		440/550	**941**	1100	114	**638**	750	123	**605**	625	134	....	....	....
		2000/2500	**1460**	1800	211	**866**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**1958**	2800	233	**1379**	2450	333	**1012**	1200	433	**833**	900	533
175	....	220	**1527**	1600	116	**1510**	2000	142A	**865**	950	136	....	....	....
		440/550	**941**	1100	114	**638**	750	123	**605**	625	134	....	....	....
		2000/2500	**1498**	1800	211	**873**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**2000**	2800	233	**1421**	2450	333	**1012**	1200	433	**833**	900	533
....	**150**	220	**1527**	1600	116	**1510**	2000	142A	**865**	950	136	....	....	....
		440/550	**941**	1200	114	**638**	750	123	**605**	625	134	....	....	....
		2000/2500	**1498**	1800	211	**873**	1600	221	**784**	1200	231	**805**	900	533
		2501/4500	**2000**	2800	233	**1421**	2450	333	**1012**	1200	433	**833**	900	533

* If standard exciter rating is higher than 12 kw at 125 volts (or 24 kw at 250 volts), add **$102** to the above prices.

Enclosed-type Control for Constant- and Adjustable-speed, Shunt- or Compound-wound Direct-current Motors

Hp	Volts	Starters: MANUAL: Starting Rheostat ‡ CR-1003		Starters: MANUAL: Drum Switch, CR3108 and Resistor, CR3190, Class 134 or 135: Cast-grid Res.	Starters: MANUAL: Drum Switch, CR3108 and Resistor, CR3190, Class 134 or 135: Non-breakable Res.	Starters: MAGNETIC: Definite-time Starter, Non-reversing (See NOTE)	Starters: MAGNETIC: Definite-time Starter, Reversing (See NOTE)	Starters and Speed Regulators: FIELD CONTROL: Manual: Speed-regulating Rheostat CR-1203		Drum Switch CR3105, Field Resistor, CR3144, and Starting Resistor, CR3190, Class 134 or 135: Cast-grid Res.	Drum Switch CR3105, Field Resistor, CR3144, and Starting Resistor, CR3190, Class 134 or 135: Non-breakable Res.	Semimagnetic: Definite-time Starter, Non-reversing (See NOTE) §	Semimagnetic: Definite-time Starter, Reversing (See NOTE) §	ARMATURE CONTROL: Speed-regulating Rheostat: For Machine Service CR-1220	ARMATURE CONTROL: Speed-regulating Rheostat: For Fan Service CR-1224	ARMATURE CONTROL: Drum Switch, CR3108, and Resistor, CR3190: Cast-grid Res.	ARMATURE CONTROL: Drum Switch, CR3108, and Resistor, CR3190: Non-breakable Res.	COMBINED ARMATURE AND FIELD CONTROL: Speed-regulating Rheostat: For Machine Service CR-1240	COMBINED ARMATURE AND FIELD CONTROL: Speed-regulating Rheostat: For Fan Service CR-1244
⅛–½	115–230	$14	....	....	....	*$46	‡$167	$40	....	....	....	*$125	‡$195	$31	$31	....	....	$51	$51
	550	25	....	....	....	*90	‡ 182	....	....	....	....	*133	‡ 210	31	31	....	....	51	51
¾–1	115	14	....	....	$127	*46	‡ 167	40	....	....	$114	*125	‡ 195	33	33	....	$134	53	53
	230	14	....	....	127	*46	‡ 167	40	....	....	114	*125	‡ 195	33	33	....	134	53	53
	550	25	....	....	127	*90	‡ 182	....	....	....	143	*133	‡ 210	33	33	....	134	53	53
1½	115	20	....	....	127	*46	‡ 167	40	....	....	114	*125	‡ 195	46	46	....	134	80	80
	230	20	....	....	127	*46	‡ 167	40	....	....	114	*125	‡ 195	46	46	....	134	80	80
	550	25	....	....	127	*90	‡ 182	....	....	....	143	*133	‡ 210	65	65	....	134	85	85
2	115	20	....	....	127	*46	‡ 167	40	....	....	114	*125	‡ 195	46	46	....	134	80	80
	230	20	....	....	127	*46	‡ 167	40	....	....	114	*125	‡ 195	46	46	....	134	80	80
	550	25	....	....	127	*90	‡ 182	....	....	....	143	*133	‡ 210	65	65	....	134	85	85
3	115	20	....	....	127	*46	‡ 170	42	....	....	114	*128	‡ 198	54	54	....	134	86	86
	230	20	....	....	127	*46	‡ 167	42	....	....	114	*125	‡ 195	54	54	....	134	86	86
	550	25	....	....	127	*90	‡ 182	....	....	....	143	*133	‡ 210	69	69	....	134	88	88
5	115	25	....	....	127	*71	‡ 205	42	....	....	143	*153	‡ 233	94	94	....	141	118	118
	230	25	....	....	127	*52	‡ 170	42	....	....	143	*128	‡ 198	87	87	....	141	118	118
	550	26	....	....	127	*90	‡ 182	....	....	....	143	*133	‡ 210	92	92	....	141	120	120
7½	115	41	....	....	202	*155	‡ 290	51	....	....	225	*218	‡ 318	112	112	$212	215	140	140
	230	26	....	....	134	*52	‡ 200	51	....	....	150	*148	‡ 228	94	94	143	146	129	129
	550	31	....	....	134	*105	‡ 217	....	....	....	150	*158	‡ 245	....	....	....	146	....	....
10	115	51	....	....	206	*160	‡ 300	85	....	....	228	*228	‡ 328	121	121	212	223	158	158
	230	46	....	....	137	*71	‡ 205	85	....	....	153	*153	‡ 233	99	99	143	154	145	145
	550	80	....	....	137	*105	‡ 217	....	....	....	153	*158	‡ 245	....	....	....	154	....	....
15	115	55	....	....	281	*250	‡ 450	85	....	....	299	*338	‡ 478	180	180	313	313	....	....
	230	53	....	....	211	*150	‡ 280	85	....	....	233	*208	‡ 308	147	147	243	243	169	169
	550	83	....	....	142	*115	‡ 230	....	....	....	158	*168	‡ 255	....	....	174	174	....	....
20	115	72	....	$282	288	*270	‡ 505	132	....	$300	305	†363	‡ 533	248	248	313	328	....	....
	230	53	....	212	217	*155	‡ 290	85	....	234	239	*218	‡ 318	167	167	243	258	194	194
	550	88	....	143	148	*120	‡ 232	....	....	234	239	*173	‡ 260	....	....	174	189	....	....
25	115	88	....	428	433	†410	‡ 705	132	....	441	446	†508	‡ 743	292	292	489	494	....	....
	230	58	....	212	217	*160	‡ 300	85	....	300	305	*228	‡ 328	225	225	273	278	....	....
	550	174	....	212	217	*190	‡ 349	....	....	234	239	*264	‡ 368	....	....	273	278	....	....
30	115	94	....	428	433	†420	‡ 725	142	....	441	446	†528	‡ 763	369	369	503	513	....	....
	230	72	....	282	287	*250	‡ 450	132	....	300	305	*338	‡ 478	322	322	357	367	....	....
	550	174	....	212	217	*195	‡ 354	....	....	234	239	*269	‡ 373	....	....	287	297	....	....
40	115	212	....	428	439	†435	‡ 745	....	....	....	....	†548	‡ 773	409	409	518	551	....	....
	230	94	....	282	294	*270	‡ 505	142	....	441	453	*363	‡ 533	359	359	372	405	....	....
	550	174	....	283	294	*205	‡ 363	....	....	234	246	*274	‡ 382	....	....	372	405	....	....
50	115	274	....	....	....	†605	‡1120	....	....	....	....	†760	‡1170	547	....	....	....	....	....
	230	99	....	428	453	†410	‡ 705	150	....	441	466	†508	‡ 743	432	432	549	589	....	....
	550	181	....	282	308	*210	‡ 369	....	....	300	325	*279	‡ 388	....	....	403	443	....	....
60	115	282	....	....	....	†620	‡1150	....	....	....	....	†790	‡1200	....	....	....	....	....	....
	230	220	....	428	461	†420	‡ 725	....	....	441	474	†528	‡ 763	594	594	579	627	....	....
	550	220	....	428	476	*333	‡ 531	....	....	300	349	*403	‡ 556	....	....	638	734	....	....
75	115	....	....	....	....	†635	‡1175	....	....	....	....	†815	‡1225	....	....	....	....	....	....
	230	220	....	428	474	†435	‡ 745	....	....	....	....	†548	‡ 773	....	....	638	684	....	....
	550	220	....	428	512	*343	‡ 541	....	....	441	525	*418	‡ 571	....	....	668	860	....	....
100	230	282	....	....	....	†605	‡1120	....	....	....	....	†760	‡1170	....	....	....	....	....	....
	550	220	....	428	555	†463	‡ 800	....	....	441	568	†583	‡ 828	....	....	728	1034	....	....
125	230	293	....	....	....	†620	‡1150	....	....	....	....	†790	‡1200	....	....	....	....	....	....
	550	236	....	....	....	†483	‡ 820	....	....	....	....	†603	‡ 848	....	....	....	....	....	....
150	230	293	....	....	....	†635	‡1175	....	....	....	....	†815	‡1225	....	....	....	....	....	....
	550	236	....	....	....	†503	‡ 840	....	....	....	....	†623	‡ 868	....	....	....	....	....	....
200	230	....	....	....	....	...	...	....	....	....	....	...	...	....	....	....	....	....	....
	550	....	....	....	....	...	...	....	....	....	....	...	...	....	....	....	....	....	....

* Add CR2943-A200A push-button station at $2.
† Add CR2940-2A1 push-button station at $6.
‡ Add CR2940-3A1 push-button station at $8.
§ Prices do not include field rheostat.
NOTE: For type and function of starter, see Industrial Control Catalog, GEA-606.

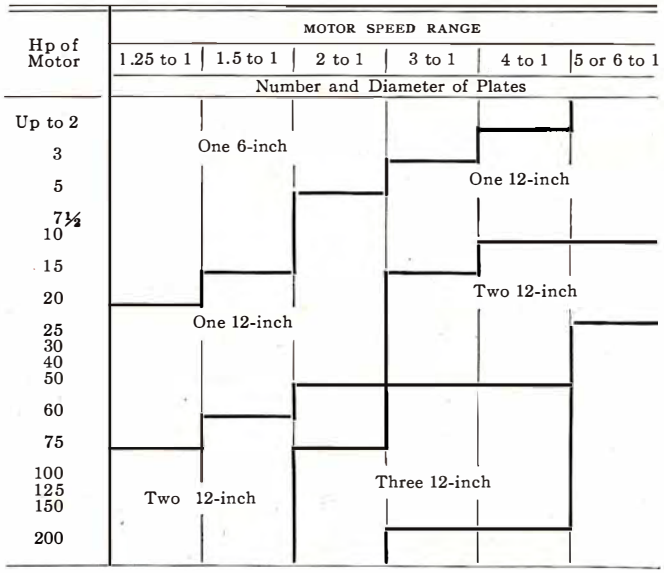
Plate-type D-c Field Rheostats

No. and Diameter of Plates	PRICES					
	CR8000 For Front-of-board Mounting *	CR8001 For Back-of-board Mounting *	CR8070 Totally Enclosed, for Front-of-board Mounting	CR8100 Chain-operated, for Floor Mounting *§	CR8170 Totally Enclosed, Chain-operated for Floor Mounting *§	CR8470 Totally Enclosed, Motor-operated ‡
1—6-in.	$7	$9	$13	.....	.....	.....
2—6-in.	14	16	26	.....	.....	.....
3—6-in.	21	23	38	.....	.....	.....
4—6-in.	27	29	50	.....	.....	.....
1—10-in.	9	11	.....	.....	.....	.....
2—10-in.	18	20	.....	.....	.....	.....
3—10-in.	27	29	.....	.....	.....	.....
4—10-in.	40	42	.....	.....	.....	.....
1—12-in.	13	15	19	$29	$33	$98
2—12-in.	23	25	37	39	51	120
3—12-in.	36	38	54	52	58	141
4—12-in.	48	50	70	64	84	.....
†5—12-in.	64	66	86	80	.....	.....
†6—12-in.	80	82	102	96	.....	.....
1—15-in.	17	19	.....	33	.....	.....
2—15-in.	30	32	.....	46	.....	.....
3—15-in.	46	48	.....	62	.....	.....
4—15-in.	63	65	.....	79	.....	.....
†5—15-in.	80	82	.....	96	.....	.....
†6—15-in.	96	98	.....	112	.....	.....

* For Monel metal contacts, make following additions: 6-in. size $2 per plate; 12-in. size, $4 per plate; 15-in. size, $6 per plate.
† For replacements only.
‡ These units are furnished only with Monel metal contacts: no price increase.
§ No chain or chain-operating mechanism is included with sprocket-operated rheostats.

Prices Include

1. Relay heaters.
2. CR8940-A1A field-discharge resistor.
3. Separately mounted "Start-Stop" push-button station (with magnetic controllers only).
4. Separately mounted control-circuit transformer (with high-voltage controllers only).
5. Starting autotransformer (with reduced-voltage controllers only).
6. All panels are drilled for either CR8000-B1, 12-in. rheostat, or a chain-type (Cat. No. 6173369G15, outline and drilling K-6202706 part 1 and part 2) or concentric (Cat. No. 6173369G5, outline and drilling K-6202706 part 1 and part 2) rheostat-operating mechanism. Space is provided for mounting a maximum of two 12-in. plates, back-of-board only.



* For rheostats for use with motors having basic speeds lower than 300 rpm, refer to the Company.

STANDARD DIMENSION PRINTS

Approximate mounting dimensions are given on pages 79-95. Listed below are standard dimension prints, covering most G-E motors, which can be approved for construction.

Single-phase

Type KCJ	Open	GEM-1094
Type KC	Open	GEM-1091
Type KC	Open (Frames 37–78)	GEM-847
Type KH	Open (Frames 15–77)	GEM-850
Type SCR	Open	GEM-600

Polyphase

Types K and KG	Open, Frames 203–326, Tri-Clad	GEM-1088
Types K and KG	Open, Frames 364–505, Tri-Clad	GEM-1100
Types K and KG	Splashproof, Frames 203–326, Tri-Clad	GEM-1095
Types K, KF, and KG	Splashproof, Frames 364–505	GEM-968
Type K	Totally enclosed, standard, Frames 204–326	GEM-549
Type K	Totally enclosed, explosion-proof, Frames 204–254	GEM-861
Types K, KF, and KG	Totally enclosed, fan-cooled, standard and explosion-proof, Frames 224–326	GEM-860
Types K, KF, and KG	Totally enclosed, fan-cooled, standard, Frames 364–505	GEM-853
Types K, KF, and KG	Totally enclosed, fan-cooled, standard, Frames 364–505 (S and Z)	GEM-766
Types K, KF, and KG	Totally enclosed, fan-cooled, explosion-proof, Frames 364–505	GEM-854
Types K, KF, and KG	Totally enclosed, fan-cooled, explosion-proof, Frames 364–505 (S and Z)	GEM-767
Types K and KG	Open, vertical, solid-shaft, Frames 203–326, Tri-Clad	GEM-1111
Types K, KF, and KG	Open, vertical, solid-shaft, Frames 364–505	GEM-728
Type M	Open, Frames 204–326	GEM-650
Type M	Open, Frames 364–505	GEM-655

Synchronous

Types TS and QS	"900 Series"	GEM-1101, 1102

Direct-current

Type BC	Fractional-horsepower (Frames 28–76)		GEM-852
Type B	Frames 203–284		GEM-550
Type CD	Frames 66–95, sleeve-bearing		GEM-920
Type CD	Frames	1126–1138 sleeve or ball bearings	GEM-1082
		1235–1242 sleeve or ball bearings	GEM-1083
		1337–1345 sleeve or ball bearings	GEM-1084
		1441–1447 sleeve or ball bearings	GEM-1085
		1539–1556 sleeve or ball bearings	GEM-1086
		1638–1655 sleeve or ball bearings	GEM-1087
Type CD	Frames 66–95, ball-bearing		GEM-921

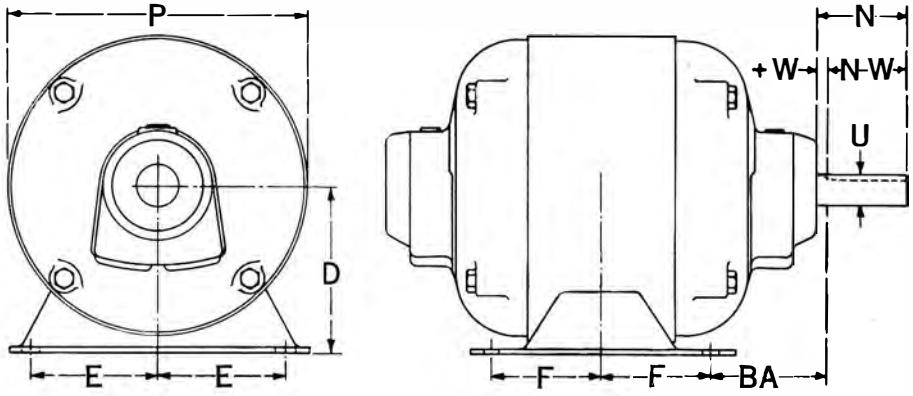
Pacific, General Electric Motorized, Speed Reducers

Fractional-hp motors combined with the Type MW speed reducer	GEM-930
Fractional-hp motors in combination with Types MS and MR speed reducers	GEM-931
Integral-hp motors, Types K, KG, and KR, open and splashproof horizontal, Frames 203 to 326 inclusive, in combination with the Type MS speed reducer	GEM-1120
Integral-hp motors, Types K, KF, and KG, open horizontal, Frames 364 to 504 inclusive, in combination with Type MS speed reducer	GEM-938
Integral-hp motors, Types K, KG, and K, open and splashproof horizontal, Frames 203 to 326 inclusive, combined with the Type MR speed reducer	GEM-1122
Integral-hp motors, Types K, KF, and KG, open horizontal, Frames 364 to 445, combined with the Type MR speed reducer	GEM-940
Integral-hp motors, Types K, KG, and KR splashproof, horizontal Frames 203 to 365, combined with the Type MT speed reducer	GEM-1124
Integral-hp motors, Types K, KF, KG, and KR totally enclosed, fan-cooled, horizontal, Frames 204 to 326, combined with the Type MS speed reducer	GEM-942
Integral-hp motors, Types K, KF, and KG totally enclosed, fan-cooled, horizontal, Frames 364 to 504, combined with speed reducer Type MS	GEM-943
Integral-hp motors, Types K, KF, KG, and KR totally enclosed, fan-cooled, horizontal, Frames 204 to 326, combined with the Type MR speed reducer	GEM-944
Integral-hp motors, Types K, KF, and KG totally enclosed, fan-cooled, horizontal, Frames 364 to 445, combined with the Type MR speed reducer	GEM-945
Integral-hp motors, Types K, KF, KG, and KR totally enclosed, fan-cooled, horizontal, Frames 204 to 365, combined with the Type MT speed reducer	GEM-946
Integral-hp motors, Types M and MR, open horizontal, Frames 224 to 326, combined with the Type MR speed reducer	GEM-970
Integral-hp motors, Types M and MR, open horizontal, Frames 364 to 504, combined with the Type MR speed reducer	GEM-971
Integral-hp motors, Types M and MR, open-horizontal, Frames 224 to 326, combined with the Type MS speed reducer	GEM-972
Integral-hp motors, Types M and MR, open horizontal, Frames 364 to 504, combined with the Type MS speed reducer	GEM-973
Integral-hp motors, Types K, KF, KG, and KR, explosion-proof, Frames 204 to 326 inclusive, combined with the Type MS speed reducer	GEM-974
Integral-hp motors, Types K, KF, KG, and KR, explosion-proof, Frames 204 to 326 inclusive, combined with the Type MR speed reducer	GEM-975
Integral-hp motors, Types K, KF, KG, and KR, explosion-proof, Frames 204 to 365 inclusive, combined with the Type MT speed reducer	GEM-976
Integral-hp motors, Types K, KF, and KG, open vertical, Frames 204 to 405 inclusive, combined with the Type SV speed reducer	GEM-988
Integral-hp motors, Types K, KF, and KG, open vertical, Frames 204 to 505 inclusive, combined with the Type MR speed reducer	GEM-989

MOUNTING DIMENSIONS FOR F-HP GENERAL-PURPOSE MOTORS

Types K, KC, KH, and BC, Frames 23 to 79

Open and Totally Enclosed, Sleeve and Ball Bearings, Solid and Resilient Base



Motor Frame, Group	Motor Ratings	DIMENSIONS IN INCHES										
		KEYWAY		Length of Flat or Key	U	N	D	E	F	P	BA	†N-W
		Width	Depth									
20	All	Flat	3/64	3/4	5/8	1 1/4	2 5/8	1 3/4	2 7/32	* 4 5/8	2 1/16	1 1/8
30	All	Flat	3/64	1 1/8	1/2	1 9/16	3	2 1/8	1 5/8	5 1/2	2 1/2	1 1/2
40	1/6 Hp, 1725 Rpm and Smaller See Note 1 Also "Special-service" Motors	Flat	3/64	1 1/8	1/2	1 9/16	3 1/2	2 7/16	1 1/2	6 5/16	2 3/4	1 1/2
	1/4 Hp, 1725 Rpm and Larger See Note 2	3/16	3/32	1 1/2	5/8	1 15/16						1 7/8
60	All	3/16	3/32	1 7/8	3/4	2 5/16	4 1/8	2 15/16	2 1/2	7 1/2	3 1/16	2 1/4
70	All	3/16	3/32	1 7/8	3/4	2 5/16	4 5/8	3 1/4	2 3/4	8 7/16	3 1/16	2 1/4

* Direct-current motors, Type BC, the "P" dimension = 4 7/16 inches.

NOTE 1.—Includes 1/4 hp, 3450 rpm; 1/5 hp, 1725 rpm; 1/8 hp, 1140 rpm; 1/20 hp, 860 rpm; 60-cycle and corresponding odd-frequency ratings; and all smaller ratings built in this frame group.

NOTE 2.—Includes 1/3 hp, 3450 rpm; 1/4 hp, 1725 rpm; 1/6 hp, 1140 rpm; 1/12 hp, 860 rpm; 60-cycle and corresponding odd-frequency ratings; and all larger ratings built in this frame group.

† W = Allowance for variation in castings after final assembly.

For complete dimensions and tolerances, ask for the appropriate GEM print as listed on page 78.

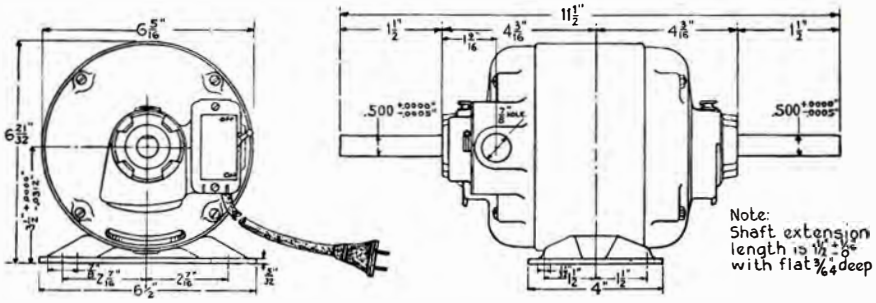
Approximate Net Weights in Lb of Fractional-hp Motors

MOTOR TYPE								MOTOR TYPE							
K		KC		KH		BC		K		KC		KH		BC	
Frame	Net Wt	Frame	Net Wt	Frame	Net Wt	Frame	Net Wt	Frame	Net Wt	Frame	Net Wt	Frame	Net Wt	Frame	Net Wt
37	23 1/2	37	24 1/2	23	10	28	10 1/2	63	40	63	42	45	24	46	32
		43	21	25	11 1/2	36	21				43				
43	20	45	24	27	13	38	22	67	54	67	56	47	28	66	50
				33	15						59	49	35	68	52
45	24	47	27	35	16 1/2	42	24	73	51	69	64			74	66
			30	37	23 1/2	44	28	77	70	73	54			76	76
47	27		30	43	20	45	31			75	62				
49	31	49	30							77	70				
			30								74				
			37							78	90				
		48	37								90				
			37												

MOUNTING DIMENSIONS FOR DRIPPROOF, FRACTIONAL-HP, SINGLE-PHASE, CONSTANT-SPEED 60-CYCLE MOTORS

For Small-workshop Machines and Similar Devices

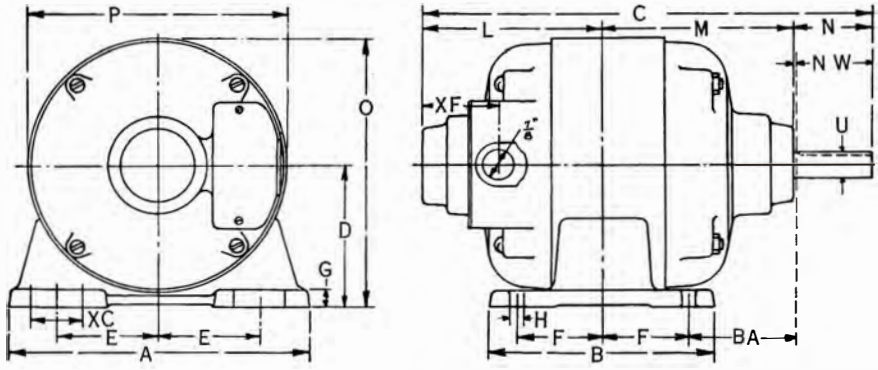
Type KH, Split-phase, Frame 45, Horizontal, Two Sleeve Bearings



MOUNTING DIMENSIONS FOR TOTALLY ENCLOSED, FRACTIONAL-HP, SQUIRREL-CAGE INDUCTION MOTORS

With Malleable Cast-iron Base

For Machine-tool and Other Industrial Applications—Type K, 2- and 3-phase, Frames 43 to 65 Inclusive Horizontal, Two Ball Bearings



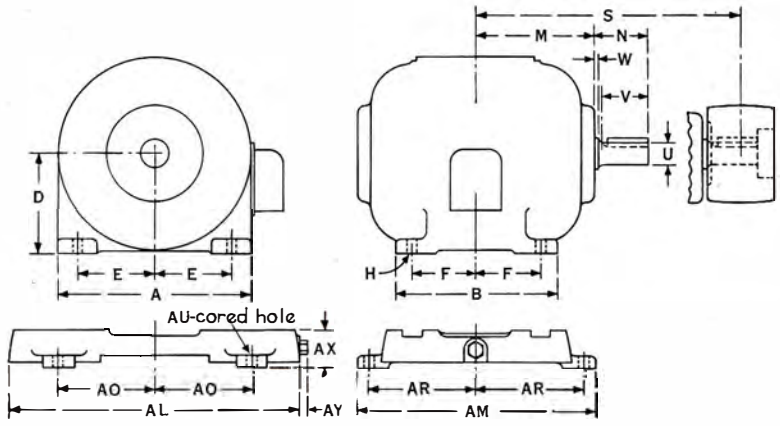
Type	Frame	Approx Net Wt in Lb	Approximate Dimensions in Inches																				
			KEYWAY		Length of Key	A	B	C	D *	E	F	G	H	L †	M †	N	N–W ‡	O	P	U §	BA	XC	XF
			Width	Depth																			
K	43	24	3/16	3/32	1 1/2	6 1/2	4	9 13/16	3 1/2	2 7/16	1 1/2	7/16	1 11/32	3 11/16	4 3/16	1 15/16	1 7/8	6 21/32	6 5/16	5/8	2 3/4	7/8	1 9/16
K	45	27	3/16	3/32	1 1/2	6 1/2	4	10 5/16	3 1/2	2 7/16	1 1/2	7/16	1 11/32	4 3/16	4 3/16	1 15/16	1 7/8	6 21/32	6 5/16	5/8	2 3/4	7/8	1 9/16
K	63	45	3/16	3/32	1 7/8	8 3/8	6 3/8	12 7/8	4 1/8	2 15/16	2 1/2	1/2	1 13/32	5 1/16	5 1/2	2 5/16	2 1/4	7 7/8	7 1/2	3/4	3 1/16	1 1/2	2 1/32
K	65	50	3/16	3/32	1 7/8	8 3/8	6 3/8	13 3/8	4 1/8	2 15/16	2 1/2	1/2	1 13/32	5 9/16	5 1/2	2 5/16	2 1/4	7 7/8	7 1/2	3/4	3 1/16	1 1/2	2 1/32

* Height of center line of shaft at end of standard shaft will come within the limits of +0.0000 inch, −0.0312 inch.
† These dimensions may vary plus or minus 1/16 inch.
‡ Dimension "W" is a variation which may occur in castings and assembly operations.
§ Shaft diameter will come within the limits of +0.0000 inch, −0.0005 inch.
AA = For ½-inch standard conduit coupling.

MOUNTING DIMENSIONS FOR HORIZONTAL "TRI-CLAD" A-C MOTORS

Open { **Types K, KG, KR (2- and 3-phase), Frames 203 to 505**
Types KC, KCJ (Single-phase), Frames 203 to 225

Splashproof—Types K, KG, KR (2- and 3-phase), Frames 203 to 326



Note: S is the distance from center line of motor to center line of pulley.

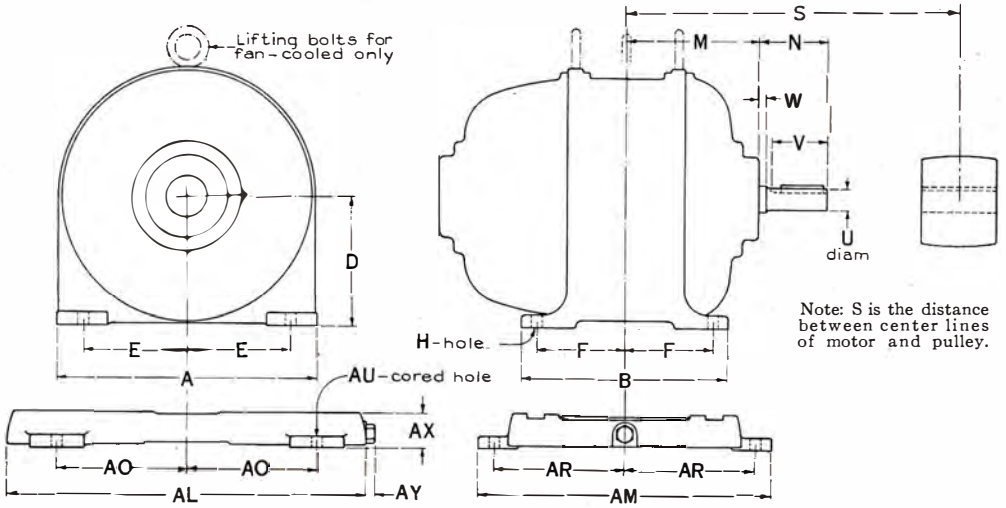
Frame, Base, and Pulley No.	APPROXIMATE NET WT IN LB			DIMENSIONS IN INCHES																			
				Pulley		Keyway																	
	Motor Only *	Base	Pulley	Diameter	Width Overall	Width	Depth	A	B	D	E	F	H	M	N	S	U	V	W	AL	AM	AO	AR	AU	AX
203 204	67 74	19 20	1¼	3	3	3/16	3/32	9¾	6⅞ 7⅞	5	4	2¾ 3¼	13/32	5¾ 6¼	2⅜	7⅜ 7⅞	¾	2	⅛	14	11 12	5	4¾ 5¼	½	1¾
224 225	92 105	22 23	2¾	4	3½	¼	⅛	11	8⅛ 8⅞	5½	4½	3⅝ 3¾	13/32	6¾ 7⅛	3⅛	8⅝ 9	1	2¾	⅛	15½	12¼ 13	5½	5⅝ 5¾	½	1¾
254	141	28	3½	4½	4½	¼	⅛	12½	10	6¼	5	4⅛	17/32	8 3/16	3 9/16	10⅝	1⅛	3⅛	3/16	17¾	15⅛	6¼	6⅝	⅝	2
284	192	33	5	5	4½	¼	⅛	14	11⅝	7	5½	4¾	17/32	9 5/16	3 15/16	11¾	1¼	3½	3/16	19¾	16⅞	7	7½	⅝	2
324 326	256 288	45 53	8½ 15	6 8	5½ 6¾	⅝	3/16	15⅞	12¾ 14¼	8	6¼	5¼ 6	21/32	10 5/16 11 1/16	5 1/16	13¼ 14⅝	1⅝	4⅝	3/16	22¾	19¼ 20¾	8	8½ 9¼	¾	2½
364 364S	380	74 —	21 —	9 —	7¾ —	½ ⅜	¼ 3/16	16½	13¾	9	7	5⅝	21/32	11¼	5⅞ 3½	15⅝ —	1⅞ 1⅝	5⅝ 3	¼	25½	20½ —	9 —	9⅛ —	¾	2½
365 365S	430	87 —	21 —	9 —	7¾ —	½ ⅜	¼ 3/16	16½	14¾	9	7	6⅛	21/32	11¾	5⅞ 3½	15⅞ —	1⅞ 1⅝	5⅝ 3	¼	25½ —	21½ —	9 —	9⅝ —	¾	2½
404 404S	620	103 —	32 —	10 —	8¾ —	½ ½	¼ ¼	19	15¼	10	8	6⅛	13/16	12 7/16	6 1/16 4 1/16	17⅛ —	2⅛ 1⅞	6⅛ 3½	5/16	28¾ —	22⅜ —	10 —	9⅞ —	⅞	3
405 405S	665	106	32	10	8¾	½ ½	¼ ¼	19	16¾	10	8	6⅞	13/16	13 3/16	3 11/16 4 1/16	17⅞	2⅛ 1⅞	6⅛ 3½	5/16	28¾ —	23⅞ —	10 —	10⅝ —	⅞	3
444 444S	875	125 —	47 —	12 —	11 —	⅝ ½	5/16 ¼	21¼	17¾	11	9	7¼	13/16	14 7/16	7 7/16 4 9/16	20¼ —	2⅜ 2⅛	6⅞ 4	5/16	31¼ —	24⅝ —	11 —	11 —	⅞	3
445 445S	1010	129	47	12 —	11 —	⅝ ½	5/16 ¼	21¼	19¾	11	9	8¼	13/16	15 7/16	7 7/16 4 9/16	21¼ —	2⅜ 2⅛	6⅞ 4	5/16	31¼ —	26⅝ —	11 —	12 —	⅞	3
504U 504S	1285	162 —	97 —	15 —	13 —	¾ ½	⅜ ¼	24¼	19½	12½	10	8	15/16	16 3/16	8 15/16 4 9/16	23 —	2⅞ 2⅛	8⅝ 4	5/16	35 —	28 —	12½ —	12½ —	1 —	3½ —
505 505S	1425	166 —	97 —	15 —	13 —	¾ ½	⅝ ¼	24¼	21½	12½	10	9	15/16	17 3/16	8 15/16 4 9/16	24 —	2⅞ 2⅛	8⅝ 4	5/16	35 —	30 —	12½ —	13½ —	1 —	3½ —

* These weights are for open polyphase motors. For net weights of other motors, refer to page 83.
For shipping weights, add 15 per cent to the net weights.
For complete dimensions and tolerances, ask for appropriate GEM print as listed on page 78.

MOUNTING DIMENSIONS OF STANDARDIZED FRAMES 203 TO 505

For A-c and D-c Motors

All Types Except Tri-Clad: Single-phase (SCR only), Polyphase, and D-c Horizontal, Ball and Sleeve Bearings, Open,* Splashproof, Totally Enclosed, and Fan-cooled



Note: S is the distance between center lines of motor and pulley.

Frame, Base, Pulley No.	APPROXIMATE NET WT IN LB † Motor Only	Base	Pulley	DIMENSIONS IN INCHES Pulley Dia	Pulley Width	Keyway Width	Keyway Depth	A	B	D	E	F	H	M *	N *	U	V	W *	AL	AM	AO	AR	AU	AX	S
203		19	1¼	3	3	3/16	3/32	10	7½	5	4	2¾	13/32	5 11/16	2 7/16	¾	2	3/16	14	11	5	4¾	½	1¾	7 5/8
204		20	1¼	3	3	3/16	3/32	10	‡8	5	4	3¼	13/32	‡6 3/16	‡2 7/16	¾	2	‡ 3/16	14	12	5	5¼	½	1¾	7⅞
224		22	2¾	4	3½	¼	⅛	11	‡8 5/8	5½	4½	3⅝	13/32	‡6 1/16	‡3 3/16	1	2¾	‡ 3/16	15½	12¼	5½	5⅜	½	1¾	8⅝
225		23	2¾	4	3½	¼	⅛	11	‡9 ⅛	5½	4½	3⅜	13/32	‡7 1/16	‡3 3/16	1	2¾	‡ 3/16	15½	13	5½	5¾	½	1¾	9
226		—	3	4	3½	¼	⅛	11	11	5½	4½	4½	13/32	7 13/16	3 3/16	1	2¾	3/16	—	—	—	—	—	—	9¾
254		28	3½	4½	4½	¼	⅛	‡12¼	‡10	6¼	5	4⅛	17/32	‡8 3/16	‡3 9/16	1⅛	3⅛	‡ 3/16	17¾	15⅛	6¼	6⅝	⅝	2	10⅝
§255		25	4	4½	4½	¼	⅛	12½	10⅞	6¼	5	4½	1/32	8 7/32	3 29/32	1⅛	3⅛	1/32	17⅝	15	5½	6¾	¾	2¾	11
284		33	5	5	4½	¼	⅛	13¾	‡11½	7	5½	4¾	1/32	9 5/16	3 15/16	1¼	3½	3/16	19¾	16⅞	7	7½	⅝	2	11¾
324		45	8½	6	5½	⅝	3/16	15¼	12½	8	6¼	5¼	21/32	10 1/16	5 5/16	1⅝	4⅝	7/16	22¾	19¼	8	8½	¾	2½	13¼
326		53	15	8	6¾	⅝	3/16	15¼	14½	8	6¼	6	21/32	11 1/16	5 1/16	1⅝	4⅝	3/16	22¾	20¾	8	9¼	¾	2½	14⅝
364		74	21	9	7¾	½	¼	16½	13¾	9	7	5⅝	21/32	11¼	5⅞	1⅞	5⅝	¼	25½	20½	9	9⅛	¾	2½	15⅝
364S		—	—	—	—	½	3/16	16½	13¾	9	7	5⅝	21/32	11¼	3½	1⅝	3	¼	—	—	—	—	—	—	—
365		87	21	9	7¾	½	¼	16½	14¾	9	7	6⅛	21/32	11¾	5⅞	1⅞	5⅝	¼	25½	21½	9	9⅝	¾	2½	15⅞
365S		—	—	—	—	⅝	3/16	16½	14¾	9	7	6⅛	21/32	11¾	3½	1⅝	3	¼	—	—	—	—	—	—	—
404		103	28	10	7¾	½	¼	19	15¼	10	8	6⅛	13/16	12 7/16	6 11/16	2⅛	6⅛	5/16	28¾	22⅝	10	9⅞	⅞	3	16⅝
404S		—	—	—	—	½	¼	19	15¼	10	8	6⅛	13/16	12 7/16	4 1/16	1⅞	3½	5/16	—	—	—	—	—	—	—
405		106	28	10	7¾	½	¼	19	16¾	10	8	6⅞	13/16	13 3/16	6 11/16	6⅛	6½	5/16	28¾	23⅞	10	10⅝	⅞	3	17⅝
405S		—	—	—	—	½	¼	19	16¾	10	8	6⅞	13/16	13 3/16	4 1/16	1⅞	3½	5/16	—	—	—	—	—	—	—
444		125	40	11	9¾	⅝	5/16	21¼	17¾	11	9	7¼	13/16	14 7/16	7 7/16	2⅜	6⅞	5/16	31¼	24⅝	11	11	⅞	3	19⅝
444Z		—	—	—	—	½	¼	21¼	17¾	11	9	7¼	13/16	14 7/16	4 1/16	1⅞	3½	5/16	—	—	—	—	—	—	—
445		129	40	11	9¾	⅝	5/16	21¼	19¾	11	9	8¼	13/16	15 7/16	7 7/16	2⅝	6⅞	5/16	31¼	26⅝	11	12	⅞	3	20⅝
445S		—	—	—	—	½	¼	21¼	19¾	11	9	8¼	13/16	15 7/16	4 9/16	2⅛	4	5/16	—	—	—	—	—	—	—
445Z		—	—	—	—	½	¼	21¼	19¾	11	9	8¼	13/16	15 7/16	4 1/16	1⅞	3½	5/16	—	—	—	—	—	—	—
504		162	47	12	11	⅝	5/16	23½	19½	12½	10	8	15/16	16 3/16	8 3/16	2⅝	7⅝	5/16	35	28	12½	12½	1	3½	22
504S		—	—	—	—	½	¼	23½	19½	12½	10	8	15/16	16 3/16	4 9/16	2⅛	4	5/16	—	—	—	—	—	—	—
504Z		—	—	—	—	½	¼	23½	19½	12½	10	8	15/16	16 3/16	4 1/16	1⅞	3½	5/16	—	—	—	—	—	—	—
505		166	84	14	13	¾	⅜	23½	21½	12½	10	9	15/16	17 3/16	8 15/16	2⅞	8⅝	5/16	35	30	12½	13½	1	3½	24
505S		—	—	—	—	½	¼	23½	21½	12½	10	9	15/16	17 3/16	4 9/16	2⅛	4	5/16	—	—	—	—	—	—	—
505Z		—	—	—	—	½	¼	23½	21½	12½	10	9	15/16	17 3/16	4 1/16	1⅞	3⅛	5/16	—	—	—	—	—	—	—

* Use this print for splashproof motors in Frames 364 to 365, S and Z only. Smaller frames are built in the Tri-Clad construction. Refer to page 81 for dimensions. However, the dimensions M, N, and W differ slightly from the above. For Frames 364 to 365, S and Z, increase M by ⅛ inch and decrease N and W by ⅛ inch. In Frames 404 to 505, S and Z, increase M by 3/16 inch and decrease N and W by 3/16 inch.

† For approximate net weights, refer to page 83.

‡ These dimensions are for polyphase motors and may differ slightly for single-phase and direct-current motors. § This frame uses base No. 5. For shipping weights, add 15 per cent to the net weights.

For complete dimensions and tolerances, ask for the appropriate GEM print as listed on page 78.

Approximate Net Weights in Lb of A-c and D-c Motors Built in Standardized Frames 204 to 505

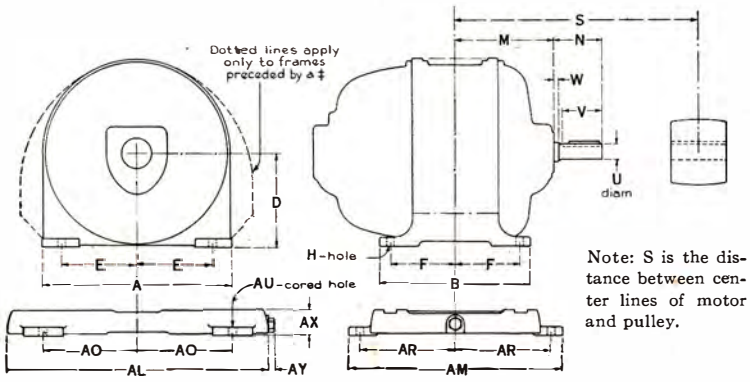
Frame No.	Polyphase					Single-phase					Direct-current	
	SQUIRREL-CAGE					TYPES SCR, †KC, AND KCJ					TYPE B	
						STANDARD AND CLASS I, GROUP D						
						Open		Totally Enclosed				
	Totally Enclosed, Fan-cooled	Splash-proof *	Stand. Totally Encl	Class I, Group D, Class II, Group G, Totally Enclosed	Open, Wound-rotor	SCR	KC	KCJ	SCR	Totally Enclosed, Fan-cooled, SCR	Open	Fan-cooled
203	—	75					70	75	—	—	95	—
204	—	82	70	75			77	82	—	—	105	—
224	130	100	100	115	120		99	104	135	145	145	157
225	165	113	110	125	135		113	119	145	155	160	172
226	—	—	—	—	—	—				‡ 190	188	207
254	215	150	150	165	170	205					210	226
255	—	—	—		—	215					—	—
284	305	200	210		235	—					280	291
324	375	270	285		310	335				375		
326	440	300	340		370	390				440		
364	615	500			495							
365	665	515			510							
404	805	635			680							
405	875	700			755							
444	1085	855			895							
445	1190	950			990							
504	1395	1165			1220							
505	1580	1345			1400							

* Polyphase splashproof motors in Frames 203 to 326 are Tri-Clad construction.
† Weight includes capacitor.
‡ This rating built in single-phase frame No. 3. See page 41.

MOUNTING DIMENSIONS FOR OPEN A-C POLYPHASE MOTORS

Types K, KF, and M (3- and 2-phase), Frames 544 to 579

Two Sleeve or Ball Bearings



Note: S is the distance between center lines of motor and pulley.

Frame *	APPROX NET WT IN LB			DIMENSIONS IN INCHES																									
				Pulley		Keyway							Bearings				Sleeve Bearings	Ball Bearings			Bearings									
													Sleeve		Ball						Sleeve	Ball							
	Motor † Only	Base	Pulley	Diam	Width Overall	Width	Depth	A	B	D	E	F	H	M	N	M	N	S	S	U	V	W	W	AL	AM	AO	AR	AU	AX
544‡	1700	155	—	—	—	¾	⅜	27¾	20¾	14¾	11⅞	8½	15/16	18 13/16	9¾	18 13/16	9¾	—	—	3⅛	9⅛	⅜	⅜	36⅜	26	11⅞	12	1	3½
546¶	1800	155	125	16	17	¾	⅜	27¾	20¾	14¾	11⅞	8½	15/16	19⅞	10½	18 13/16	10½	28⅜	27 5/16	3⅜	9⅞	⅜	⅜	36⅜	26	11⅞	12	1	3½
546S	1700	—	—	—	—	⅜	5/16	27¾	20¾	14¾	11⅞	8½	15/16	18 13/16	5⅛	18 13/16	5⅜	—	—	2⅜	4½	⅜	⅞	—	—	—	—	—	—
547S§	1950	—	—	—	—	⅜	5/16	27¾	22¼	14¾	11⅞	9¼	15/16	20 13/16	5⅛	—	—	—	—	2⅜	4½	⅜	—	—	—	—	—	—	—
548S¶	1750	—	—	—	—	⅜	5/16	27¾	22¼	14¾	11⅞	9¼	15/16	20 13/16	5⅛	19 13/16	5⅜	—	—	2⅜	4½	⅜	⅞	—	—	—	—	—	—
549Z§	2200	—	—	—	—	½	¼	27¾	25¼	14¾	11⅞	10¾	15/16	21 13/16	4⅛	—	—	—	—	1⅞	3½	⅜	—	—	—	—	—	—	—
552¶	2005	180	125	16	17	¾	⅜	30½	20	16	13¼	8	15/16	18⅞	10½	16¼	10½	27⅜	24¾	3⅜	9⅞	⅜	⅜	40⅜	25¾	13¼	11¾	1	3½
556¶	2385	190	191	18	19	1	½	30½	22½	16	13¼	9¼	15/16	20⅞	12	19¼	12	29⅞	28¼	3⅞	11⅜	⅜	⅜	40⅜	28¼	13¼	13	1	3½
557S§	2750	—	—	—	—	¾	⅜	30½	22½	16	13¼	9¼	15/16	20⅞	7⅛	—	—	—	—	3⅜	6¾	⅜	—	—	—	—	—	—	—
558	2790	265	191	18	19	1	½	30½	26	16	13¼	11	1 1/16	22⅜	12	21	12	31⅜	30	3⅞	11⅜	⅜	⅜	40⅞	32¾	13¼	15	1⅛	4¼
559S§	3080	—	—	—	—	¾	⅜	30½	26	16	13¼	11	1 1/16	22⅜	7⅛	—	—	—	—	3⅜	6¾	⅜	—	—	—	—	—	—	—
6334¶	2500	230	212	20	19	1	½	32	24	17	13½	10	1 1/16	21⅛	12	21⅛	12	30⅛	30⅛	3⅞	11⅜	⅜	⅜	42½	30¾	13½	14	1⅛	4¼
6334S§	2850	—	—	—	—	¾	⅜	32	24	17	13½	10	1 1/16	21⅛	6⅛	—	—	—	—	2⅞	5½	⅜	—	—	—	—	—	—	—
6335¶	3000	215	260	22	21	1	½	32	26	17	13½	11	1 1/16	22⅛	13½	22⅛	13½	32⅛	32⅛	4⅜	12⅞	⅜	⅜	42½	32¾	13½	15	1⅛	4¼
6335S§	3310	—	—	—	—	¾	⅜	32	26	17	13½	11	1 1/16	22⅛	6⅛	—	—	—	—	2⅞	5½	⅜	—	—	—	—	—	—	—
6336¶	3500	253	260	22	21	1	½	32	29	17	13½	12½	1 1/16	23⅝	13½	23⅜	13½	33⅜	33⅜	4⅜	12⅞	⅜	⅜	42½	35¾	13½	16½	1⅛	4¼
6336S§	3825	—	—	—	—	¾	⅜	32	29	17	13½	12½	1 1/16	23⅜	6⅛	—	—	—	—	2⅞	5½	⅜	—	—	—	—	—	—	—
564¶	4200	360	380	26	25½	1	¼	⅜	38½	27	20	16¼	11	1 1/16	23⅜	15 1/16	—	—	35 3/16	—	47⅛	14⅜	7/16	—	49½	34½	16¼	15⅜	1⅜	4¾
564S¶	4100	—	—	—	—	1	½	38½	27	20	16¼	11	1 1/16	22⅜	8⅛	—	—	—	—	3⅞	7½	⅜	—	—	—	—	—	—	—
566¶	4850	370	380	26	25½	1	¼	⅜	38½	29½	20	16¼	12¼	1 1/16	24⅜	15 1/16	—	—	36 7/16	—	47⅛	14⅜	7/16	—	49½	37	16¼	16⅞	1⅜	4¾
566S¶	4775	—	—	—	—	1	½	⅜	38½	29½	20	16¼	12¼	1 1/16	23⅞	8⅛	—	—	—	—	3⅞	7½	⅜	—	—	—	—	—	—	—
568¶	5600	400	380	26	25½	1	¼	⅜	38½	32½	20	16¼	13¾	1 1/16	26⅛	15 1/16	—	—	37 15/16	—	47⅛	14⅜	7/16	—	49½	40	16¼	18⅜	1⅜	4¾
568S¶	5500	—	—	—	—	1	½	⅜	38½	32½	20	16¼	13¾	1 1/16	25⅜	8⅛	—	—	—	—	3⅞	7½	⅜	—	—	—	—	—	—	—
574¶	7150	630	380	26	25½	1	¼	⅜	49½	36	25	21	15	1 1/16	28⅜	15 1/16	—	—	40 3/16	—	47⅛	14⅜	7/16	—	62	44¾	21	20½	1⅝	5½
574S¶	7600	—	—	—	—	1	½	⅜	49½	36	25	21	15	1 1/16	28⅜	9⅛	—	—	—	—	4⅜	8½	⅜	—	—	—	—	—	—	—

* Frame designations ending in "S" or "Z" have a short shaft extension for direct connection only.
† To find approximate net weight of wound-rotor motors, increase weight of squirrel-cage motor in same frame size 5½ to 7 per cent.
‡ Frame 544 may be used for V-belt drive.
§ These frames are the closed-box side-air-discharge construction.
¶ These frames are the skeleton frame construction.
For complete dimensions and tolerances, ask for the appropriate GEM print as listed on page 78.

MOUNTING DIMENSIONS FOR OPEN, VERTICAL, SOLID-SHAFT SQUIRREL-CAGE "TRI-CLAD" INDUCTION MOTORS

Type K (2- and 3-phase), Frames 203 V or VY to 326V or VY Inclusive

For Direct Drive—Two Ball Bearings

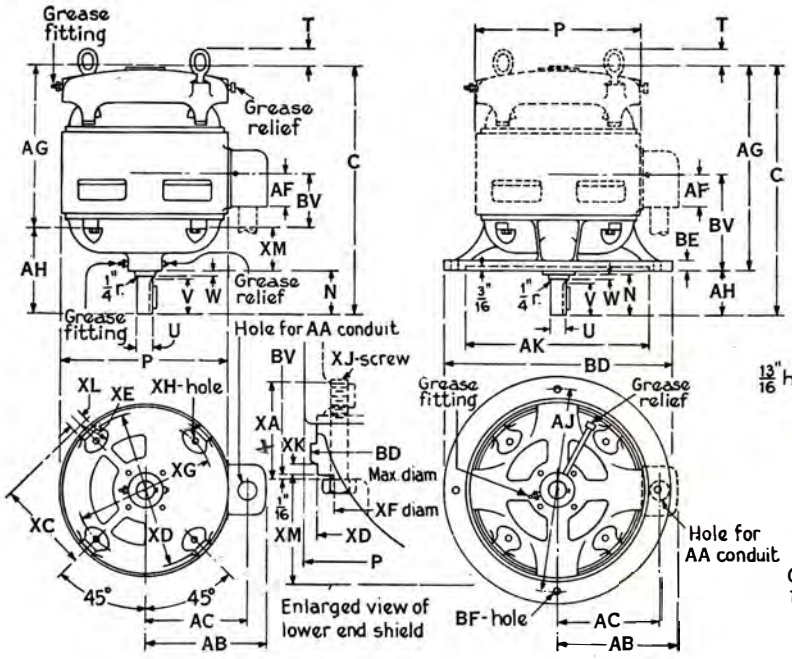


Fig. 1

Fig. 2

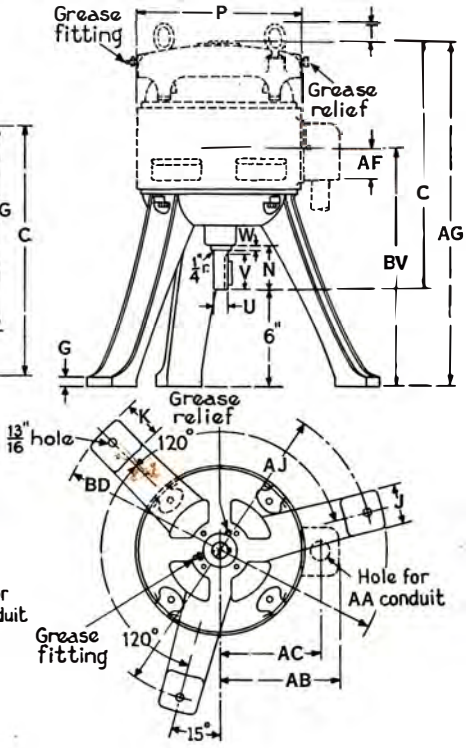


Fig. 3

Provided mounting conditions permit, conduit boxes may be placed so that entrance can be made upward, downward, or from either side.

FRAME		APPROX NET WT IN LB			DIMENSIONS IN INCHES																			
					Keyway			Common Dimensions														Fig. 1		
Fig. 1 and 3	Fig. 2	Fig. 1	Fig. 2	Fig. 3	Width	Depth	Key Length	C	N	P	T	U	V	W	AA	AB	AC	AF	XA	AG	AH	BD
203VY	203V	75	90	98	3/16	3/32	1 5/8	14	2 3/8	9 11/16	2 1/4	3/4	2	1/8	3/4	7 1/16	6	2 3/16	1 3/4*	9	5	9 7/16
204VY	204V	82	97	105	3/16	3/32	1 5/8	15	2 3/8	9 11/16	2 1/4	3/4	2	1/8	3/4	7 1/16	6	2 3/16	1 3/4*	10	5	9 7/16
224VY	224V	97	112	122	1/4	1/8	2	16 3/4	3 1/8	11 1/8	2 3/16	1	2 3/4	1/8	3/4	7 3/4	6 11/16	2 3/16	1 15/16*	10 9/16	6 3/16	10 7/8
225VY	225V	117	132	142	1/4	1/8	2	17 1/2	3 1/8	11 1/8	2 3/16	1	2 3/4	1/8	3/4	7 3/4	6 11/16	2 3/16	1 15/16*	11 5/16	6 3/16	10 7/8
254VY	254V	156	175	185	1/4	1/8	2 3/8	20 1/16	3 9/16	12 3/8	2 1/16	1 1/8	3 1/8	3/16	1	8 15/16	7 3/8	2 3/8	2 1/8	12 3/8	7 7/16	12 1/4
284VY	284V	210	235	245	1/4	1/8	2 3/4	22 11/16	3 15/16	14 1/8	1 15/16	1 1/4	3 1/2	3/16	1	9 11/16	8 3/8	2 5/8	2 7/16	14 1/4	8 7/16	13 3/4
324VY	324V	280	325	335	3/8	3/16	3 3/4	25 13/16	5 1/16	15 13/16	2 9/16	1 3/8	4 5/8	3/16	1 1/4	11 11/16	9 5/8	3 3/4	2 11/16	15 7/8	9 15/16	15 1/4
326VY	326V	310	355	365	3/8	3/16	3 3/4	27 5/16	5 1/16	15 13/16	2 9/16	1 3/8	4 5/8	3/16	1 1/2	11 11/16	9 5/8	3 3/4	2 11/16	17 3/8	9 15/16	15 1/4

U: Shaft diameter will come within the limits +.0000 in. −.0005 in.

V represents length of straight part of shaft.

FRAME		DIMENSIONS IN INCHES																										
		Fig. 1												Fig. 2								Fig. 3						
Fig. 1 and 3,	Fig. 2	BV	XC	XD +.000" −.003"	XE	XF	XG	XH	XJ	XK	XL	XM	AG	AH	AJ	AK +.005" −.000"	BD	BE	BF	BV	G	J	K	AG	AJ	BD	BV
203VY	203V	3 1/8	4 3/4	9 3/16	1 5/16	8 3/8	8 1/2	5/8	7/16–18	1/4	1	2 5/8	11 1/4	2 3/4	12 1/2	11	14	1 1/16	1 7/32	5 3/8	7/8	2 3/4	2 11/16	20	18 3/4	20 1/2	14 1/8
204VY	204V	3 3/8	4 3/4	9 3/16	1 5/16	8 3/8	8 1/2	5/8	7/16–18	1/4	1	2 5/8	12 1/4	2 3/4	12 1/2	11	14	1 1/16	1 7/32	5 3/8	7/8	2 3/4	2 11/16	21	18 3/4	20 1/2	14 3/8
224VY	224V	3 11/16	5 3/8	10 3/8	1	10 1/4	9 7/8	7/16	5/8–16	1/4	1 1/16	3 1/16	14	2 3/4	12 1/2	11	14	5/8	1 7/32	7 1/8	13/16	2 3/4	2 11/16	22 3/4	18 3/4	20 1/2	15 7/8
225VY	225V	4 1/16	5 3/8	10 5/8	1	10 1/4	9 7/8	7/16	5/8–16	1/4	1 1/16	3 1/16	14 3/4	2 3/4	12 1/2	11	14	5/8	1 7/32	7 1/2	13/16	2 3/4	2 11/16	23 1/2	18 3/4	20 1/2	16 1/4
254VY	254V	4 1/8	6	12	1	11 5/8	11 1/8	7/16	5/8–16	1/4	1 3/16	3 7/16	17 1/16	2 3/4	12 1/2	11	14	3/4	1 7/32	9	1/8	3 1/4	2 11/16	26 1/16	18 3/4	20 1/2	17 3/4
284VY	284V	4 11/16	6 3/8	13 1/2	1	13 1/8	12 3/8	7/16	5/8–16	1/4	1 1/4	4 1/2	18 1/16	4 1/2	16	14	18	3/4	1 3/16	8 3/4	13/16	3 1/4	2 11/16	28 11/16	22	23 7/8	19 1/4
324VY	324V	5 1/16	7 3/8	15	1 5/16	14 3/8	13 7/8	9/16	1/2–13	1/4	1 1/2	4 7/8	21 1/16	4 1/2	16	14	18	7/8	1 3/16	10 7/8	13/16	3 1/4	2 11/16	31 11/16	22	23 7/8	21 5/8
326VY	326V	6 1/16	7 3/8	15	1 5/16	14 3/8	13 7/8	9/16	1/2–13	1/4	1 1/2	4 7/8	22 11/16	4 1/2	16	14	18	7/8	1 3/16	11 5/8	13/16	3 1/4	2 11/16	33 1/16	22	23 7/8	22 1/8

* Dimension "XA" is to the bottom of the tapped hole on Frames 203, 204, 224, and 225.

For shipping weight of motor, add 15 per cent to the above net weights.

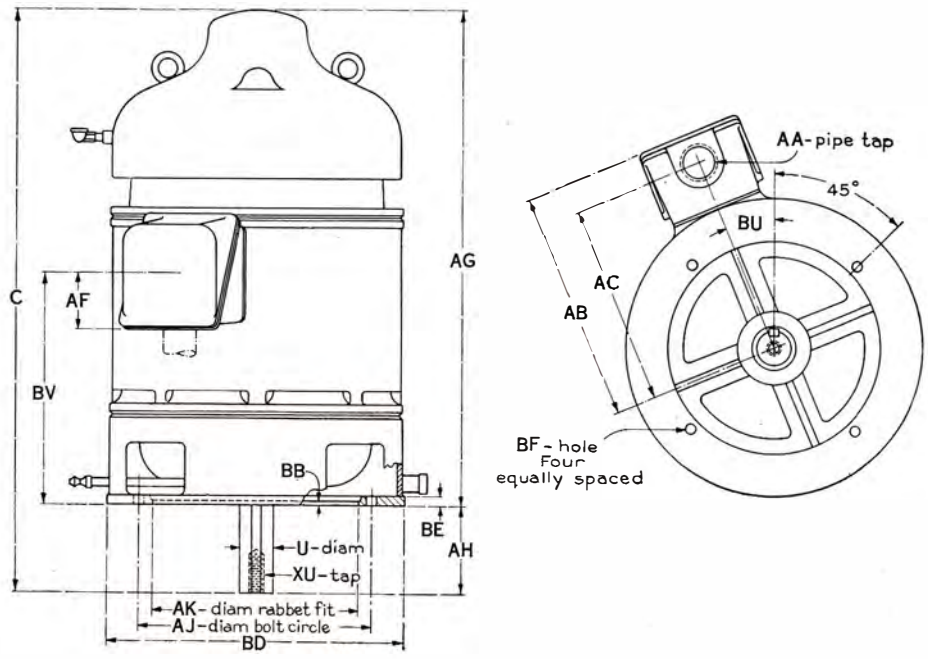
For complete dimensions and tolerances, ask for the appropriate GEM print as listed on page 78.

MOUNTING DIMENSIONS FOR SHIELDED (Dripproof) VERTICAL SOLID-SHAFT SQUIRREL-CAGE INDUCTION MOTORS

Types K and KF (2- and 3-phase), Frames N6206 to N6312 Inclusive

Normal or High Thrust

For Direct Drive, *Ball Thrust and Guide Bearings



Provided mounting conditions permit, conduit boxes may be placed so that entrance can be made upward, downward, or from either side.

Frame	Approx Net Wt in Lb	DIMENSIONS IN INCHES																			
		Keyway		Key Length	C	U	AA	AB	AC	AF	AG	AH	AJ	AK +.005" −.000"	BB	BD	BE	BF	BU Degrees	BV	XU †
		Width	Depth																		
N6206	285	¼	⅛	2½	26½	1¼	1	11⅜	9⅜	2¼	22	4½	14¾	13½	¼	16⅜	⅜	1¹⁄₁₆	0	8⅛	—
N6207	315				27½	1⅜	1¼				23									8⅜	
N6208	385	⅜	³⁄₁₆		29½		1½				25									9⅜	
N6301 N6302	500 545	½	¼	2½	31½	1⅞	1½	13½	11½	3⅛	27	4½	14¾	13½	¼	16¾	⅜	1¹⁄₁₆	22½	11⅜	—
N6303 N6304	675 735	½	¼	2½	35	1⅞	2	15⁵⁄₁₆	13	3⁹⁄₁₆	30½	4½	14¾	13½	¼	19	⅜	1¹⁄₁₆	22½	13¹¹⁄₁₆	—
N6305 N6306	935 1030	⅜	⁵⁄₁₆	3	40⅛	2⅛	2	16⁷⁄₁₆	14⅛	3⁹⁄₁₆	35⅜	4½	14¾	13½	¼	21³⁄₁₆	⅜	1¹⁄₁₆	22½	16¹⁄₁₆	—
N6307 N6308	1390 1520	⅜	⁵⁄₁₆	4¼	46¾	2⅛	3	19½	16¼	5⅜	41¾	5	14¾	13½	¼	24⅜	¾	1¹⁄₁₆	22½	18⁵⁄₁₆	¾–10x1½
N6309	1600	⅜	⁵⁄₁₆	4¼	49	2⅛	3	19½	16¼	5⅜	44	5	14¾	13½	¼	24⅜	¾	1¹⁄₁₆	22½	19⅞	¾–10x1½
N6311 N6312	2360 2630	¾	⅜	5¼	58	2⅜	3	21½	18¼	5⅜	52½	5½	22	19	⁵⁄₁₆	28¼	⅞	1	0	25½	1–8x2

* High-thrust motors have oil-lubricated upper thrust and lower guide bearings, except Frames N6306 and smaller which have grease-lubricated guide bearings.

Normal-thrust motors have grease-lubricated lower thrust and upper guide bearings, Frames N6306 and smaller.

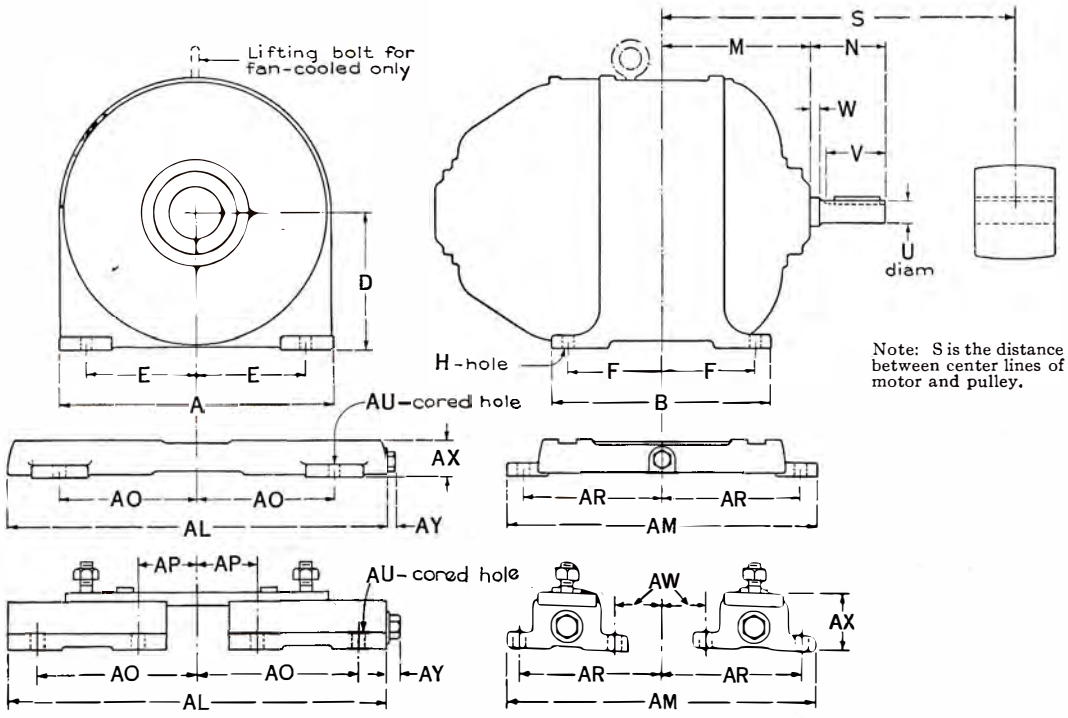
† Shaft not drilled and tapped for Frames N6306 and smaller.

For shipping weight of motor, add 15 per cent to the above net weights.

MOUNTING DIMENSIONS FOR CONSTANT- AND ADJUSTABLE-SPEED D-C MOTORS

Type CD, Frames 66 to 95 and 1126 to 1655

Two Sleeve or Ball Bearings, Open and Totally Enclosed, *Fan-cooled



Note: S is the distance between center lines of motor and pulley.

Frame	Base or Rail	APPROX NET WT IN LB: Motor Only ‡	Base or 2 Rails	Pulley	PULLEY: Dia	Width	KEYWAY: Width	Depth	A	B	D	E	F	H	BEARINGS: Ball M	Sleeve M	N	S	U	V	W	AL	AM	AO	AP	AR	AU	AX	AW
66	324	355	45	8½	6	5½	⅝	3/16	15¼	12½	8	6¼	5¼	2 1/32	10 5/16	10 5/16	5 1/16	13¼	1⅝	4⅝	3/16	22⅞	19¼	8	—	8½	¾	2½	—
67	326	415	53	15	8	6¾	⅝	3/16	15¼	14	8	6¼	6	2 1/32	11 1/16	11 1/16	5 1/16	14⅝	1⅝	4⅝	3/16	22⅞	20¾	8	—	9¼	¾	2½	—
73	7	435	55	9	7	5½	⅝	3/16	17¼	12¼	9¼	7⅛	4¾	2 5/32	9 3/16	11 3/16	4⅝	†14 5/16	1⅝	3⅞	¼	24⅛	17½	7¾	—	7⅞	⅞	3¼	—
75	182	485	55	15	8	6¾	⅝	3/16	17¼	13½	9¼	7⅛	5⅝	2 5/32	9 11/16	11 1/16	5⅛	†15 7/16	1⅝	4⅝	¼	23	17½	6 17/32	—	8	¾	3¼	—
83	7	650	55	17	8	7¾	½	¼	19¾	13	10½	8⅝	5	2 5/32	10⅝	12⅞	5⅞	†17⅛	1⅞	5⅝	¼	24⅛	17½	7¾	—	7⅞	⅞	3¼	—
85	9½	715	65	28	10	7¾	½	¼	19¾	14¼	10½	8⅝	5⅝	2 5/32	11	13½	6 11/16	†17⅝	2⅛	6⅛	5/16	27⅛	19	8⅝	—	8⅝	⅞	3¼	—
93	10	955	120	33	10	9¾	½	¼	22¾	15	12	9⅝	6	2 5/32	12 7/16	15⅛	7 7/16	†20	2⅝	6⅞	5/16	32⅞	21 1/4	10⅝	—	9¾	1	3¾	—
95	10	985	120	33																									
1126S	—	1560	—	—	—	—	½	¼		18			7¾		16½	16½	4	—	1⅞	3½			25¾			12			—
1126	41	1600	425	80	13	15	⅝	5/16							17⅝	17⅝	8⅛	24¾	2⅝	7⅝									3½
1128S	—	1600	—	—	—	—	½	¼		19			8¼		17	17	4	—	1⅞	3½			26¾			12½			—
1128	41	1640	425	80	13	15	⅝	5/16							17⅞	17⅞	8⅛	25¼	2⅝	7⅝									4
1129S	—	1715	—	—	—	—	½	¼		19½			8½		17¼	17¼	4	—	1⅞	3½			27¼			12¾			—
1129	41	1755	425	80	13	15	⅝	5/16							18⅛	18⅛	8⅛	25½	2⅝	7⅝									4¼
1130S	—	1655	—	—	—	—	½	¼		20			8¾		17½	17½	4	—	1⅞	3½			27¾			13			—
1130	41	1695	425	80	13	15	⅝	5/16							18⅜	18⅝	8⅛	25¾	2⅝	7⅝									4½
1131S	—	1815	—	—	—	—	½	¼	25½	20½	14	11¾	9	1 1/16	17¾	17¾	4	—	1⅞	3½	¼	36½	28¼	15¾	5	13¼	13/16	5	—
1131	41	1815	425	80	13	15	⅝	5/16							18⅜	18⅝	8⅛	26	2⅝	7⅝									4¾
1133S	—	1955	—	—	—	—	½	¼		21½			9½		18¼	18¼	4	—	1⅞	3½			29¼			13¾			—
1133	41	1995	425	80	13	15	⅝	5/16							19⅛	19⅛	8⅛	26½	2⅝	7⅝									5¼
1135S	—	1930	—	—	—	—	½	¼		22½			10		18¾	18¾	4	—	1⅞	3½			30¼			14¼			—
1135	41	1970	425	80	13	15	⅝	5/16							19⅝	19⅝	8⅛	27	2⅝	7⅝									5¾
1136S	—	2075	—	—	—	—	½	¼		23			10¼		19	19	4	—	1⅞	3½			30¾			14½			—
1136	41	—	425	80	13	15	⅝	5/16							19⅞	19⅞	8⅛	27¼	2⅝	7⅝									6
1137S	—	2045	—	—	—	—	½	¼		23½			10½		19¼	19¼	4	—	1⅞	3½			31¼			14¾			—
1137	41	2085	425	80	13	15	⅝	5/16							20⅛	20⅛	8⅛	27½	2⅝	7⅝									6¼
1138S	—	2170	—	—	—	—	½	¼		24			10¾		19½	19½	4	—	1⅞	3½			31¾			15			—
1138	41	—	425	80	13	15	⅝	5/16							20⅝	20⅝	8⅛	27¾	2⅝	7⅝									6½

* For dimensions of totally enclosed, fan-cooled motors in frames larger than 95, refer to the Company.

† This dimension is for sleeve-bearing motors; ball-bearing motors are slightly shorter.
Motors in Frames 1126 to 1655 are furnished with slide rails instead of bases.

‡ These weights are for open motors. For fan-cooled construction Frames 66 to 95, increase 7 to 14%. For shipping weights, add 15% to the net weights.

For complete dimensions and tolerances, ask for appropriate GEM print as listed on page 78.

Table continued on page following

MOUNTING DIMENSIONS FOR CONSTANT- AND ADJUSTABLE-SPEED D-C MOTORS (Cont.)

Type CD, Frames 66 to 95 and 1126 to 1655 (Cont.)

Two Sleeve or Ball Bearings, Open and Totally Enclosed, *Fan-cooled (Cont.)

Frame	Base or Rail	APPROX NET WT IN LB Motor Only‡	Base or 2 Rails	Pulley	PULLEY Dia	PULLEY Width Over-all	KEYWAY Width	KEYWAY Depth	Dimensions in Inches A	B	D	E	F	H	BEARINGS Ball M	BEARINGS Sleeve M	N	S	U	V	W	AL	AM	AO	AP	AR	AU	AX	AW
1235S	—	2295	—	—	—	—	3/8	5/16		22 1/2			10		19 3/4	19 3/4	5	—	2 3/8	4 1/2			—			—			—
1235	42	2340	430	100	14	17	3/4	3/8							20 3/4	20 3/4	9 3/8	29 1/4	3 1/8	9 1/8			30 1/4			14 1/4			5 3/4
1238S	—	2450	—	—	—	—	3/8	5/16		24			10 3/4		20 1/2	20 1/2	5	—	2 3/8	4 1/2			—			—			—
1238	42	—	430	100	14	17	3/4	3/8	27		15	12 1/2		1 1/16	21 1/2	21 1/2	9 3/8	29 7/8	3 1/8	9 1/8	1/4	38	31 3/4	16 1/2	5 3/4	15	13/16	5	6 1/2
1239S	—	2395	—	—	—	—	3/8	5/16					11		20 3/4	20 3/4	5	—	2 3/8	4 1/2			—			—			—
1239	42	2440	430	100	14	17	3/4	3/8		24 1/2					21 3/4	21 3/4	9 3/8	30 1/8	3 1/8	9 1/8			32 1/4			15 1/4			6 3/4
1242S	—	2555	—	—	—	—	3/8	5/16					11 3/4		21 1/2	21 1/2	5	—	2 3/8	4 1/2			—			—			—
1242	42	2610	430	100	14	17	3/4	3/8		26					22 1/2	22 1/2	9 3/8	30 7/8	3 1/8	9 1/8			33 3/4			16			7 1/2
1337S	—	3150	—	—	—	—	3/8	5/16					10 1/2		21 1/8	21 1/8	5 1/2	—	2 3/8	5			—			—			—
1337	43	3205	435	170	18	19	3/4	3/8		23 1/2					21 5/8	21 5/8	10 3/8	31	3 3/8	9 7/8			31 1/4			14 3/4			6 1/4
1339S	—	3165	—	—	—	—	3/8	5/16					11		21 3/8	21 3/8	5 1/2	—	2 3/8	5			—			—			—
1339	43	3220	435	170	18	19	3/4	3/8		24 1/2					22 1/8	22 1/8	10 3/8	31 1/2	3 3/8	9 7/8			32 1/4			15 1/4			6 3/4
1341S	—	3290	—	—	—	—	3/8	5/16	30		17	14	11 1/2	1 1/16	22 1/8	22 1/8	5 1/2	—	2 3/8	5	1/4	41	—	18	7 1/4	—	13/16	5	—
1341	43	3345	435	170	18	19	3/4	3/8		25 1/2					22 5/8	22 5/8	10 3/8	32	3 3/8	9 7/8			33 1/4			15 3/4			7 1/4
1344S	—	3410	—	—	—	—	3/8	5/16					12 1/4		22 7/8	22 7/8	5 1/2	—	2 3/8	5			—			—			—
1344	43	3465	435	170	18	19	3/4	3/8		27					23 3/8	23 3/8	10 3/8	32 3/4	3 3/8	9 7/8			34 3/4			16 1/2			8
1345S	—	3555	—	—	—	—	3/8	5/16					12 1/2		23 1/8	23 1/8	5 1/2	—	2 3/8	5			—			—			—
1345	43	3610	435	170	18	19	3/4	3/8		27 1/2					23 3/8	23 3/8	10 3/8	33	3 3/8	9 7/8			35 1/4			16 3/4			8 1/4
1441S	—	4070	—	—	—	—	3/4	3/8					11 1/2		22 7/8	22 7/8	6	—	2 7/8	5 1/2			—			—			—
1441	44	4155	445	215	18	23	1	1/2		25 1/2					23 1/8	23 1/8	11 7/8	34 1/2	3 7/8	11 3/8			33 1/4			15 3/4			7 1/4
1444S	—	4205	—	—	—	—	3/4	3/8		27			12 1/4		23 5/8	23 5/8	6	—	2 7/8	5 1/2			—			—			—
1444	44	4290	445	215	18	23	1	1/2	34		19	15 7/8		1 1/16	23 7/8	23 7/8	11 7/8	35 1/4	3 7/8	11 3/8	1/4	44 3/4	34 3/4	19 7/8	9 1/8	16 1/2	13/16	5	8
1445S	—	4470	—	—	—	—	3/4	3/8					12 1/2		23 7/8	23 7/8	6	—	2 7/8	5 1/2			—			—			—
1445	44	—	445	215	18	23	1	1/2		27 1/2					24 1/8	24 1/8	11 7/8	35 1/2	3 7/8	11 3/8			35 1/4			16 3/4			8 1/4
1447S	—	4350	—	—	—	—	3/4	3/8					13		24 3/8	24 3/8	6	—	2 7/8	5 1/2			—			—			—
1447	44	4435	445	215	18	23	1	1/2		28 1/2					24 3/8	24 3/8	11 7/8	36	3 7/8	11 3/8			36 1/4			17 1/4			8 3/4
1539S	—	5035	—	—	—	—	3/4	3/8					11 1/2		24	24	7	—	3 3/8	6 1/2			—			—			—
1539	45	5150	460	315	22	25 1/2	1	1/2		26					24 3/8	24 3/8	13 3/8	37	4 3/8	12 7/8			33 1/4			15 3/4			7 1/4
1543S	—	5435	—	—	—	—	3/4	3/8					12 1/2		25	25	7	—	3 3/8	6 1/2			—			—			—
1543	45	—	460	315	22	25 1/2	1	1/2		28					25 3/8	25 3/8	13 3/8	38	4 3/8	12 7/8			35 1/4			16 3/4			8 1/4
1546S	—	5610	—	—	—	—	3/4	3/8					13 1/4		25 3/4	25 3/4	7	—	3 3/8	6 1/2			—			—			—
1546	45	5725	460	315	22	25 1/2	1	1/2		29 1/2					26 1/8	26 1/8	13 3/8	38 3/4	4 3/8	12 7/8			36 3/4			17 1/2			9
1549S	—	5795	—	—	—	—	3/4	3/8	37		21	17 1/4		1 5/16	26 1/2	26 1/2	7	—	3 3/8	6 1/2	1/4	47 1/2	—	21 1/4	10 1/2	—	13/16	5	—
1549	45	5910	460	315	22	25 1/2	1	1/2		31			14		26 7/8	26 7/8	13 3/8	39 1/2	4 3/8	12 7/8			38 1/4			18 1/4			9 3/4
1550S	—	6140	—	—	—	—	3/4	3/8					14 1/4		26 3/4	26 3/4	7	—	3 3/8	6 1/2			—			—			—
1550	45	—	460	315	22	25 1/2	1	1/2		31 1/2					27 1/8	27 1/8	13 3/8	39 3/4	4 3/8	12 7/8			38 3/4			18 1/2			10
1553S	—	6320	—	—	—	—	3/4	3/8					15		27 1/2	27 1/2	7	—	3 3/8	6 1/2			—			—			—
1553	45	6435	460	315	22	25 1/2	1	1/2		33					27 7/8	27 7/8	13 3/8	40 1/2	4 3/8	12 7/8			40 1/4			19 1/4			10 3/4
1556S	—	6500	—	—	—	—	3/4	3/8					15 3/4		28 1/4	28 1/4	7	—	3 3/8	6 1/2			—			—			—
1556	45	6615	460	315	22	25 1/2	1	1/2		34 1/2					28 3/8	28 3/8	13 3/8	41 1/4	4 3/8	12 7/8			41 3/4			20			11 1/2
1638S	—	6525	—	—	—	—	1	1/2					11 1/4		25 3/8	25 3/8	8	—	3 7/8	7 1/2			—			—			—
1638	46	6750	475	400	24	29 1/2	1 1/4	5/8		25 1/2					25 7/8	25 7/8	16 3/8	40 1/2	5 3/8	15 7/8			32 3/4			15 1/2			7
1642S	—	7130	—	—	—	—	1	1/2					12 1/4		26 3/8	26 3/8	8	—	3 7/8	7 1/2			—			—			—
1642	46	—	475	400	24	29 1/2	1 1/4	5/8		27 1/2					26 7/8	26 7/8	16 3/8	41 1/2	5 3/8	15 7/8			34 3/4			16 1/2			8
1645S	—	7355	—	—	—	—	1	1/2					13		27 1/8	27 1/8	8	—	3 7/8	7 1/2			—			—			—
1645	46	—	475	400	24	29 1/2	1 1/4	5/8		29					27 7/8	27 7/8	16 3/8	42 1/4	5 3/8	15 1/8			36 1/4			17 1/4			8 3/4
1648S	—	7575	—	—	—	—	1	1/2					13 3/4		27 7/8	27 7/8	8	—	3 7/8	7 1/2			—			18			9 1/2
1648	46	7800	475	400	24	29 1/2	1 1/4	5/8	43	30 1/2	24	20		1 5/16	28 3/8	28 3/8	16 3/8	43	5 3/8	15 7/8	1/4	53	37 3/4	24	13 1/4	—	13/16	5	—
1649S	—	8180	—	—	—	—	1	1/2					14		28 1/8	28 1/8	8	—	3 7/8	7 1/2			—			—			—
1649	46	—	475	400	24	29 1/2	1 1/4	5/8		31					28 5/8	28 5/8	16 3/8	43 1/4	5 3/8	15 7/8			38 1/4			18 1/4			9 3/4
1650S	—	8600	—	—	—	—	1	1/2					14 1/4		28 3/8	28 3/8	8	—	3 7/8	7 1/2			—			—			—
1650	46	—	475	400	24	29 1/2	1 1/4	5/8		31 1/2					28 7/8	28 7/8	16 3/8	43 1/2	5 3/8	15 7/8			38 3/4			18 1/2			10
1653S	—	8835	—	—	—	—	1	1/2					15		29 1/8	29 1/8	8	—	3 7/8	7 1/2			—			—			—
1653	46	—	475	400	24	29 1/2	1 1/4	5/8		33					29 3/8	29 3/8	16 3/8	44 1/4	5 3/8	15 7/8			40 1/4			19 1/4			10 3/4
1655S	—	9235	—	—	—	—	1	1/2					15 1/2		29 3/8	29 3/8	8	—	3 7/8	7 1/2			—			—			—
1655	46		375	400	24	29 1/2	1 1/4	5/8		34					30 1/8	30 1/2	16 3/8	44 3/4	5 3/8	15 7/8			41 1/4			19 3/4			11 1/4

* For dimensions of totally enclosed, fan-cooled motors in frames larger than 95, refer to the Company.
† This dimension is for sleeve-bearing motors; ball-bearing motors are slightly shorter.
Motors in Frames 1126 to 1655 are furnished with slide rails instead of bases.
‡ These weights are for open motors. For fan-cooled construction Frames 66 to 95, increase 7 to 14%. For shipping weights, add 15% to the net weights.
For complete dimensions and tolerances, ask for appropriate GEM print as listed on page 78.

MOUNTING DIMENSIONS FOR F-HP PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motors—Type K, KH, KC, and BC
Reducer—Type MW, Open, Horizontal
Frames—½MW-42 to ½MW-47

Frame No.	Volts	Ship. Wt, Lb	Dimensions in Inches				
			C	TYPE KC ONLY			
				XE	XH	XR	ZO
½MW-42	32 115–230	60	14 13¾	—	—	—	—
½MW-43	110 220–440	60	13¼	—	—	—	—
½MW-44	32 115–230	60	14⅜ 14⅛	—	—	—	—
½MW-45	110 220–440	60	13¾	1½	5 3/16	2 5/32	11 1/16
½MW-46	115–230	60	14⅞	—	—	—	—
½MW-47	110	60	14⅛	1 15/16	5 3/16	2 29/64	11 11/16

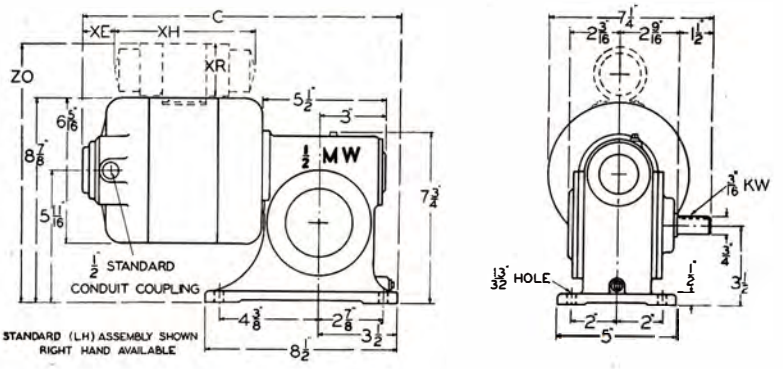


Fig. 1

Motors—Type K, KH, KC, and BC
Reducer—Type MHW, Open, Horizontal
Frames—1MHW-42 to 1MHW-47

Frame No.	Volts	Ship. Wt, Lb	Dimensions in Inches				
			C	TYPE KC ONLY			
				XE	XH	XR	ZO
1MHW-42	32 115–230	105	18¼ 18	—	—	—	—
1MHW-43	110 220–440	105	17½	—	—	—	—
1MHW-44	32 115–230	105	18⅜ 18⅜	—	—	—	—
1MHW-45	110 220–440	105 105	18	1½	5 3/16	2 5/32	10½
1MHW-46	32 115–230	105	19⅜ 19⅛	—	—	—	—
1MHW-47	110	105	18⅜	1 15/16	5 3/16	2 29/64	11

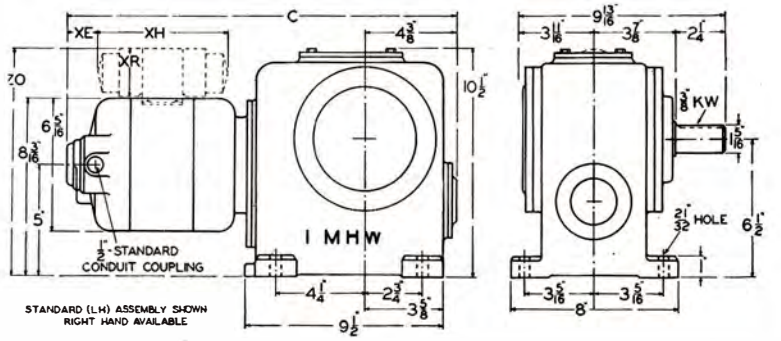


Fig. 2

Motors—Type K, KC, and BC
Reducer—Type MT, Open, Horizontal
Frames—3MT-63 to 3MT-77

Frame No.	Volts	Ship. Wt, Lb	Dimensions in Inches				
			C	O	P	AB	AC
3MT-63	110–220–440	215	24⅜	9¼	7½	5 1/64	4 5/16
3MT-66	115 or 230	215	25 13/16	9¼	7½	5 1/64	4 5/16
3MT-73	110–220–440	230	25⅞	9 23/32	8 7/16	5 31/64	4 23/32
3MT-74	115 or 230	230	29 9/16	9 23/32	8 7/16	5 31/64	4 23/32
3MT-77	110	230	26⅞	9 23/32	8 7/16	5 31/64	4 23/32

TYPE KC ONLY

Frame No.	ZO	XE	XH	XR
3MT-63	13⅞	1¼	7 1/16	3⅜
3MT-73	13⅞	1 11/16	7 1/16	3⅜
3MT-77	13⅞	2 11/16	7 1/16	3⅜

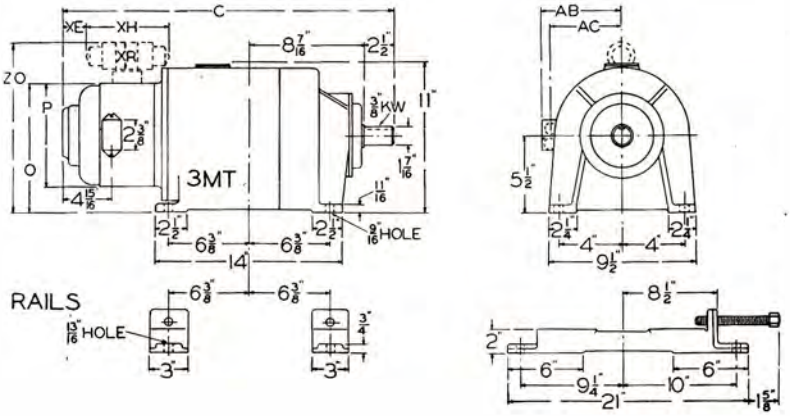


Fig. 3

FRACTIONAL-HORSEPOWER-MOTOR FRAME SIZES

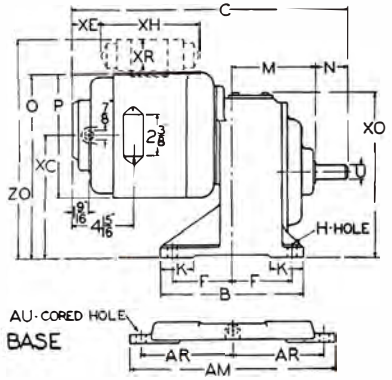
Hp	Sync Speed, Rpm	MOTOR TYPE				Hp	Sync Speed, Rpm	MOTOR TYPE			
		K	KH	KC	BC			K	KH	KC	BC
1/6	1800	43	45	45	42	½	1800 1200	63 73	....	63 77	66 74
¼	1800	43	47	47	44						
⅓	1800	45	....	47	46	¾	1800 1200	73 204	....	73	74 204

For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.

MOUNTING DIMENSIONS FOR F-HP PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motor—Types K, KH, KC, and BC. Reducer—Types MS and MR
Frames ½ MS-42 to 1MS-77; 3MR-63 to 5MR77

Open, Horizontal
For Gear, Chain, Belt, or Direct Connection



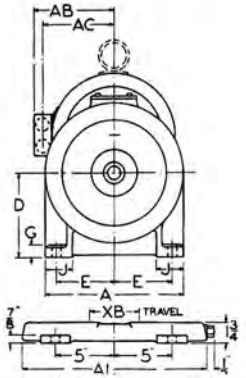
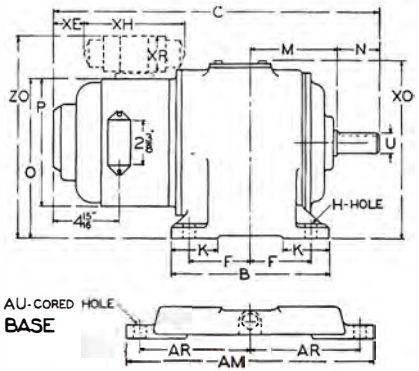


Fig. 1



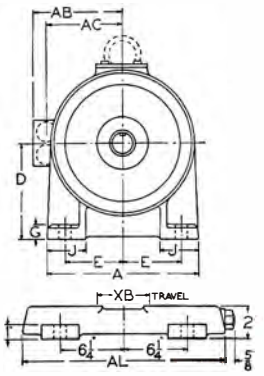


Fig. 2

Frame No. †	Fig.	Base No.	APPROX NET WT in Lb		KEYWAY		Dimensions in Inches																							TYPE KC ONLY			
			Unit	Base	Width	Depth	Key Length	A	B	C 110, 220, 440, 550 Volts	C 32 Volts	C 115 or 230 Volts	D	E	F	G	H	J	K	M	N	O	P	U	AB	AC	AM	AR	XB △	XC	XO	XE	XH	XR	ZO
½ MS-42	1	02	48	15	3/16	3/32	1¼	6½	6¼	.....	13¾	13½	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅝	.....	.....	.....	.....
½ MS-43	1	02	46	15	3/16	3/32	1¼	6½	6¼	13	.....	.....	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅝	1½	5 3/16	2 5/32	10 21/32
½ MS-44	1	02	50	15	3/16	3/32	1¼	6½	6¼	.....	14⅛	13⅞	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅝	.....	.....	.....	.....
½ MS-45	1	02	48	15	3/16	3/32	1¼	6½	6¼	13½	.....	.....	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅜	1⅝	5 3/16	2 5/32	10 21/32
½ MS-46	1	02	53	15	3/16	3/32	1¼	6½	6¼	.....	.....	14 15/16	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅜	.....	.....	.....	.....
½ MS-47	1	02	52	15	3/16	3/32	1¼	6½	6¼	13⅞	.....	.....	3½	2¾	2⅝	9/16	13/32	1¼	1½	3 11/16	1½	8 5/16	6 5/16	⅝	.....	.....	10½	4½	½	5 5/32	8⅜	1 13/16	5 3/16	2 39/64	11⅛
1 MS-63	1	204	80	20	3/16	3/32	1½	8¼	7¾	16 5/16	.....	.....	4¼	3½	3¼	⅝	17/32	1⅜	2½	4⅝	1¾	10¼	7½	⅞	5 1/64	4 5/16	12	5¼	2	6½	10¾	2¼	4 15/16	2⅝	12 11/16
1 MS-66	1	204	85	20	3/16	3/32	1½	8¼	7¾	.....	.....	17¼	4¼	3½	3¼	⅝	17/32	1⅜	2½	4⅝	1¾	10¼	7½	⅞	5 1/64	4 5/16	12	5¼	2	6½	10¾	.....	.....	.....	.....
1 MS-73	1	204	100	20	3/16	3/32	1½	8¼	7¾	17⅜	.....	.....	4¼	3½	3¼	⅝	17/32	1⅜	2½	4⅝	1¾	10¾	8 7/16	⅞	5 31/64	4 25/32	12	5¼	2	6½	10¾	2¾	4 15/16	2⅝	13¼
1 MS-74	1	204	104	20	3/16	3/32	1½	8¼	7¾	.....	.....	18	4¼	3½	3¼	⅝	17/32	1⅜	2½	4⅝	1¾	10¾	8 7/16	⅞	5 31/64	4 25/32	12	5¼	2	6½	10¾	.....	.....	.....	.....
1 MS-77	1	204	120	20	3/16	3/32	1½	8¼	7¾	18⅜	.....	.....	4¼	3½	3¼	⅝	17/32	1⅜	2½	4⅝	1¾	10 13/32	8 7/16	⅞	5 31/64	4 25/32	12	5¼	2	6½	10¾	2 21/32	4 15/16	3⅜	14 5/32
3MR-63	2	254	95	28	¼	⅛	2	9½	9½	18 13/16	.....	.....	5½	4	4⅛	1 1/16	9/16	2¼	2½	4 15/16	2¼	9¼	7½	1⅛	5 1/64	4 5/16	15⅛	6⅝	2	.....	10½	2¼	4 15/16	2⅝	11 7/16
3MR-66	2	254	100	28	¼	⅛	2	9½	9½	.....	.....	19¾	5½	4	4⅛	1 1/16	9/16	2¼	2½	4 15/16	2¼	9¼	7½	1⅛	5 1/64	4 5/16	15⅛	6⅝	2	.....	10½	.....	.....	.....	.....
3MR-73	2	254	110	28	¼	⅛	2	9½	9½	19⅞	.....	.....	5½	4	4⅛	1 1/16	9/16	2¼	2½	4 15/16	2¼	9¾	8 7/16	1⅛	5 31/64	4 25/32	15⅛	6⅝	2	.....	10½	2¾	4 15/16	2⅜	12¼
3MR-74	2	254	115	28	¼	⅛	2	9½	9½	.....	.....	20½	5½	4	4⅛	1 1/16	9/16	2¼	2½	4 15/16	2¼	9¾	8 7/16	1⅛	5 31/64	4 25/32	15⅛	6⅝	2	.....	10½	.....	.....	.....	.....
5MR-73	2	254	170	28	⅜	3/16	2¾	11	10	23 3/16	.....	.....	6½	4⅝	4¼	¾	1 1/16	2¾	2½	7 11/16	3	10 13/32	8 7/16	1½	5 31/64	4 25/32	15⅛	6⅝	3	.....	13	2¾	4 15/16	2⅜	.....
5MR-74	2	254	175	28	⅜	3/16	2¾	11	10	.....	.....	23 13/16	6½	4⅝	4¼	¾	1 1/16	2¾	2½	7 11/16	3	10¾	8 7/16	1½	5 31/64	4 25/32	15⅛	6⅝	3	.....	13	.....	.....	.....	.....
5MR-77	2	254	180	28	⅝	3/16	2¾	11	10	18⅝	.....	.....	6½	4⅝	4¼	¾	1 1/16	2¾	2½	7 11/16	3	10 13/32	8 7/16	1½	5 31/64	4 25/32	15⅛	6⅝	3	.....	13	1 21/32	7 11/16	3⅜	

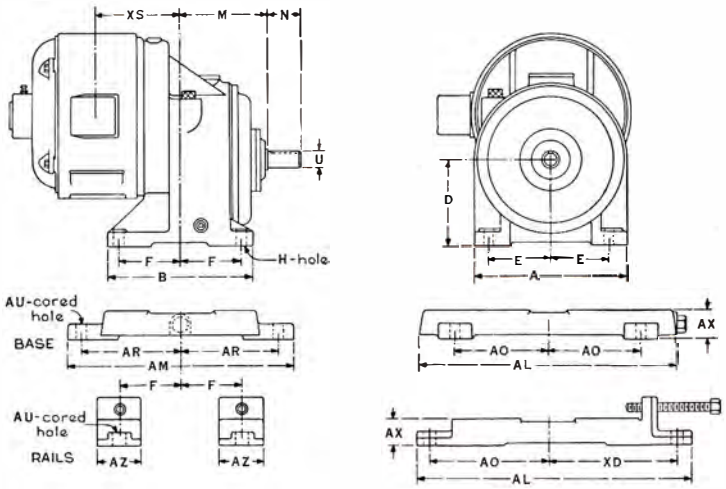
△XB is total movement of unit on base or rails for tightening chain or belt. † Reducer frame numbers precede dash; motor frame numbers follow dash.
For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.
For shipping weights, add 15 per cent to above net weights.

MOUNTING DIMENSIONS FOR PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motors: Types K and KG (2- and 3-phase)
Frames 203 to 326, Open and Splashproof (Tri-Clad)
Frames 364 to 504, Open (Not Tri-Clad)

Ball Bearings
For Gear, Chain, Belt, or Direct Drive

Reducers: Type MS
Frames 1MS*203 to 50MS*504



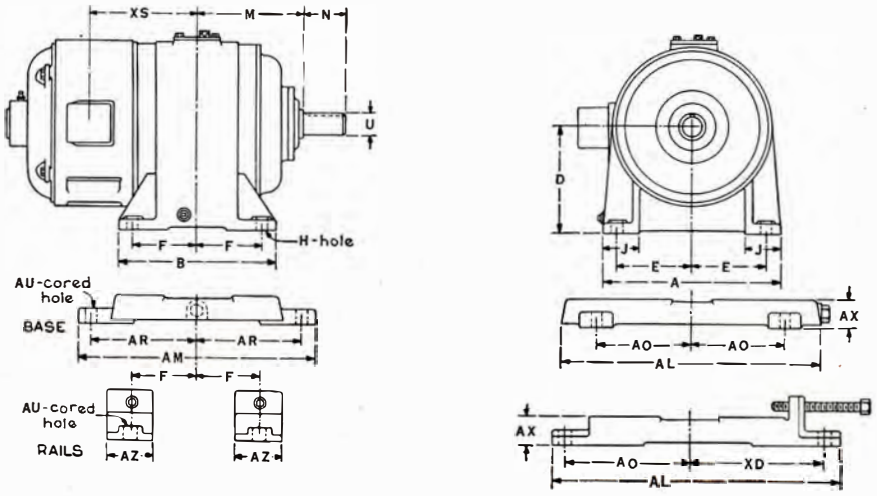
Frame No.	Base or Rail No. ‡	APPROX. NET WT IN LB † Unit	APPROX. NET WT IN LB Base or Two Rails	KEYWAY Width	KEYWAY Depth	A	B	D	E	F	H	M	N	U	AL	AM	AO	AR	AU	AX	XS	AZ	XD
				Dimensions in Inches																			
1MS*203 1MS*204	204	110 115	20	3/16	3/32	8¼	7¾	4¼	3½	3¼	17/32	4⅝	1¾	⅞	14	12	5	5¼	½	1¾	4 9/16 5 1/16		
2MS*203 2MS*204	225	150 155	23	¼	⅛	10	9¾	6	4	3¾	2 1/32	5 7/16	2¼	1⅛	15½	13	5½	5¾	½	1¾	4¾ 5¼		
2MS*224 2MS*225	225	165 180	23	¼	⅛	10	9¾	6	4	3¾	2 1/32	5 7/16	2¼	1⅛	15½	13	5½	5¾	½	1¾	5 1/16 5 7/16		
5MS*224 5MS*225	284	225 230	33	⅜	3/16	12½	12	6½	5	4¾	2 5/32	6⅝	3	1½	19¾	16⅞	7	7½	⅝	2	5 3/16 5 9/16		
5MS*254 5MS*284	284	260 310	33	⅜	3/16	12½	12	6½	5	4¾	2 5/32	6⅝	3	1½	19¾	16⅞	7	7½	⅝	2	5⅝ 5 15/16		
10MS*254 10MS*284	326	405 455	53	½	¼	17¼	14	9	7⅛	6	2 9/32	8 1/16	3½	1⅞	22¾	20¾	8	9¼	¾	2½	7 5/16 7 5/8		
10MS*324 10MS*326	326	490 525	53	½	¼	17¼	14	9	7⅛	6	2 9/32	8 1/16	3½	1⅞	22¾	20¾	8	9¼	¾	2½	8 1/16 8 13/16		
20MS*324 20MS*326	445	675 710	129	⅝	5/16	18	19	10	7½	8¼	1⅛	10 1/16	4	2 7/16	31¼	26⅝	11	12	⅞	3	7 15/16 8 11/16		
20MS*364 20MS*365	445	890 930	130	⅝	5/16	18	19	10	7½	8¼	1⅛	10 1/16	4	2 7/16	31¼	26⅝	11	12	⅞	3	9 7/16		
20MS*404 20MS*405	445	1020 1060	130	⅝	5/16	18	19	10	7½	8¼	1⅛	10 1/16	4	2 7/16	31¼	26⅝	11	12	⅞	3	10 1/16		
20MS*444 20MS*445	445	1160 1220	130	⅝	5/16	18	19	10	7½	8¼	1⅛	10 1/16	4	2 7/16	31¼	26⅝	11	12	⅞	3	11 13/16		
50MS*365 50MS*405	6	1400 1500	160	⅞	7/16	26	24	12½	10	10½	1⅝	12 9/16	5	3 7/16	41	—	18½	—	1 1/16	3½	10⅝ 11⅝	5	20
50MS*444 50MS*445	6	1600 1660	160	⅞	7/16	26	24	12½	10	10½	1⅝	12 9/16	5	3 7/16	41	—	18½	—	1 1/16	3½	12¾	5	20
50MS*504	6	1880	160	⅞	7/16	26	24	12½	10	10½	1⅝	12 9/16	5	3 7/16	41	—	18½	—	1 1/16	3½	13⅝	5	20

* The letter A, B, or C, denoting Class I, II, or III, motorized speed reducers respectively (see page 52), is omitted, since the dimensions of a given unit are the same, regardless of the classification.
† The weights given above are for open units. Splashproof units will be somewhat heavier.
‡ Numbers 204 to 445 are sliding bases. The No. 6's are rails.
For shipping weights, add 15 per cent to the above net weights.
For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.

MOUNTING DIMENSIONS FOR PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motors: Types K and KG (2- and 3-phase)
Frames 203 to 326, Open and Splashproof (Tri-Clad)
Frames 364 to 455, Open (Not Tri-Clad)
Reducers: Type MR
Frames 3MR*203 to 50MR*445

Ball Bearings
For Gear, Chain, Belt, or Direct Drive



Frame No.	Base or Rails No. §	APPROX NET WT, LB		KEYWAY		Dimensions in Inches														
		Unit †	Base	Width	Depth	A	B	D	E	F	H	M	N	U	AL	AM	AO	AR	AU	AX	XS
3MR*203 3MR*204	254	117 124	28	¼	⅛	9½	9½	5½	4	4⅛	9/16	4 15/16	2¼	1⅛	17¾	15⅛	6¼	6⅜	⅝	2	6¼ 6¾
5MR*203 5MR*204	254	163 174	28	⅜	3/16	11	10	6½	4⅜	4¼	1 1/16	7 1/16	3	1½	17¾	15⅛	6¼	6⅜	⅝	2	6 9/16 7 1/16
5MR*224 5MR*225 5MR*254	254	179 192 229	28	⅜	3/16	11	10	6½	4⅜	4¼	1 1/16	7 1/16	3	1½	17¾	15⅛	6¼	6⅜	⅝	2	6⅞ 7¼ 7 13/16
9MR*224 9MR*225 9MR*254	324	324 337 364	45	½	¼	15¾	12⅜	9	6½	5¼	13/16	8 5/16	3½	2⅛	22¾	19¼	8	8½	¾	2½	7 5/16 7 11/16 7¾
9MR*284 9MR*324 9MR*326	324	417 466 503	45	½	¼	15¾	12⅜	9	6½	5¼	13/16	8 5/16	3½	2⅛	22¾	19¼	8	8½	¾	2½	8 1/16 10 10¾
15MR*254 15MR*284	444	915 967	125	¾	⅜	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅜	11	11	⅞	3	11 ⅜ 11 11/16
15MR*324 15MR*326	444	1000 1030	125	¾	⅜	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅜	11	11	⅞	3	12⅛ 12⅞
35MR*326	505	1450	166	⅞	7/16	25	21½	14	11	9	1⅛	14⅜	5	3 7/16	35	30	12½	13½	1	3½	13¾
15MR*364 15MR*365	444	1200 1250	125	¾	⅜	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅜	11	11	⅞	3	13¼
15MR*405	444	1350	125	¾	⅜	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅜	11	11	⅞	3	14
35MR*364 35MR*365	505	1500 1550	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅜	5	3 7/16	35	30	12½	13½	1	3½	14⅛
35MR*405	505	1650	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅜	5	3 7/16	35	30	12½	13½	1	3½	14⅞
35MR*444 35MR*445	505	1750 1810	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅜	5	3 7/16	35	30	12½	13½	1	3½	16
50MR*405	‡ 8	3300	265	1	½	36	34	19	14	14	1⅜	18 5/16	6½	3⅞	50½	.....	23⅛	.....	1 3/16	3½	19⅛
50MR*444 50MR*445	‡ 8	3400 3460	265	1	½	36	34	19	14	14	1⅜	18 5/16	6½	3⅞	50½	.....	23⅛	.....	1 3/16	3½	20¼

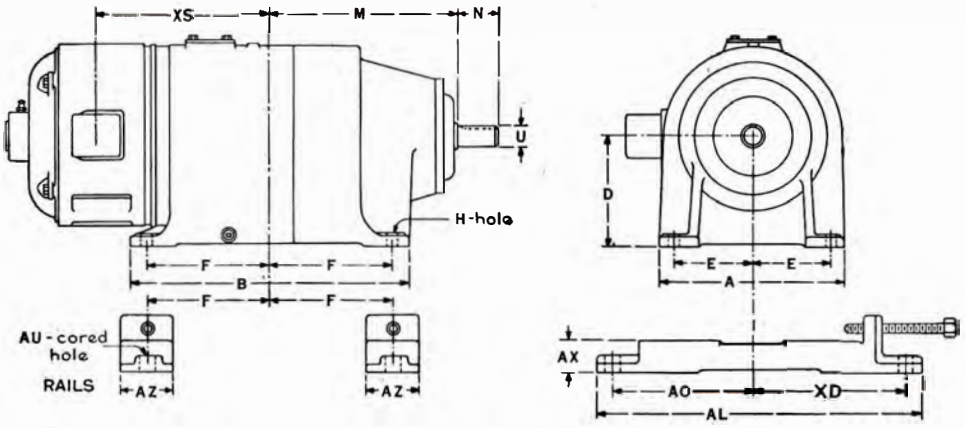
* The letter A, B, or C, denoting Class I, II or III, motorized speed reducers respectively (see page 52), is omitted, since the dimensions of a given unit are the same regardless of the classification.
† Weights given are for open units. Splashproof units are slightly heavier.
‡ The dimensions AZ and XD for No. 8 rails are 6 in. and 24⅜ in. respectively.
§ Numbers 254 to 505 are sliding bases. The No. 8's are rails.
For shipping weights, add 15 per cent to the above net weights.
For complete dimensions and tolerances, refer to the appropriate GEM print listed on page **78.**

MOUNTING DIMENSIONS FOR PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motors: Types K and KG (2- and 3-phase)
Frames 203 to 326, Open and Splashproof (Tri-Clad)
Frames 364 to 365, Open and Splashproof (Not Tri-Clad)

Ball Bearings
For Gear, Chain, Belt, or Direct Drive

Reducers, Type MT
Frames 3MT*203 to 15MT*365



Frame No. †	Rail No.	APPROX NET WT, LB		Dimensions in Inches																	
				KEYWAY		Key Length	A	B	D	E	F	H	M	N	U	AL	AO	AU	AX	AZ	XD	XS
		Unit	Rails	Width	Depth																	
3MT*203 3MT*204	2	220 225	35	3/8	3/16	2 1/4	9 1/2	14	5 1/2	4	6 3/8	9/16	8 7/16	2 1/2	1 7/16	21	9 1/4	1 3/16	2	3	10	8 9/16 9 1/16
5MT*203 5MT*204	2	295 300	35	1/2	1/4	3 1/4	11	17 3/4	6 1/2	4 3/8	8	1 3/16	11 1/16	3 1/2	2 3/16	21	9 1/4	1 3/16	2	3	10	10 5/16 10 13/16
5MT*224 5MT*225 5MT*254	2	310 325 375	35	1/2	1/4	3 1/4	11	17 3/4	6 1/2	4 3/8	8	1 3/16	11 1/16	3 1/2	2 3/16	21	9 1/4	1 3/16	2	3	10	10 3/8 11 11 9/16
9MT*224 9MT*225	4	515 530	65	3/4	3/8	4 1/4	15	22	9	6 1/2	9 3/4	1 5/16	14 1/2	4 1/2	2 15/16	28 1/2	12 3/4	1 5/16	2 1/2	4	13 3/4	11 13/16 12 3/16
9MT*254 9MT*284 9MT*324	4	570 630 680	65	3/4	3/8	4 1/4	15	22	9	6 1/2	9 3/4	1 5/16	14 1/2	4 1/2	2 15/16	28 1/2	12 3/4	1 5/16	2 1/2	4	13 3/4	12 1/4 12 9/16 14 1/2
15MT*284 15MT*324 15MT*326	6	1465 1525 1550	160	7/8	7/16	4 3/4	22	28 1/2	12	9	12 3/4	1 1/16	19	5	3 1/2	41	18 1/2	1 1/16	3 1/2	5	20	17 3/16 17 5/8 18 5/8
15MT*364 15MT*365	6	1725 1750	160	7/8	7/16	4 3/4	22	28 1/2	12	9	12 3/4	1 1/16	19	5	3 1/2	41	18 1/2	1 1/16	3 1/2	5	20	18 3/4

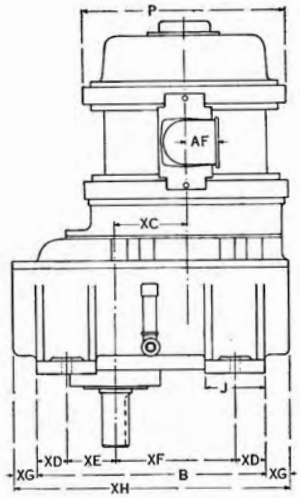
* The letter A, B, or C denoting Class I, II or III speed reducers respectively (see page 52), is omitted, since the dimensions of a given unit are the same, regardless of the classification.

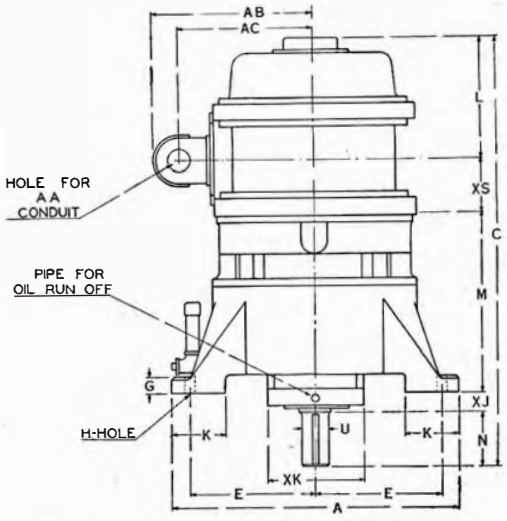
† The weights given above are for open units. splashproof units are slightly heavier.
For shipping weights, add 15 per cent to above net weights.
For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.

MOUNTING DIMENSIONS FOR PACIFIC, GENERAL ELECTRIC MOTORIZED, VERTICAL SPEED REDUCERS

Motors—Types K, KF, and KG (2- and 3-phase)
Reducers—Type SV, Open, Vertical
Frames 1SV*204 to 20SV*405

For Thrust Loads
Two Ball Bearings





Frame No.	Approx Net Wt, Lb	Dimensions in Inches													
		KEYWAY		Key Length	A	B	C	E	G	H	J	K	L	M	N
		Width	Depth												
1SV*204	110	3/16	3/32	1½	9¼	8	18 3/16	4	11/16	9/16	2¼	2¼	6¼	6 13/16	1¾
2SV*204	150	¼	⅛	2	11½	9½	19¾	5	13/16	11/16	2½	2½	6¼	7¾	2¼
2SV*224 2SV*225	170 180	¼	⅛	2	11½	9½	20 5/16 21 1/16	5	13/16	11/16	2½	2½	6¾ 7⅛	8	2¼
2SV*254	230	¼	⅛	2	11½	9½	22¾	5	13/16	11/16	2½	2½	8¼	8½	2¼
5SV*204	160	⅜	3/16	2¾	14¼	12	21 11/16	6¼	15/16	13/16	3	2¾	6¼	8 15/16	3
5SV*224 5SV*225	200 210	⅜	3/16	2¾	14¼	12	22¼ 22 5/16	6¼	15/16	13/16	3	2¾	6¾ 7⅛	9 3/16	3
5SV*254	245	⅜	3/16	2¾	14¼	12	24 11/16	6¼	15/16	13/16	3	2¾	8¼	9 11/16	3
10SV*254	375	½	¼	3⅜	17	15⅝	26½	7½	1⅛	15/16	3½	3½	8¼	10¾	3½
10SV*284	425	½	¼	3⅜	17	15⅝	28 5/16	7½	1⅛	15/16	3½	3½	9⅜	11⅛	3½
10SV*324 10SV*326	475 535	½	¼	3⅜	17	15⅝	29½ 31½	7½	1⅛	15/16	3½	3½	10⅛ 11⅛	11⅜	3½
20SV*324 20SV*326	660 710	⅝	5/16	3¾	21½	19	33 35	9½	1¼	1⅛	4	4	10⅛ 11⅛	14⅜	4
20SV*364 20SV*365	840 870	⅝	5/16	3¾	21½	19	36 7/16	9½	1¼	1⅛	4	4	11 13/16	14¾	4
20SV*405	1000	⅝	5/16	3¾	21½	19	38 13/16	9½	1¼	1⅛	4	4	13¼	14 15/16	4

Frame No.	DIMENSIONS IN INCHES														
	P	U	AA	AB	AC	AF	XC	XD	XE	XF	XG	XH	XJ	XK	XS
1SV*204	9 9/16	⅜	¾	7⅝	6½	1⅞	2¼	1⅛	1¾	4	½	9	⅝	3½	2¾
2SV*204	9 9/16	1⅛	¾	7⅝	6½	1⅞	3	1¼	2	5	1	11½	¾	4	2¾
2SV*224 2SV*225	11	1⅛	¾	8 11/32	7 7/32	1⅞	3	1¼	2	5	1	11½	¾	4	2 9/16 2 15/16
2SV*254	12 7/16	1⅛	1	9⅞	8 7/16	2¼	3	1¼	2	5	1	11½	¾	4	3
5SV*204	9 9/16	1½	¾	7⅝	6½	1⅞	4	1½	2½	6½	1¼	14½	¾	5½	2¾
5SV*224 5SV*225	11	1½	¾	8 11/32	7 7/32	1⅞	4	1½	2½	6½	1¼	14½	¾	5½	2 9/16 2 15/16
5SV*254	12 7/16	1½	1	9⅞	8 7/16	2¼	4	1½	2½	6½	1¼	14½	¾	5½	3
10SV*254	12 7/16	1⅞	1	9⅞	8 7/16	2¼	5.6	1¾	3¼	8⅞	1⅝	18⅞	1	5½	3
10SV*284	14	1⅞	1	10 21/32	9 7/32	2¼	5.6	1¾	3¼	8⅞	1⅝	18⅞	1	5½	3 5/16
10SV*324 10SV*326	15½	1⅞	1¼ 1½	11 31/32 12 19/32	10 17/32 10 31/32	2⅝ 2 15/16	5.6	1¾	3¼	8⅞	1⅝	18⅞	1	5½	3½ 4½
20SV*324 20SV*326	15½	2 7/16	1¼ 1½	11 31/32 12 19/32	10 17/32 10 31/32	2⅝ 2 15/16	7	2	4	11	2¼	23½	1	6½	3½ 4½
20SV*364 20SV*365	17⅛	2 7/16	1½	13½	11¾	2⅞	7	2	4	11	2¼	23½	1	6½	4⅞
20SV*405	19⅜	2 7/16	2	14⅞	13	3½	7	2	4	11	2¼	23½	1	6½	5⅝

* The letter A, B, or C, denoting Class I, II, or III, motorized speed reducers respectively (see page 52), is omitted, since the dimensions of a given unit are the same, regardless of the classification.

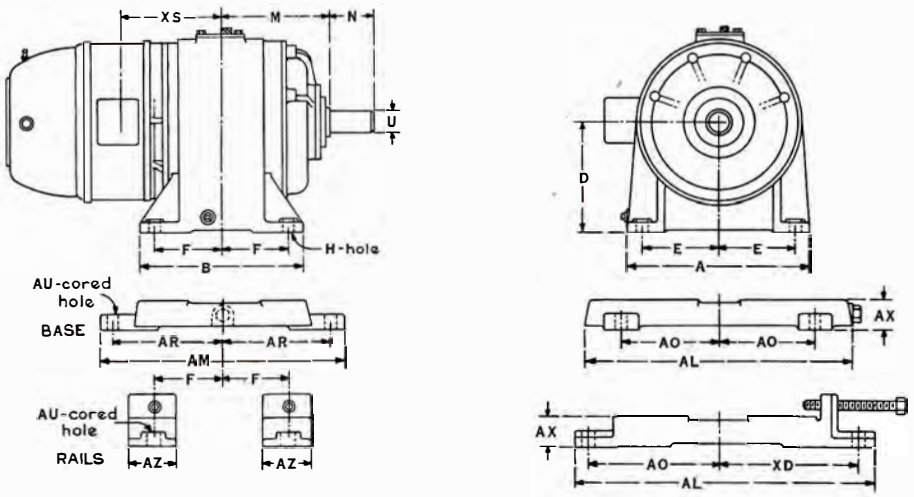
For shipping weights, add 15 per cent to the above net weights.

For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.

MOUNTING DIMENSIONS FOR PACIFIC, GENERAL ELECTRIC MOTORIZED, SPEED REDUCERS

Motors: Types K and KG (2- and 3-phase)
Frame 204 to 224, Totally Enclosed
Frame 225 to 445, Totally Enclosed, Fan-cooled
Reducers, Type MR
Frames 3MR*204 to 50MR*445

Ball Bearings
For Gear, Chain, Belt, or Direct Drive



Frame No.	Base or Rails No. ‡	APPROX NET WT, LB		KEYWAY		Dimensions in Inches														
		Unit	Base	Width	Depth	A	B	D	E	F	H	M	N	U	AL	AM	AO	AR	AU	AX	XS
†3MR*204 †3MR*224	254	120 140	28	¼	⅛	9½	9½	5½	4	4⅛	9/16	4 15/16	2¼	1⅛	17¾	15⅛	6¼	6⅝	⅝	2	7 1/16
†5MR*204 †5MR*224	254	170 185	28	⅜	3/16	11	10	6½	4⅝	4¼	1 1/16	7 1/16	3	1½	17¾	15⅛	6¼	6⅝	⅝	2	7⅝ 7 3/16
5MR*225 5MR*254	254	290 350	2	⅜	3/16	11	10	6½	4⅝	4¼	1 1/16	7 1/16	3	1½	17¾	15⅛	6¼	6⅝	⅝	2	9 1/16 9½
‡9MR*224 9MR*225	324	330 385	45	½	¼	15¾	12⅝	9	6½	5¼	13/16	8 15/16	3½	2⅛	22¾	19¼	8	8½	¾	2½	7⅝ 9½
9MR*254 9MR*284	324	430 500	45	½	¼	15¾	12⅝	9	6½	5¼	13/16	8 15/16	3½	2⅛	22¾	19¼	8	8½	¾	2½	9 7/16 10¼
9MR*324 9MR*326	324	570 630	45	½	¼	15¾	12⅝	9	6½	5¼	13/16	8 15/16	3½	2⅛	22¾	19¼	8	8½	¾	2½	11 7/16 12⅞
15MR*284 15MR*324 15MR*326	444	1050 1080 1160	125	¾	⅝	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅝	11	11	⅞	3	13⅛ 13¼ 14¼
35MR*326	505	1580	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅝	5	3 7/16	35	30	12½	13½	1	3½	15⅛
15MR*364 15MR*365	444	1410 1460	125	¾	⅝	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅝	11	11	⅞	3	13¾ 14¼
15MR*405	444	1660	125	¾	⅝	22	17½	12	9	7¼	15/16	11¾	4½	2⅞	31¼	24⅝	11	11	⅞	3	15¼
35MR*364 35MR*365	505	1850 1900	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅝	5	3 7/16	35	30	12½	13½	1	3½	14⅝ 15⅛
35MR*405	505	2100	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅝	5	3 7/16	35	30	12½	13½	1	3½	16⅛
35MR*444 35MR*445	505	2300 2400	166	⅞	7/16	25½	21½	14	11	9	1⅛	14⅝	5	3 7/16	35	30	12½	13½	1	3½	17 18
50MR*405	§ 8	3700	265	1	½	36	34	19	14	14	1⅜	18 5/16	6½	3⅞	50½	.....	23⅛	.....	1 3/16	3½	20⅛
50MR*444 50MR*445	§ 8	3900 4000	265	1	½	36	34	19	14	14	1⅜	18 5/16	6½	3⅞	50½	.....	23⅛	.....	1 3/16	3½	20⅞ 21⅞

* The letter A, B, or C denoting Class I, II, or III motorized speed reducers respectively (see page 52) is omitted, since the dimensions of a given unit is the same, regardless of the classification.
† Units with Frame 204 and 224 motors are totally enclosed.
‡ Numbers 254 to 505 are sliding bases. The No. 8's are rails.
§ The dimensions AZ and XD for No. 8 rail are 6 in. and 24⅝ in. respectively.
For shipping weights, add 15 per cent to the above net weights.
For complete dimensions and tolerances, ask for the appropriate GEM print listed on page 78.

HOW TO SELECT AND APPLY MOTORS

THE correct selection and application of a motor involves a great many factors affecting the installation, operation, and subsequent servicing of the motor. The selection is determined in whole or in part by the user or certain intermediaries, such as the manufacturers of motor-equipped devices, based on known facts and calculations, field tests, and close study of the processes and driven machines.

While this form cannot include many special problems and conditions, it is presented as a general guide to the conditions most commonly encountered in motor application.

MOTOR-APPLICATION GUIDE FORM

POWER SUPPLY

I. Voltage

The supply voltage must be known in order to select proper motors and control. If the voltage is sustained at less than 90 per cent or more than 110 per cent of the nameplate voltage, special motors and control may be required. Larger motors, built to order, will usually be designed for the exact voltage to be maintained.

The accompanying tables indicate the preferred maximum and minimum horsepower limits for the different distribution voltages.

Approximately 90 per cent of the single-phase supply systems in the range of 100 to 125 volts are now either 115 or 120 volts.

208 volts is the common 3-phase supply voltage for 4-wire networks. Induction motors of 220-volt design will operate satisfactorily at 208 volts, although with modified operating characteristics.

Reasonable Limits

Voltage	Minimum Hp	Maximum Hp
A-c, 1-phase		
110–115–120	None	1½
220–230–240	None	10
440–550	5	10
A-c, 2- and 3-phase		
110–115–120	None	15
220–230–240	None	200
440–550	None	500
2200	40	None
4000	75	None
6600	400	None
Direct-current		
115	None	30
230	None	200
550–600	½	None

II. Phases

1. Three-phase supply most desirable, but only single-phase is offered for most residential and rural districts.

2. Two-phase power supply is found only in a few scattered areas; therefore 2-phase motors are not generally available in stock.

3. Two-winding multispeed motors are difficult to wind for two-phase; therefore transformation to allow three-phase motors is recommended.

4. If change of direction of rotation of driven machine would be disastrous, power system should be checked to determine likelihood of phase reversal; may necessitate phase-failure relays.

III. Frequency

1. 60-cycle systems predominate; 50-cycle systems in southern California and few isolated systems; 50-cycle systems common in foreign countries.

2. 60-cycle induction motors usually suitable for 50-cycle operation at same voltage, with modified characteristics.

3. 40- and 25-cycle systems isolated and relatively small, so stock motors are not generally available.

4. Higher frequencies obtainable for special high-speed-motor applications, by use of induction frequency converters or alternators.

IV. A-c Versus D-c System

For most applications, a-c supply is satisfactory, since suitable performance can usually be obtained with a-c motors and control.

Where special characteristics, such as extra-wide speed range or severe accelerating or reversing duty, are involved, conversion by means of motor-generator sets, rectifiers, and in special cases, converters, may be justified.

V. Power Rates

1. *Energy charge*—This may affect choice of motors and control, as efficiencies vary widely, particularly when speed adjustment is involved.

2. *Power-factor clause*

A. Many rate schedules incorporate a power-factor clause, adjusting the rate according to power factor; others involve penalty or bonus if power factor is, for example, below 80 per cent or above 90 per cent lagging.

B. Capacitors or synchronous motors may reduce power bill by improving power factor.

C. Synchronous motor operating at full load and rated excitation delivers to the power system leading kva equal to

$$\frac{0.746 \times \text{hp rating}}{\text{Eff} \times \text{p f}} \sqrt{1-(\text{p f})^2}$$

(At partial loads, and rated excitation, more leading kva is supplied.)

3. *Demand charge*—Most rate schedules have a demand charge giving a rate based on maximum demand in a given period of time, as well as energy consumed. Choice of motor may smooth out demand and lower the rate.

VI. Voltage Regulation

1. *Effect on motors and control*—The voltage regulation of the supply should be known in order to select motors which will deliver sufficient torque, even with the probable drop in voltage, to start and carry the load. All induction-motor torques and synchronous-motor starting torque and pull-in torque vary as the voltage squared.

2. *Effect of motors and control on supply system*

A. Starting currents

(a) On pure power circuits, high starting current may cause dips in voltage, affecting other apparatus (see VI, 1 and VII, 1).

(b) On combined light and power lines, a drop of about 2 per cent from high motor-starting current may cause objectionable light flicker. Drop of 6 per cent is sometimes permissible in case of infrequent starting (2 or 3 starts per day).

(c) Starting current can be varied through motor design or use of different control, or both. In general, a-c motors having squirrel-cage secondary have highest starting currents, while phase-wound secondary types have lowest current.

(d) Power companies usually limit the starting current which may be drawn by motors. Two types of rules are common, one type specifying the allowable number of amperes for each horsepower rating. The more recent "Increment" type of rules is based on the "capacity to serve" a given installation. Usually, the total current is not limited, but must be taken in increments or steps, the magnitude of each step being determined by the total connected load. If the locked-rotor current of the motor exceeds the allowable increment, a suitable reduced-voltage starter will be required.

B. Current pulsation

(a) Loads drawing pulsating currents from the line may cause corresponding line-voltage variations. Frequencies of pulsation in the range of 250 to 600 per minute may cause objectionable light flicker, even if the voltage variation is as small as ½ of 1 per cent.

(b) Usual limit for current pulsation is 66 per cent of motor full-load current, although the system regulation may require a limit of 30 or 40 per cent to avoid light flicker.

VII. Continuity of Power

1. Dips in voltage from switching or other line disturbances may necessitate time-delay undervoltage protection, and, in case of synchronous motors, high-torque designs and resynchronizing control. Sustained low voltage may necessitate higher-torque motors. A-c motor starting torques vary as the voltage squared.

2. If continuity of power is indispensable, standby units or automatic transfer to another power source may be required.

VIII. Short-circuit Current

The point of connection to the power system may necessitate the use of high-interrupting-capacity controllers or additional fuses or breakers of high interrupting capacity to handle the probable high short-circuit current.

IX. Voltage Surges

1. Motors supplied from high-voltage overhead power lines may be subjected to high surges in voltage, produced by lightning, switching, etc., and may require special insulation and possibly external protective equipment.

2. D-c motors on trolley circuits may be subjected momentarily to excessive voltages which also may require special designs or external protective equipment.

THE DRIVEN MACHINE

I. Mechanical Arrangement

1. *Horizontal or vertical shaft*—Arrangement of the driven machine usually determines whether horizontal or vertical motor is needed. Horizontal motors are more generally available and less expensive; most grease-lubricated ball-bearing motors will operate in either position. Fractional-hp waste-packed sleeve-bearing motors are satisfactory for short periods of vertical operation where no thrust is involved.

2. *Tilted shaft*—If momentary, this will require special construction of bearing housings for oil-ring-lubricated sleeve-bearing motors, to avoid loss of lubricant. In case of long periods of tilted operation, bearings suitable for end thrust may be necessary. Ball-bearing motors with grease lubrication are suitable for tilted operation.

3. *Inverted operation and rolling*

A. Where the driven machine requires mounting the motor with the feet above or to one side of the shaft, rearrangement of the end shields of most motors makes them suitable.

B. If the driven machine requires operation of the motor at a changing angle from the horizontal (shaft remaining horizontal) of more than 10 or 12 degrees, ball-bearing motors will usually be required. Within this angle, sleeve-bearing motors with modified oil gages are applicable.

4. *Portable machines*—A portable type of driven machine may require motors and control of greater compactness and less weight than standard, and may necessitate special bearing construction for ring-oiled sleeve-bearing motors.

5. *Method of connection*

A. *Direct connection* should always be considered where required speed coincides with available motor speed. Maintenance, efficiency, power factor, space, and initial cost will determine the choice between direct connection and other methods. When direct connection is possible, "*built-in*" construction (where parts of the driven machine are common with, and complete, the motor structure, such as shaft or bearings) should be considered.

B. *Belt drive*—Diameters and widths of pulleys or sheaves and center distances are factors in determining motor-bearing pressures and shaft deflection. The table on page 98 shows limits for two-bearing motors and limits of good practice for belting. Flat belts should not run at greater speeds than about 5000 feet per minute. Flat belting of vertical-shaft motors is difficult.

C. *Chain drive*—Very conservative limits are shown in the table on page 98. The chain manufacturer should be consulted when higher horsepower and speed ratings are involved, so that the best drive from the standpoints of quietness and economy of operation may be selected.

Horsepower Limits for Two-bearing Motors (Belt Drive)

Motor Speed, Rpm	Flat-belt Drive, Max Hp	V-belt Drive, Max Hp
1700–1800	40	60; ball-brg, 75
1440–1500	40	60; ball-brg, 75
1150–1200	75	100; ball-brg, 125
850–900	125	200
680–720	200	300
560–600	200	300
500–514	150	300
440–450	150	250

Horsepower Limits for Two-bearing Motors (Chain Drive)

Motor Speed, Rpm	Maximum Hp
1700–1800	5
1440–1500	10
1150–1200	25
850–900	50
720–750	75

D. *Gear drive*—Compactness and arrangement of drive often indicate "gear-motors," obtainable in a variety of mechanical constructions with speed ratios of 3 to 1 upwards and generally limited to about 75 hp maximum.

Where the pinion of ordinary spur gearing is mounted on the motor shaft, two-bearing motors should be limited to horsepower ratings shown in "chain-drive" table above.

Maximum pitch-line speed with steel pinions is about 1300 feet per minute.

6. *Space limitations*—Space limitations may affect the choice of motor and require (a) built-in construction, (b) gear-motor, (c) forced ventilation using an external blower, or (d) small frame with Class B insulation permitting higher temperature rise.

II. Speeds, Speed Range and Regulation

1. *Speeds*—The operating speed, or a number of speeds, or the speed range of a driven machine will influence the type of motor and control.

2. *Speed range*—Where more than one speed or a range of speeds is required, one of the following types may be applicable, depending upon the power supply and the speed range required. Those marked (*) have relatively wide speed regulation, which may make them unsuitable for some loads.

Types and Speed Ranges

Type	Speed Range
Single-phase, A-c	
*A. Brush-shifting repulsion motor	2½:1
*B. Capacitor-motor with tapped winding	2:1
C. Multispeed capacitor-motor	2 or 3 fixed speeds
Polyphase, A-c	
A. Multispeed squirrel-cage	2, 3, or 4 fixed speeds
*B. Wound-rotor motor	2:1
*C. 2-speed wound-rotor motor	4:1
D. Brush-shifting shunt motor	4:1
*E. Brush-shifting series motor	3:1
F. Squirrel-cage motors with variable frequency supply	Very wide range
G. Speed Variator	Very wide range

Types and Speed Ranges (Cont)

Type	Speed Range
Direct-current	
A. Shunt-wound standard "constant-speed" motor with field control	2:1 in some cases
*B. D-c motor with armature control	Wide
C. Adjustable-speed motor	From 3:1 to 6:1
D. Shunt motor with adjustable voltage supply	Very wide

3. *Speed regulation*—The maximum speed regulation (variation in speed with load) allowable by the driven machine may vary from zero to a high percentage. In case of zero speed regulation, synchronous motors are required. Series-type motors have inherently wider speed regulation than shunt (and squirrel-cage) types.

III. Synchronized Operation

Some driven machines have to operate in synchronism with other machines, necessitating synchronous motors or Selsyn equipment.

IV. Direction of Rotation and Reversing

The driven machine may operate in one direction only or may be of the reversible type. Most types of motors can be ordered for reversing operation, using a suitable controller. If the driven machine will be damaged by operation in the wrong direction, phase-reversal relays or reversing protection switches may be required.

V. Hp Requirement

The horsepower required by the driven machine determines the motor rating. Where the load varies with time, a horsepower vs. time curve will permit determining the peak horsepower required and the calculation of the root-mean-square (rms) hp indicating the proper motor rating from a heating standpoint. In case of extremely large variations in load or where shutdown, accelerating, or decelerating periods constitute a large portion of the cycle, the rms horsepower may not give a true indication of the equivalent continuous load, and the motor manufacturer should be consulted.

Where the load is maintained at a constant value for an extended period (varying from 15 minutes to 2 hr, depending on the size), the horsepower rating required will usually not be less than this constant value, regardless of other parts of the cycle.

If the driven machine is to operate at more than one speed, the horsepower required at each speed must be determined.

VI. Torques

The torque required to operate the driven machine at every moment between initial breakaway and final shutdown is important in determining the type of motor. A torque-speed curve is desirable and sometimes essential.

1. *Starting torque*—The starting torque or breakaway torque required by the driven machine may be as low as 10 per cent, as in the case of medium-size centrif-

ugal pumps, or as high as 225 to 250 per cent of full-load torque, as in the case of a loaded reciprocating two-cylinder compressor. The breakaway torque may vary greatly at different times because of frequency of start, temperature changes, type and amount of lubricant, etc. The motor torque available at the shaft must be well above the torque required by the driven machine, taking into consideration these variables as well as the possibility of low voltage and the type of starter used.

2. *Acceleration*—The torque required after breakaway for acceleration to full speed varies with different driven machines, remaining at a rather high value throughout acceleration for such machines as loaded compressors and plunger pumps. The torque delivered by the motor must at all points up to full speed be in excess of the torque required by the driven machine. The greater this excess torque, the faster will be the acceleration. The approximate time required for acceleration from rest to full speed =

$$\frac{\text{rpm} \times \text{WR}^2}{\text{T} \times 308} \text{ (in seconds)}$$

where rpm = full-load speed in revolutions per min
T = torque = average ft-lb available for acceleration
WR^2 = lb-ft squared (inertia) of rotating parts

If the time to accelerate is greater than about 20 seconds, special motors or starters may be required to avoid overheating.

3. *Running torque*—The running torque is determined by the horsepower and speed of the driven machine, and at any given point the torque in lb-ft $= \frac{5250 \times \text{hp}}{\text{speed in rpm}}$.

The peak horsepower determines the maximum torque required by the driven machine. The motor must have a breakdown, or maximum running, torque in excess of this figure in order to avoid stalling. Certain driven machines, like reciprocating compressors, have load torques which pulsate periodically. To prevent excessive pulsation in the line current of the motor, proper flywheel effect (WR^2) must be provided either in the motor or the driven machine. Where synchronous motors are used, the flywheel effect must be made such that the natural frequency of the motor does not approximate the frequency of any impulses in the load torque. Natural frequency in cycles per minute $= \frac{35200}{\text{rpm}} \sqrt{\frac{\text{Pr} \times \text{f}}{\text{WR}^2}}$ where WR^2 = weight in lb × (radius of gyration in ft)^2 (motor and load), rpm = speed in revolutions per minute of motor, f = line frequency, Pr = synchronizing power of motor in kilowatts per electrical radian.

VII. Inertia (WR^2) of Driven Machine

The inertia or flywheel effect (WR^2) of the rotating parts of the driven machine affect the accelerating time and, therefore, the heating of motors and control, particularly where reversing duty or frequent starting is involved. (See above paragraph VI, 2 on Acceleration.)

In case synchronous motors are applied, the WR^2 must be known, since the pull-in torque required of this motor varies approximately as the square root of the total WR^2 (motor and load).

The WR^2 of a rotating member of the driven machine which operates at a different speed from that of the motor may be converted to an equivalent value at the motor shaft by multiplying by

$$\left(\frac{\text{rpm of rotating member}}{\text{rpm of motor}}\right)^2.$$

VIII. Thrust

The driven machine may impose an axial thrust on the motor bearings. This is particularly true of such machines as propeller-type fans and deep-well pumps.

Ball bearings are useful in taking thrust, and standard ball-bearing motors may often furnish sufficient thrust capacity. Extremely heavy thrusts may require special plate-type oil-lubricated bearings.

IX. Balance

Certain driven machines, such as precision grinders, require motors which are specially balanced to give very small amplitudes of vibration. This is necessary to insure high quality of the finished product.

X. End Play

Certain driven machines require motors with limited or zero end play and may necessitate the use of motors with preloaded ball bearings or sleeve bearings with end-play-limiting devices.

XI. Frequency of Starting

The frequency of starting the driven machine affects the motor and control by increasing their heating, particularly where accelerating time is prolonged by high WR^2 and high load torques. In general, driven machines starting more than 4 to 6 times per hour may require special motors and control.

XII. Deceleration

Some driven machines must be decelerated quickly and will require control for dynamic braking of synchronous motors and direct-current motors or perhaps plugging of induction motors.

XIII. Operating Schedule

Where the driven machine operates for a large number of hours per year, motors with higher efficiency may often be justified, even at higher prices. Where fractional-horsepower motors are involved, higher-efficiency "long-annual-service" designs are available for application to machines operating for more than 1000 hr per year.

XIV. Method of Control

Magnetic controllers may be required to permit remote operation or automatic operation of the driven machine in response to temperature or pressure variation, level changes, etc.

SURROUNDING CONDITIONS

I. Ambient Temperature

Normal ambient temperature is assumed to be not more than 40 C. For ambient temperatures exceeding 40 C, Class A insulated motors with lower temperature rise may be used as long as the total temperature (ambient plus rise) does not exceed 90 C for open motors and 95 C for enclosed motors. These limits may

be raised to 110 C for open motors and 115 C for enclosed motors by using Class B insulation.

An ambient temperature lower than about 0 C (32 F) may necessitate a change to lighter lubricant.

II. Altitude

No change in design is considered necessary for most electric machines for altitudes not exceeding 3300 ft above sea level. For higher altitudes, the temperature rise of electric machinery generally will increase approximately 1 per cent for each 330 ft increase in altitude above 3300 ft.

III. Surrounding Atmospheres

1. *Excessive moisture*—Driven machines in atmospheres filled with steam or excessive moisture may necessitate special-insulation low-voltage designs, and/or enclosed motors and control.

2. *Corrosive or solvent atmospheres*—Where corrosive or solvent atmospheres harmful to insulation are involved, totally enclosed or enclosed ventilated equipment is preferable, although open motors with special insulation may, in some cases, be sufficient.

3. *Explosive atmospheres*—Explosive atmospheres of both gaseous and dusty nature are classified by the National Electrical Code as follows:

Class I, Group A, atmospheres containing acetylene.

Class I, Group B, atmospheres containing hydrogen or gases or vapors of equivalent hazard, such as manufactured gas.

Class I, Group C, atmospheres containing ethyl-ether vapor.

Class I, Group D, atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer-solvent vapors, and natural gas.

Class II, Group E, atmospheres containing metal dust.

Class II, Group F, atmospheres containing carbon black, coal or coke dust.

Class II, Group G, atmospheres containing grain dust.

Local inspection authorities will usually determine the degree of hazard involved for a given installation, Group A being the most hazardous of the first class, and Group E the most hazardous of the second class.

Explosion-proof motors and control, utilizing the wide-flange principle, are available in generally used ratings for Class I, Group D, locations. Alternatives are enclosures filled with inert gas, or pipe-ventilated equipment. Apparatus for Groups A, B, and C require special designs, not generally available.

Special approved dust-tight motors and control are available in most ratings for Class II, Group G, dust locations, with alternative of pipe-ventilated equipment. Atmospheres of the more hazardous Group E and F dust conditions may require special dust-tight designs (not generally available) or pipe-ventilated equipment.

4. *Dusty atmospheres*—Dusty atmospheres (not explosive) of an abrasive or conducting nature usually necessitate the use of dust-tight enclosed apparatus.

As an alternative, pipe-ventilated equipment may be used, and in some cases, open motors with special insulation may suffice.

Where lint is present, such as in parts of textile mills, standard screenless open-type or enclosed non-ventilated motors are preferable.

5. *Outdoor conditions*—Outdoor application usually necessitates total enclosure for protection against rain and snow. A change in lubricant with seasonal temperature changes may be necessary. Splashproof or protected-type motors should usually be restricted to low voltage and mild climate. Special weather-resisting finishes are necessary in all cases, and periodic painting by the user with weather-resisting paint is advisable.

IV. Water

Where operation for long periods under water is required, special enclosed equipment, with counter air pressure to prevent the entrance of water, is usually necessary.

For occasional flooding or submersion, extremely tight totally enclosed nonventilated motors equipped with stuffing boxes may suffice.

Where "hosing down" or splashing of water is involved, splashproof motors will usually meet all but extreme conditions, the latter requiring enclosed motors.

V. Quietness

Installations in residences and in public buildings, such as theaters, hospitals, and schools, may require the use of quiet motors and sound-isolating bases. In many cases, special building layout and construction may be needed to insure the necessary degree of quietness.

VI. Codes, Standards, Ordinances

Motors and control must conform to local and national standards, such as shown below, in order to (a) permit connection of power, (b) satisfy safety and fire requirements, and (c) permit lowest insurance rates.

A. *NEMA standards* which recommend certain mounting dimensions for induction motors and, in general, minimum performance characteristics for all types of motors and control.

B. *AIEE standards* which specify temperature limits for insulation materials and prescribe the methods of rating and testing apparatus.

C. *National Electrical Code* which is the general guide of inspectors in determining the acceptability of enclosures, protection, and installation of motors.

D. *State laws* which stress safety and reduction of fire hazards.

E. *City ordinances* which may specify particular construction considered necessary locally to avoid fires and accidents.

HOW TO SELECT MOTORS

MOTORS—ELECTRICAL TYPES AND CHARACTERISTICS

THE preceding guide form outlined many of the fundamental considerations involved in determining the type of motor best suited to a given job. The various mechanical constructions mentioned are described in previous sections of this catalog. The electrical characteristics, however, have not thus far been outlined. The following pages give a rather comprehensive over-all view of the different electrical types and characteristics. Included are curves which show the relationship of speed, torque, and current for the different types. These data will help you in selecting the motor best suited to meet the conditions determined by checking the guide form.

The following different electrical types of motors are described:

Single-phase motors
Polyphase motors
Direct-current motors
Synchronous motors

ELECTRICAL TYPES AND CHARACTERISTICS OF SINGLE-PHASE MOTORS

The single-phase motor was one of the earliest designs of alternating-current motors developed. It has been perfected throughout the years from the original repulsion type into many improved types, such as the modern split-phase motor and the capacitor-motor.

The principal uses of single-phase motors are domestic in character—clocks, appliances, etc. Industry also uses them to a large extent on single-phase feeder lines and on lighting circuits—for operating power tools, fans, blowers, heating and air conditioning units, etc.

A description of the important electrical types follows.

TYPE KH SPLIT-PHASE MOTORS

This motor is one of the most useful fractional-horsepower types. It employs a squirrel-cage rotor for constant-speed operation. It has a starting winding of high resistance, which is physically displaced in the stator from the main winding. This displacement, plus the electrical phase displacement produced by the relative electrical resistance values in the two windings, creates starting ability similar to that of a polyphase motor. A centrifugal switch transfers the motor from the starting to the running condition during operation. A typical speed-torque curve is shown in Fig. 2.

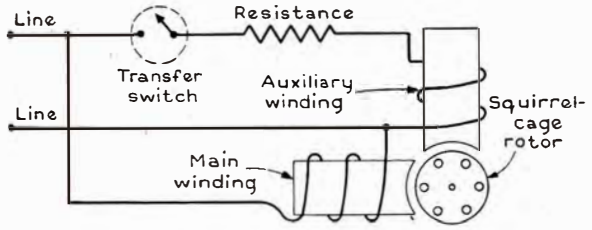


Fig. 1
Schematic diagram for Type KH motor

TYPE KSP SHADED-POLE MOTORS

Where the power requirements of the drive are small, up to 10 or 15 watts—*i.e.*, instruments, toys, hair dryers, small fans, etc.—this motor is economical to select. It obtains its starting ability by a short-circuited ring embedded off center in the pole fan. This ring obtains an induced field, delayed in magnetic timing in relation to the main field, to produce a starting torque. A typical speed-torque curve of these motors is shown in Fig. 4.

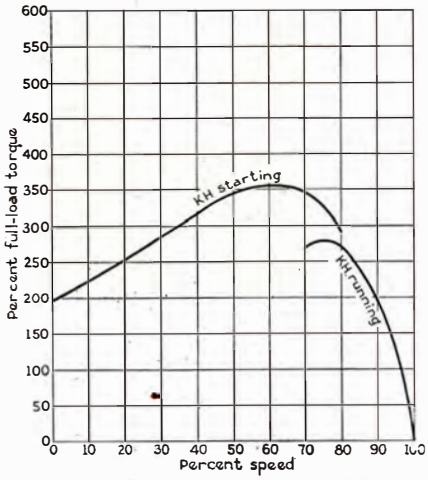


Fig. 2
Typical speed-torque curve of Type KH motor

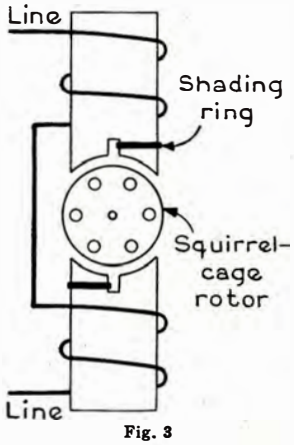


Fig. 3
Schematic diagram for Type KSP motor

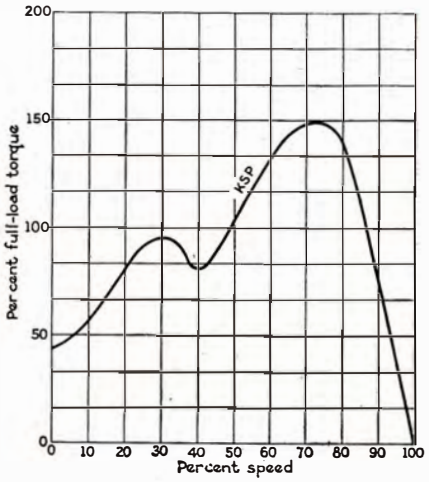


Fig. 4
Typical speed-torque curve of Type KSP motor

TYPE P SERIES, VARYING-SPEED UNIVERSAL MOTORS

The universal motor is designed for use on either alternating or direct current. It is of the series-wound type, that is, it is provided with a field winding on the stator, which is connected in series with a commutating winding on the rotor. Full-load speeds generally range from 5000 to 10,000 rpm with no-load speeds from 12,000 to 18,000 rpm. Typical applications are portable tools, office appliances, electric cleaners, kitchen appliances, etc.

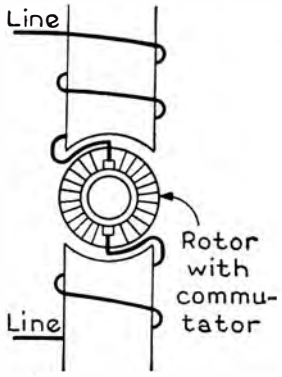


Fig. 5
Schematic diagram for Type P motor

(For speed-torque curves, see Fig. 14)

TYPE SCR REPULSION-INDUCTION MOTORS

In addition to a single-phase stator winding, the repulsion-induction motor employs two rotor windings, one a cast squirrel-cage and the other a wire-wound repulsion winding terminating on a commutator. The commutator brushes are short-circuited. Currents induced in the short-circuited winding produce a field which acts with the main field to produce starting torque, and to give repulsion characteristic, similar to those of a series motor. The torque produced is a result of the characteristics of the repulsion and squirrel-cage windings. Near synchronism, the squirrel-cage winding predominates in its effect, and the motor runs as an induction motor.

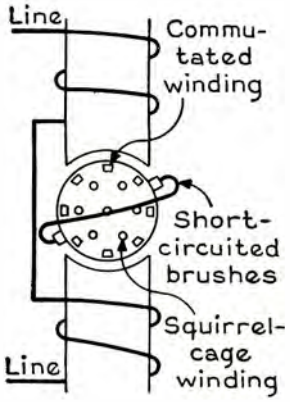


Fig. 6
Schematic diagram for Type SCR motor

TYPES KCP, KC, AND KCJ CAPACITOR-MOTORS

The capacitor-motor obtains its starting torque from a rotating magnetic field produced by two stator windings physically displaced. The main winding is connected directly across the line, while the auxiliary, or starting, winding is connected to the line through one or more units of series capacitors. Thus, the current in each winding will be out-of-phase electrically.

The simplest type, mechanically, is the low-torque, permanent-split capacitor-motor, Type KCP. A capacitor is permanently connected in series with the auxiliary winding. The capacitor is selected to give quiet operation and good operating efficiency, and the starting torque is suitable for direct-connected drives requiring low starting torque, *i.e.* fan, blowers, certain types of centrifugal pumps, etc. This type of motor can be arranged for adjustable-varying speed by use of a tapped winding or autotransformer regulator.

Higher starting torques are obtainable in two lines—"normal-starting-torque," Type KC (integral-hp sizes only, as Type KH motors are used for moderate torque in fractional-hp sizes) and "high-starting-torque," Type KCJ (Type KC in fractional-hp sizes).

The size of capacitor and the electrical balance of the two windings determine the starting ability. Both capacitor-start, induction-run, and capacitor-start, capacitor-run, designs are used, depending on the size and torque required.

In the "induction-run" design, the capacitor and auxiliary winding are switched out completely at 70 per cent speed during starting by a centrifugal mechanism and a switch or voltage relay.

In the "capacitor-run" design, there are two capacitors. One of these is switched out during starting, leaving the other capacitor and the auxiliary winding in the circuit during running.

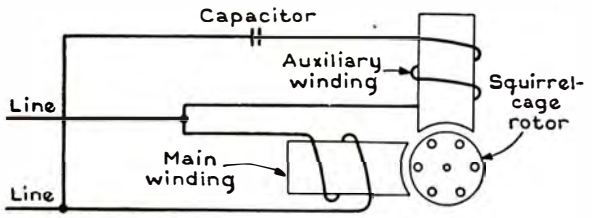


Fig. 7
Schematic diagram for permanent-split capacitor-motor, Type KCP

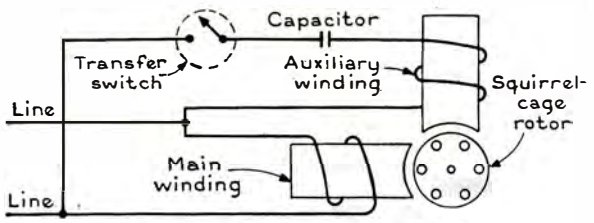


Fig. 8
Schematic diagram for capacitor-start, induction-run capacitor-motor, Type KC

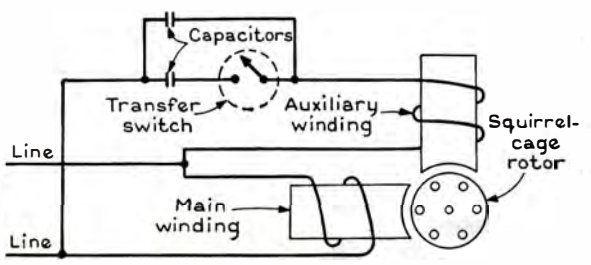


Fig. 9
Schematic diagram for capacitor-start, capacitor-run capacitor-motor, Type KCJ

Speed-torque Curves of Single-phase Motors

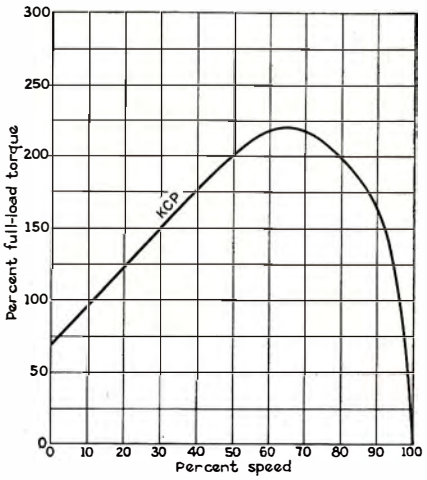


Fig. 10
Typical speed-torque curve of permanent-split low-starting-torque capacitor-motor, Type KCP

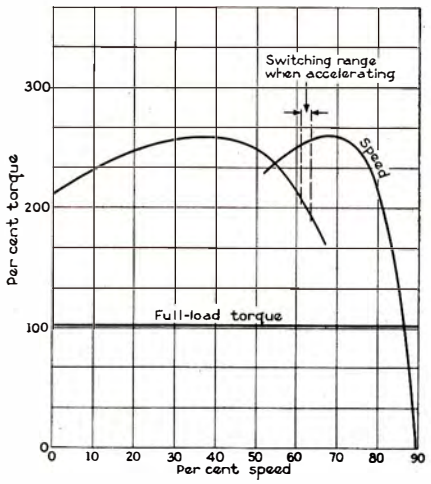


Fig. 11
Typical speed-torque curve of normal-starting-torque capacitor-motor, Type KC (integral-hp sizes)

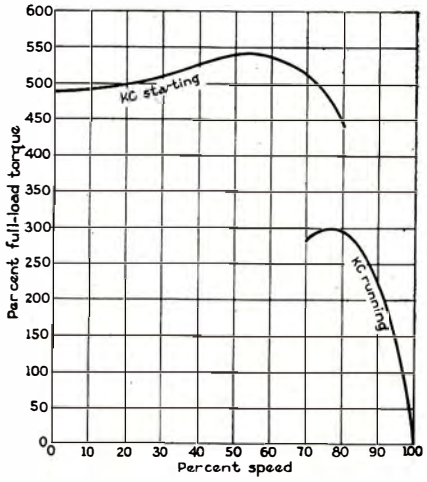


Fig. 12
Typical speed-torque curves of high-starting-torque fractional-hp capacitor-motors, Type KC

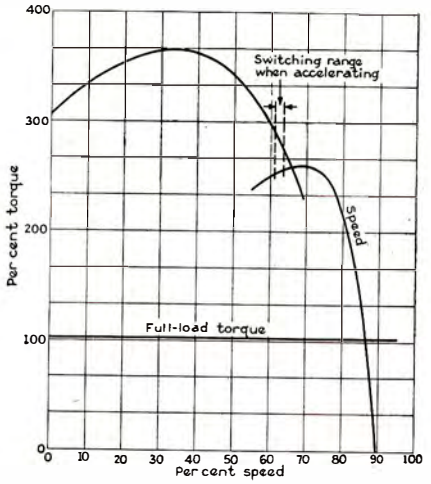


Fig. 13
Typical speed-torque curves of high-starting torque integral-hp capacitor-motors, Type KCJ

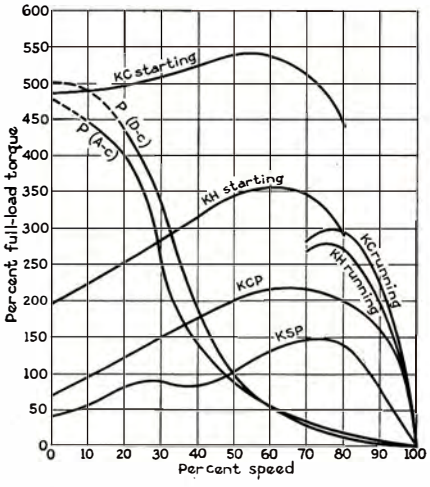


Fig. 14
A comparison of typical speed-torque curves of fractional-horsepower single-phase motors

ELECTRICAL TYPES AND CHARACTERISTICS OF POLYPHASE MOTORS

With the invention of the induction motor by Tesla in 1888, there became available both wound-rotor and ordinary squirrel-cage types. The limited capacity of the early supply systems forced the extensive use of wound-rotor motors. As a-c systems grew in capacity, the squirrel-cage motor came into greater use, but pending the development of the technique of special squirrel-cage designs, many intermediate types of wound-rotor motors came into use for a limited period. Among them were the wound-rotor motor with manually operated collector-short-circuiting mechanism, the wound-rotor motor with internal resistances and hand-operated short-circuiting device, and later the wound-rotor motor with internal resistances automatically short-circuited in steps by a centrifugal mechanism.

With the advent of different types of squirrel-cage motors, practically all of these intermediate types passed out of the picture because of their susceptibility to abuse by operators and their sensitiveness to voltage variation. Today, the requirements for integral-horsepower polyphase motors are rather well covered by three types of squirrel-cage motors (two of them being special-purpose machines) and the wound-rotor motor. Of course, devices for these motors are playing an increasingly important part in their proper application in industry.

WOUND-ROTOR MOTORS

Curves on Fig. 1 indicate the speed-torque, speed-current characteristics of the wound-rotor motor (Type M) with rings short-circuited and full voltage applied. These are merely reference curves, inasmuch as the wound-rotor motor is practically never started with rings short-circuited, because of the uncertain value of initial starting torque under this condition, and because of the high starting current. Even with low values of secondary resistance (20 per cent or less), the torque at zero speed will vary appreciably with the position of the rotor, and with no external resistance in the secondary circuit (with rings short-circuited), the starting torque may actually be zero.

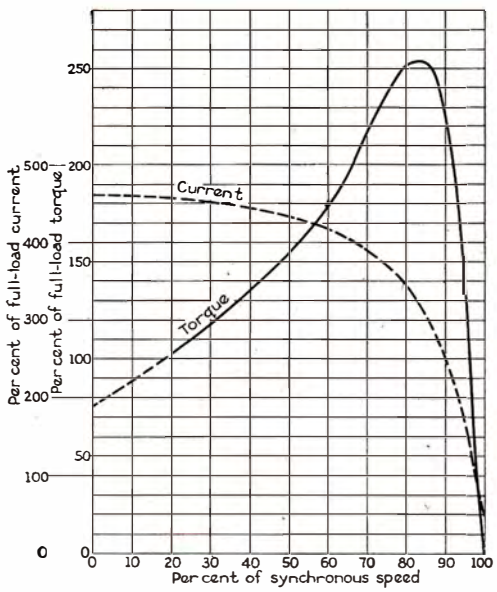


Fig. 1
Typical speed-torque and speed-current curves of Type M motor, for short-circuited rotor condition

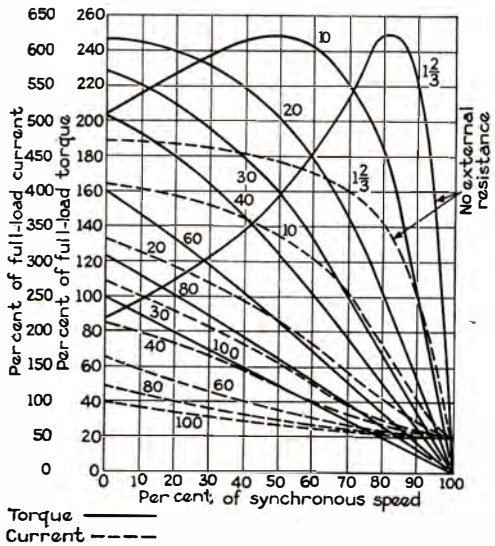


Fig. 2
Typical speed-torque and speed-current curves of wound-rotor induction motor, Type M

Fig. 2 shows the various speed-torque curves and corresponding speed-current curves obtainable with a wound-rotor motor using different values of external secondary resistance. The numbers on the curves indicate the secondary (rotor) circuit resistance in per cent of the value required to give full-load torque at standstill.

SQUIRREL-CAGE MOTORS

The squirrel-cage motor is highly dependable, reliable, and economical. General Elecrtic builds three basic types of squirrel-cage motors in the moderate sizes listed in this catalog. These types are the:

Normal-starting-torque, low-starting-current, Type K
High-starting-torque, low-starting-current, Type KG
High-starting-torque, high-slip, Type KR.

Normal-torque, Low-starting-current Type K (Code F—in Sizes Larger Than 15 Hp)

In order to meet the increasing demand for motors acceptable for full-voltage starting, the new Tri-Clad motors, in the general-purpose normal-torque types, have been designed with low starting current and with starting and running characteristics which make them applicable wherever previous Types K and KF motors have been used. The type letter *K* is used throughout for normal-torque motors, but is supplemented by a code letter stamped on the nameplate indicating, in terms of locked-rotor kva per horsepower, the low-current design now available as standard in Tri-Clad motors.

The starting currents of this new line make these motors acceptable for full-voltage starting to many

power companies throughout the country, including such companies as:

Brooklyn Edison Co.
Commonwealth Edison Co., Chicago
Consolidated Gas, Electric Light and Power Co., Baltimore (some restrictions)
Hartford (Conn.) Electric Light Co.
New York Edison Co.
Low Angeles Bureau of Light, Dept. of Water and Power

This is the most popular type of squirrel-cage motor for general-purpose applications. Fig. 3 shows typical speed-torque and speed-current curves of this motor.

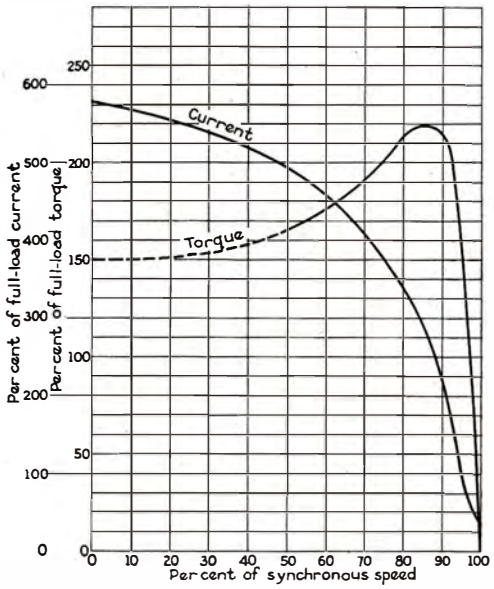


Fig. 3
Normal-starting-torque, low-starting-current squirrel-cage motor, Type K

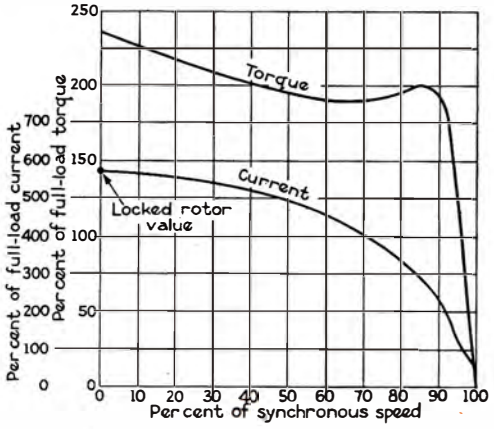


Fig. 4
High-starting-torque, low-starting-current squirrel-cage motor, Type KG

High-starting-torque, Low-starting-current Motor, Type KG

This motor was developed principally for automatic compressor applications where high starting torque with magnetic control and full-voltage starting was desired. Fig. 4 shows typical torque and current characteristics of this type of motor.

The Type KG motor has the famous Valv-amp rotor, an original G-E development.

High-starting-torque, High-slip Motor, Type KR

This motor has high starting torque and high running slip, obtained largely by an increase in the resistance of the rotor winding. Its high starting torque is utilized in applications like winches, capstans, etc., where high starting torque is needed, but where full-speed running time is short. This motor is also used, because of its high slip, for punch-press and similar applications where flywheels are involved. Fig. 5 shows typical torque and current characteristics of this motor.

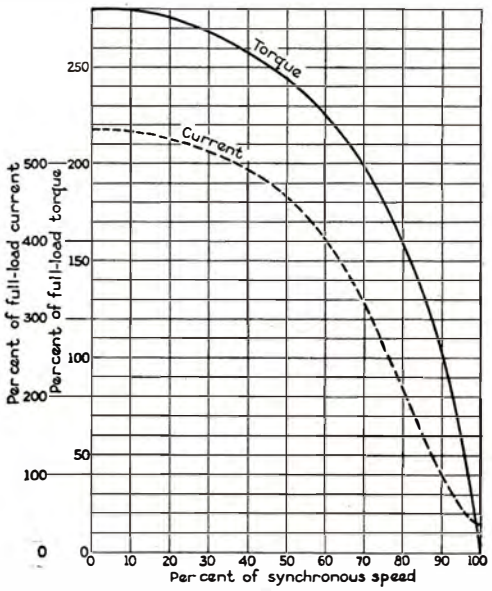


Fig. 5
High-starting-torque, high-slip squirrel-cage motor, Type KR

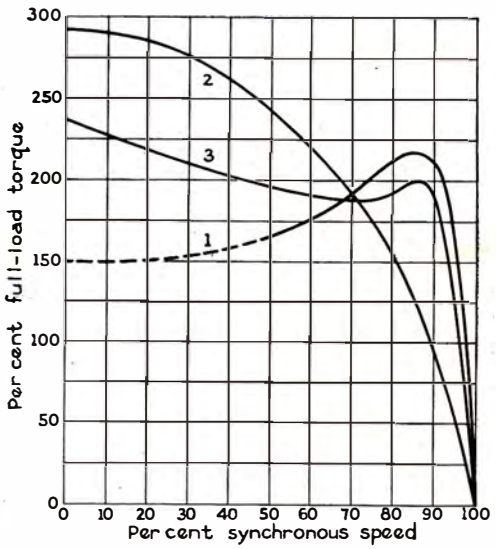


Fig. 6

1. **Normal-starting-torque, low-starting-current, Type K**
2. **High-starting-torque, high-slip, Type KR**
3. **High-starting-torque, low-starting-current, Type KG**

General Comparison of Types

Fig. 6 shows typical speed-torque curves for the three general types of squirrel-cage motors.

Similarly, Fig. 7 shows typical current curves for the three types of squirrel-cage motors described.

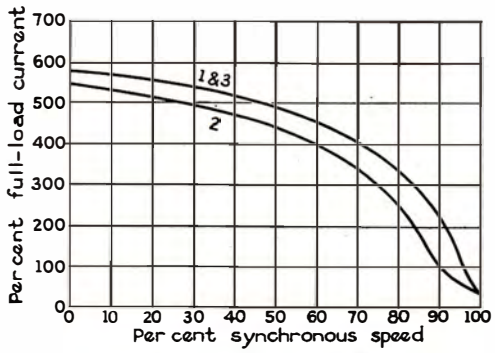


Fig. 7
Speed-current curves for squirrel-cage motors

1. **Normal-starting-torque, low-starting-current, Type K**
2. **High-starting-torque, high-slip, Type KR**
3. **High-starting-torque, low-starting-current, Type KG**

HEATING

Open Motors

All open, continuously rated, 25-, 30-, 40-, and 60-cycle polyphase induction motors, when operated at rated voltage and frequency, will carry full load continuously without exceeding 40 C rise on the coil windings, cores, and mechanical parts in contact with or adjacent to the insulation.

This temperature rise applies to Class A insulation and is based on an ambient temperature (temperature of the cooling medium surrounding the motor) not exceeding 40 C, and an altitude not greater than 1000 meters (3300 feet) above sea level.

Open, continuously rated, 40 C rise, 60-cycle induction motors will operate continuously on 50 cycles at rated load and voltage without exceeding 50 C rise.

Splashproof and Dripproof Motors

Standard splashproof and dripproof motors, when operated at rated voltage and frequency, will carry full load continuously without exceeding 50 C rise under standard conditions of temperature and altitude.

Totally Enclosed and Totally Enclosed, Fan-cooled Motors

All totally enclosed, nonventilated, and totally enclosed, fan-cooled, continuously rated motors will carry full load continuously without exceeding 55 C rise under standard conditions of temperature and altitude.

SERVICE FACTOR

Open Motors

All open, continuously rated, 40 C rise polyphase induction motors, (except Type KR), when operated at rated voltage and frequency, will carry continuously 1.15 times their rated load, with possible slight differences in efficiency and power factor from those at rated load.

Totally Enclosed; Totally Enclosed, Fan-cooled; Splashproof; and Dripproof Motors

Because of the restricted ventilation and higher temperature rise at which these motors operate, the above service factor does not apply.

RATED SPEED

The rated full-load speed is an approximate value, but will always equal or exceed the published value, except in the case of wound-rotor motors where the speed is affected by the resistance of the secondary cables and control, and except in the case of high-slip Type KR motors for which average speed is shown. If a specific value of full-load speed is required, refer to the nearest G-E office.

ALLOWABLE VARIATION FROM RATED FREQUENCY AND VOLTAGE

1. All polyphase induction motors will operate successfully at rated load and voltage with frequencies not more than 5 per cent above or below the rated frequency, but not necessarily in accordance with the standards established for operation at normal rating.
2. All motors will operate successfully at rated load and frequency with voltage not more than 10 per cent above or below rated voltage, but not necessarily in accordance with the standards established for operation at normal rating.
3. All motors will operate successfully at rated load with combined variation in voltage and frequency not more than 10 per cent above or below the rating, provided the limits of variation given in paragraphs (1) and (2) are not exceeded, but not necessarily in accordance with the standards established for operation at normal rating.

EFFICIENCIES

The efficiencies for polyphase induction motors take into consideration the stray-load losses and are determined in accordance with the AIEE Test Code and ASA Standards.

The efficiencies of vertical ball-bearing motors, when the motors are operating with no-thrust load, are the same as those of the corresponding horizontal motors of the same rating, type, and frame size.

If extra load is supported by the motor bearings; for example, the weight and thrust of the impeller of a direct-connected centrifugal pump; suitable allowance must be made for the additional bearing losses when calculating the over-all efficiency of the unit.

Data from the ball-bearing manufacturers indicate this loss to be approximately 0.0075 hp per 100 rpm per 1000-lb-thrust load.

Example

Wanted 75 hp, 1800 rpm with 1500-lb additional thrust load. Full-load speed 1775 rpm.

$0.0075 \times 17.75 \times 1.5 = 0.1997$ hp additional loss.

No-thrust efficiency = 91%.

$\frac{75 \text{ hp}}{0.91} = 82.5$ hp input.

$\frac{75 \text{ hp}}{82.5\text{-hp} + 0.1997 \text{ hp}} = 90.7\%$

STARTING TORQUES

Normal-starting-torque, Normal-starting-current, and Normal-torque, Low-starting-current Motors

The starting torque of normal-starting-torque, normal-starting-current, and normal-starting-torque, low-starting-current, 25- and 60-cycle, general-purpose, polyphase squirrel-cage induction motors with rated voltage and frequency applied at the instant of starting,

will not be less than the following percentage of full-load torque for belted applications:

For 2 poles—150%
For 4 poles—150%
For 6 poles—135%
For 8 poles—125%
} of full-load torque

For 10 poles—120%
For 12 poles—115%
For 14 poles—110%
For 16 poles—105%
} of full-load torque

NOTE.—Motors above the two-bearing belted range, listed for direct connection only, will have not less than 100 per cent starting torque. These motors are used principally for driving centrifugal pumps, fans, and blowers, and the starting torque is ample for such applications.

High-starting-torque, Low-starting-current, Continuous-rated Motors

The starting torque of high-torque, low-starting-current motors, 4, 6, and 8 poles, will be approximately 250 per cent of full-load torque for those ratings built in Frames 225 to 326 inclusive. Larger ratings, 4, 6, and 8 poles, up to 100 hp, will have approximately 200 per cent of full-load torque.

Nine-per-cent slip, Continuous-rated, Open, 40 C Rise Motors

High-slip (7 to 11 per cent), relatively low-starting-current, 4-, 6-, and 8-pole, squirrel-cage induction motors will have a minimum starting torque of 270 per cent in Frames 204 to 326, and 300 per cent in Frames 364 and larger.

Wound-rotor, Continuous-rated, 40 C Motors

The starting torque of a wound-rotor induction motor depends upon the value of the external starting resistance. A starting torque approximately equal to the breakdown torque of the motor can be obtained by using the proper value of starting resistance. Starting resistors normally furnished with wound-rotor motors are designed to give 150 per cent torque at standstill on the first point of the controller. With the controller in this position, the motor will draw approximately 150 per cent current from the line.

30- and 40-cycle, Open, Continuous-rated, 40 C Rise Motors

Motors for operation on 30 and 40 cycles will have approximately the same percentage of starting torque as the 25- and 60-cycle motors of the same horsepower, speed, and type.

STARTING CURRENTS

Newly designed Type K motors, former Type KF, and all Type KG motors will, in general, have starting currents not greater than the values shown below.

Rated Horsepower	Amperes at 220 Volts	Rated Horsepower	Amperes at 220 Volts
1	27	20	290
1½	37	25	365
2	47	30	435
3	60	40	580
5	90	50	725
7½	120	60	870
10	150	75	1085
15	220		

The current drawn from the line by a motor when started with a compensator, for various taps will be as follows: On 80-per-cent tap of the compensator, the current drawn from the line will be 64 per cent of the locked-rotor current; on the 65-per-cent tap, the current drawn from the line will be 42 per cent of the locked-rotor current; on the 50-per-cent tap, the current taken from the line will be 25 per cent of the locked-rotor current; as given for any particular motor.

ALTITUDE

Standard motors are designed to operate in altitudes up to 1000 meters (3300 feet) at rated load, voltage, and frequency without exceeding the temperature rise stamped on nameplate.

When it is desired to operate such motors in higher altitudes (see Note below), the temperature rise in degrees C can be determined by the following formula:

$$\text{Temperature rise at specified altitude} = \frac{T}{1.00 - \frac{A - 3300}{330 \times 100}}$$

Where T = Temperature rise in degrees C at sea level

A = Required altitude in feet.

NOTE.—No correction in temperature rise is made for altitudes less than 1000 meters (3300 feet).

General Effect of Voltage and Frequency Variation on General-purpose Induction-motor Characteristics

■ = Increase ▲ = Decrease

		Starting and Maximum Running Torque	Synchronous Speed	% Slip	Full-load Speed	EFFICIENCY Full Load	EFFICIENCY ¾ Load	EFFICIENCY ½ Load	POWER FACTOR Full Load	POWER FACTOR ¾ Load	POWER FACTOR ½ Load	Full-load Current	Starting Current	Temperature Rise, Full Load	■ Maximum Overload Capacity	Magnetic Noise, No Load in Particular
Voltage Variation	120% Voltage	■ 44%	No change	▲ 30%	■ 1.5%	■ Small	▲ ½ to 2 points	▲ 7 to 20 points	▲ 5 to 15 points	▲ 10 to 30 points	▲ 15 to 40 points	▲ 11%	■ 25%	▲ 5 to 6 C	■ 44%	■ Noticeable
	110% Voltage	■ 21%	No change	▲ 17%	■ 1%	■ ½ to 1 point	Practically no change	▲ 1 to 2 points	▲ 3 points	▲ 4 points	▲ 5 to 6 points	▲ 7%	■ 10 to 12%	▲ 3 to 4 C	■ 21%	■ Slight
	Function of Voltage	(Voltage)²	Constant	1 / (Voltage)²	(Syn speed slip)	—	—	—	—	—	—	—	Voltage	—	(Voltage)²	—
	90% Voltage	▲ 19%	No change	■ 23%	▲ 1½%	▲ 2 points	Practically no change	■ 1 to 2 points	■ 1 point	■ 2 to 3 points	■ 4 to 5 points	■ 11%	▲ 10 to 12%	■ 6 to 7 C	▲ 19%	▲ Slight
Frequency Variation	105% Frequency	▲ 10%	■ 5%	Practically no change	■ 5%	■ Slight	■ Slight	■ Slight	■ Slight	■ Slight	■ Slight	▲ Slight	▲ 5 to 6%	▲ Slight	▲ Slight	▲ Slight
	Function of Frequency	1 / (Frequency)²	Frequency	—	(Syn speed slip)	—	—	—	—	—	—	—	1 / Frequency	—	—	—
	95% Frequency	■ 11%	▲ 5%	Practically no change	▲ 5%	▲ Slight	▲ Slight	▲ Slight	▲ Slight	▲ Slight	▲ Slight	■ Slight	■ 5 to 6%	■ Slight	■ Slight	■ Slight

NOTE: This table shows general effects, which will vary somewhat for specific ratings.

ELECTRICAL TYPES AND CHARACTERISTICS OF DIRECT-CURRENT MOTORS

Direct-current motors were the earliest form of electric-power equipment. However, the simplicity of the induction motor and the advantages gained by a-c distribution eventually led to the use of a-c motors in the majority of applications.

However, the high standards of performance required in many modern industrial applications can be obtained more readily with d-c drives.

The chief advantages of d-c motors are as follows:

1. Adjustable speed
2. Speeds not limited to synchronous zones
3. Great flexibility of speed-torque characteristics
4. Ease and simplicity of control

The various electrical types of direct-current motors that General Electric can supply to meet modern industrial applications are described on the following pages.

TYPES OF WINDINGS

Shunt-wound Motors

Compared with other types of d-c motors, shunt-wound motors, when connected to a constant supply voltage and with fixed field excitation, operate at approximately constant speed, regardless of load. There is some drop in speed from no load to full load. This drop may vary from 10 to 15 per cent of full-load speed, varying with saturation, armature reaction, and brush position. Shunt-wound motors may be either constant-speed or adjustable-speed, as defined on the following page.

Because of commutation limitations, shunt-wound motors in integral-horsepower sizes are not suitable for across-the-line starting.

Shunt-wound motors, designed for operation over a given speed range by field control, are not technically shunt-wound motors in that a stabilizing series field (about 5 per cent shunt-field ampere turns) is added to assure stable speed under weak field conditions. This winding eliminates the possibility of armature reaction demagnetizing the weakened shunt field with change in load. This assures drooping speed characteristics from no load to full load.

Compound-wound Motors

The addition of a cumulative, series field winding to the shunt field produces the compound-wound motor. This motor has a greater speed drop than a shunt-wound motor (about 25 per cent) from no load to full load.

Compound-wound motors are used on loads requiring high starting torque, or on loads subject to torque pulsations. The compound-wound motor is not practical for applications requiring adjustable speed by field control. With weakened shunt field, the series-field flux becomes a greater portion of the total flux; hence, changes in load may produce unstable speed.

Compound-wound motors up to 5 hp are suitable for across-the-line starting.

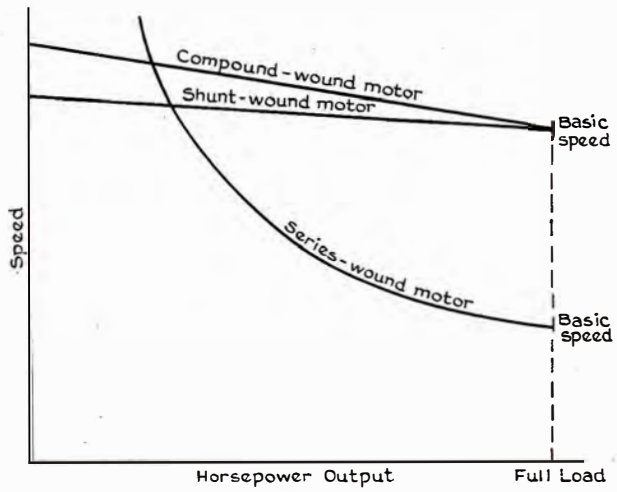
Series-wound Motors

Series-wound motors have the field winding in series with the armature, and are subject to wide changes in speed with changes in load. A series motor with reduction in load will vary from rated speed at full load to infinite speed at no load. Because of this speed characteristic and the resultant possibility of dangerously high speeds at reduced loads, these motors are not suitable for belt drive or for use on any load where the torque might drop below 15 per cent of full-load torque.

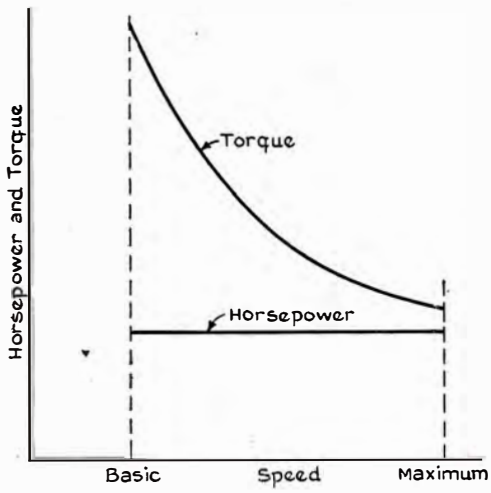
Series motors are used on loads requiring very high starting torques or severe accelerating duty, or where the high-speed characteristic may be advantageous.

CONSTANT-TORQUE AND CONSTANT-HORSEPOWER DRIVES

A constant-torque drive is one which is capable of operating at constant torque throughout its speed range. A constant-horsepower drive is one which is capable of operating at constant horsepower through-



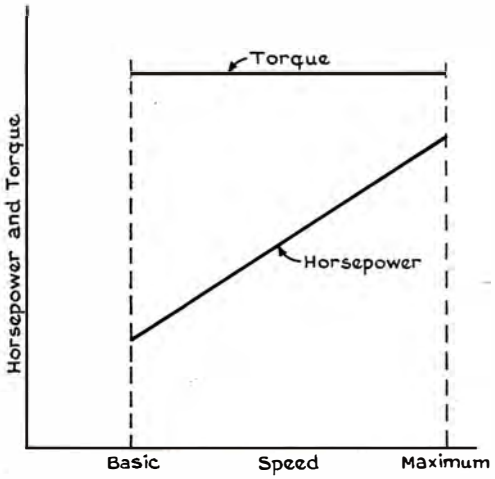
Speed-output curves



Curves for constant-horsepower motor

out its range. The accompanying curves show the variations of torque and horsepower with speed of the two.

A d-c motor operating with constant field excitation and with the armature supplied from a variable-voltage source is a constant-torque motor. An adjustable-speed d-c motor, having speed variation by means of shunt-field control, is a constant-horsepower drive.



Curves for constant-torque motor

Either type of motor can be operated as constant-torque or constant-horsepower drive but, for fullest utilization of material in the unit, each can be operated only as the type for which it is inherently suited.

For applications requiring constant torque, the variable-voltage system of control makes possible the use of a smaller motor and, conversely, for constant-horsepower applications, the field-control motor will be the smaller. However, the economies of a particular installation may alter the recommendation.

For example, a constant-torque application, where constant-voltage d-c supply is available, may use a constant-torque, field-controlled, adjustable-speed motor. Although a smaller motor could be used with variable-voltage control, the additional cost of a motor-generator set and a variable-voltage control makes its use uneconomical or impractical.

SPEED RATINGS

Any shunt d-c motor is designed so that adjustment of speed from basic speed can be made by changing the field current. The basic speed, as listed in this catalog, is the full-load, full-field hot speed (subject to listed tolerances), and any listed speed range is obtained by shunt-field weakening. Both mechanical and electrical limitations set the maximum safe speed as listed.

The listings of motors are divided into constant-speed and adjustable-speed. The differences are given below:

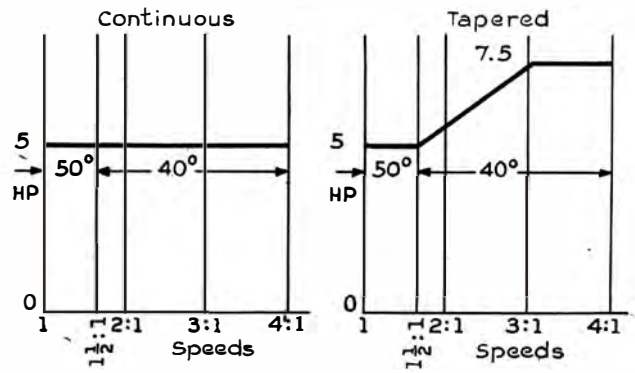
Constant-speed D-c Motors

These motors are those designed for operation over speed ranges of less than 3:1. They deliver constant horsepower from basic speed to maximum speed. With full field excitation on the motor, it is possible to supply an adjustable voltage to the armature to obtain speeds below basic speed. With this type of operation, the motor is suitable for a constant-torque drive below basic speed. The minimum speed at which the motor can operate is limited by temperature rise because the motor carries full-load current at the lower speeds and the natural ventilation is reduced.

Adjustable-speed D-c Motors

These motors are those designed for operation over a speed range of 3:1 or greater by field control. They are all shunt wound, are listed as either constant-horsepower or tapered-horsepower, and can be furnished as constant-torque motors (see the preceding paragraphs on constant torque and constant horsepower). The comparison of the constant-horsepower and tapered-horsepower motors is shown by the accompanying curves. The tapered-horsepower motor delivers the lower listed horsepower, 50 C rise from basic speed to 150 per cent basic speed, horsepower tapering from the lower to the higher listed value between 150 per cent and 300 per cent basic speed, and delivers the higher listed horsepower value above 300 per cent basic speed.

Adjustable-speed motors, like constant-speed motors, can be operated below basic speed by adjustable-voltage armature control.



ARMATURE-VOLTAGE CONTROL

In the previous paragraphs, several references have been made to the operation of a d-c motor below basic speed by varying the armature voltage while the field excitation is held constant. This system can be used on any constant-torque drive, and the lower limit of speed is set only by heating caused by reduced ventilation. In general, a constant-speed or adjustable-speed motor can be operated continuously without injurious heating from about 30 per cent to 40 per cent of basic speed, depending on the rated basic speed.

There are several methods for changing the applied armature voltage: multivoltage control, resistance control, and adjustable generator-voltage control.

The multivoltage system (the least common of the three) utilizes a multivoltage power supply so that with constant-field excitation, the motor armature can be supplied from any one of two or more different voltages. This system is advantageous where a 115/230-volt system is available, and has been used with a three- or-more-unit d-c balancer set, used as a voltage divider to give 62.5/115/177.5/230 volts, from a 230-volt bus.

The resistance-control system utilizes a variable, series, or parallel resistance in the armature circuit.

There are two major disadvantages of the system: poor speed regulation and low over-all efficiency caused by resistance loss.

The adjustable generator-voltage control is the most widely used of the three. A motor-generator set supplies an adjustable voltage to the motor armature circuit, and a constant voltage is used to excite the d-c motor and the generator of the set. Speed control of the motor is obtained by varying the generator voltage. Such a system provides accurate adjustment of speed, and the speed regulation of the motor is as good or better than with shunt-field control.

Characteristics* and Applications of D-c Motors, 1 to 300 Hp

Type	Starting Duty	Maximum Momentary Running Torque	Speed Regulation	Speed Control †	Applications
Shunt-wound, constant-speed	Medium starting torque. Varies with voltage supplied to armature, and is limited by starting resistor to 125 to 200 per cent full-load torque	125 to 200 per cent. Limited by commutation	8 to 12 per cent	Basic speed to 200 per cent basic speed by field control	Drives where starting requirements are not severe. Use constant-speed or adjustable-speed, depending on speed required. Centrifugal pumps, fans, blowers, conveyors, elevators, wood- and metal-working machines
Shunt-wound, adjustable-speed			10 to 20 per cent, increases with weak fields	Basic speed to 600 per cent basic speed (lower for some ratings) by field control	
Compound-wound, constant-speed	Heavy starting torque. Limited by starting resistor to 130 to 260 per cent of full-load torque	130 to 260 per cent. Limited by commutation	Standard compounding 25 per cent. Depends on amount of series winding	Basic speed to 125 per cent basic speed by field control	Drives requiring high starting torque and fairly constant speed. Pulsating loads. Shears, bending rolls, plunger pumps, conveyor crushers, etc.
Series-wound, varying-speed	Very heavy starting torque. Limited to 300 per cent to 350 per cent full-load torque	300 to 350 per cent. Limited by commutation	Very high. Infinite no-load speed	From zero to maximum speed, depending on control and load	Drives where very high starting torque is required and speed can be regulated. Cranes, hoists, gates, bridges, car dumpers, etc.

* Table shows average values for standard motors.
† Minimum speed below basic speed by armature control limited by heating.

General Effect of Voltage Variation on Direct-current-motor Characteristics

■ = Increase ▲ = Decrease

Voltage Variation	Starting and Max Run Torque	Full-load Speed	Efficiency: Full Load	Efficiency: ¾ Load	Efficiency: ½ Load	Full-load Current	Temperature Rise, Full Load	Maximum Overload Capacity	Magnetic Noise
SHUNT-WOUND									
120% Voltage	■ 30%	110%	■ Slight	No change	▲ Slight	▲ 17%	■ Main field. ▲ Commutator field and armature	■ 30%	■ Slight
110% Voltage	■ 15%	105%	■ Slight	No change	▲ Slight	▲ 8.5%	■ Main field. ▲ Commutator field and armature	■ 15%	■ Slight
90% Voltage	▲ 16%	95%	▲ Slight	No change	■ Slight	■ 11.5%	▲ Main field. ■ Commutator field and armature	▲ 16%	▲ Slight
COMPOUND-WOUND									
120% Voltage	■ 30%	112%	■ Slight	No change	▲ Slight	▲ 17%	■ Main field. ▲ Commutator field and armature	■ 30%	■ Slight
110% Voltage	■ 15%	106%	■ Slight	No change	▲ Slight	▲ 8.5%	■ Main field. ▲ Commutator field and armature	■ 15%	■ Slight
90% Voltage	▲ 16%	94%	▲ Slight	No change	■ Slight	■ 11.5%	▲ Main field. ■ Commutator field and armature	▲ 16%	▲ Slight

NOTES: Starting current is controlled by starting resistor.
This table shows general effects, which will vary somewhat for specific ratings.

TYPES AND CHARACTERISTICS OF SYNCHRONOUS MOTORS

1. Advantages of synchronous motors

   (a) Initial cost—Lower than squirrel-cage induction motors in low-speed ratings (450 rpm and below) of medium and large hp (50 hp and above), also in very large hp ratings (500 to 1000 hp and above) at medium speed (514 to 900 rpm).

   (b) Unity or leading power factor—When applicable, synchronous motors provide power-factor improvement at lower cost than any other means.

   (c) Efficiencies—Generally higher than for induction motors of corresponding rating. This is a particularly important advantage in larger hp ratings.

   (d) Other features that may be advantageous:
   Constant speed independent of load
   Large air gap—two or three times that of induction motors
   Lower starting current—in some ratings

   Synchronous motors are rarely used in sizes below 20 hp, and seldom used in sizes below 50 hp. Principal field of application is in sizes of 100 hp and larger.

2. Standard lines of synchronous motors
   High-speed line—500 rpm and above
   Low-speed line—less than 500 rpm

3. High-speed synchronous motors

   (a) Construction—Stator is similar to that in induction motor. Rotor of salient-pole type

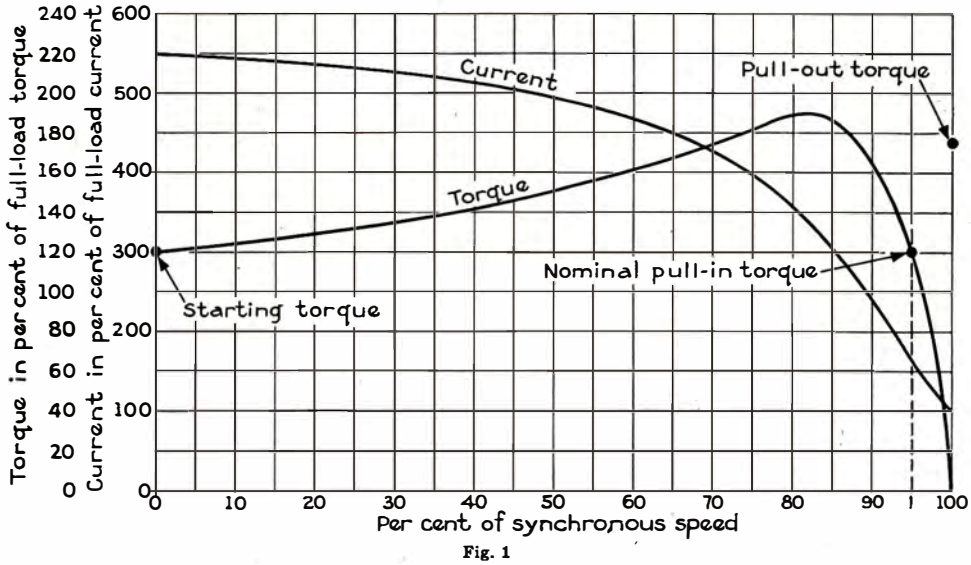


Fig. 1
Speed-torque and speed-current curves of a typical high-speed synchronous motor

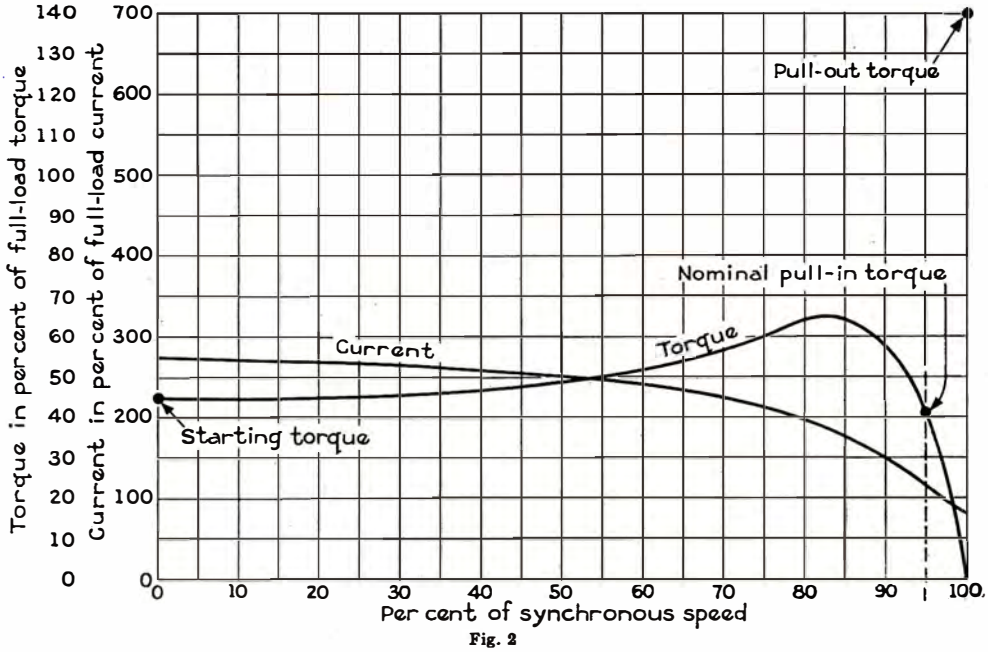


Fig. 2
Speed-torque and speed-current curves of a typical low-speed synchronous motor for compressor drive

has insulated field winding which is brought out to collector rings. Rotor also has "amortisseur," or squirrel-cage, winding on the rotor since motor starts and accelerates as a squirrel-cage induction motor. Direct-connected exciter is frequently provided.

(b) Characteristics—
Torques (ratings up to 500 hp)—starting and pull-in, 110 per cent, pull-out, 150 per cent; starting current, 500 to 700 per cent. Typical speed-torque and speed-current curves are shown in Fig. 1. Variation with load of reactive kva and power factor is shown in Fig. 3 and 4.

(c) Typical applications—

Centrifugal pumps	Line shafts
D-c generators	Centrifugal compressors
Belt-driven reciprocating compressors	Rubber mills
Fans	Paper mills
Blowers	

4. Low-speed synchronous motors

(a) Construction—Usually furnished "engine type," i.e., without base, shaft, or bearings. When coupled to load, base, shaft, and pedestal-type bearings are added. Belted or motor-generator set exciters are usually used.

(b) Characteristics—
Torques—Standard "compressor torques," 40 per cent starting, 30 per cent pull-in, and 140 per cent pull-out. Higher values can be obtained by special design.
Starting current—With compressor torques—250 to 350 per cent. Higher torques mean higher starting current.
Typical speed-torque and speed-current curves are shown in Fig. 2.

(c) Typical applications
Reciprocating compressors (largest field of use)

Jordan engines	Line shafts
Centrifugal and screw-type pumps	Rubber mills
Ball and tube mills	Band mills
Vacuum pumps	Chippers
Electroplating generators	Metal-rolling mills

5. Synchronous-motor control

(a) Primary control—similar to that provided for squirrel-cage induction motor—may be full-voltage or reduced-voltage, manual or magnetic.

(b) Field control—always magnetic and consists of:
Field and field-discharge contactors
Field-application and field-removal relays
Discharge resistor
Field rheostat
Line and field ammeters

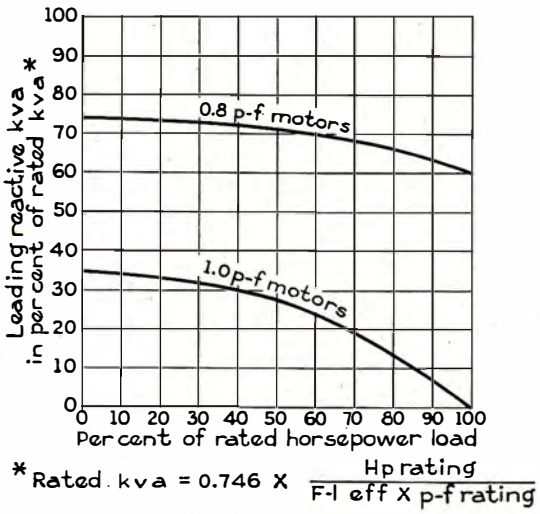


Fig. 3
Approximate leading kva drawn by high-speed synchronous motors operating at partial loads with full-load excitation maintained

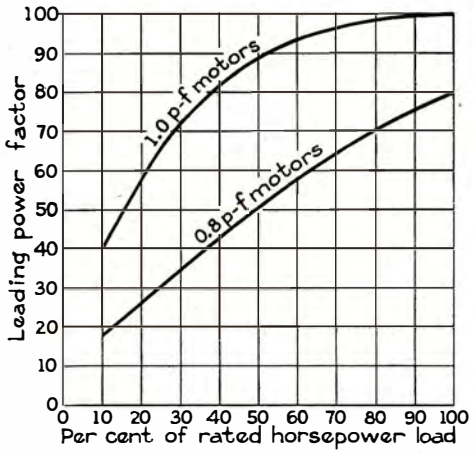
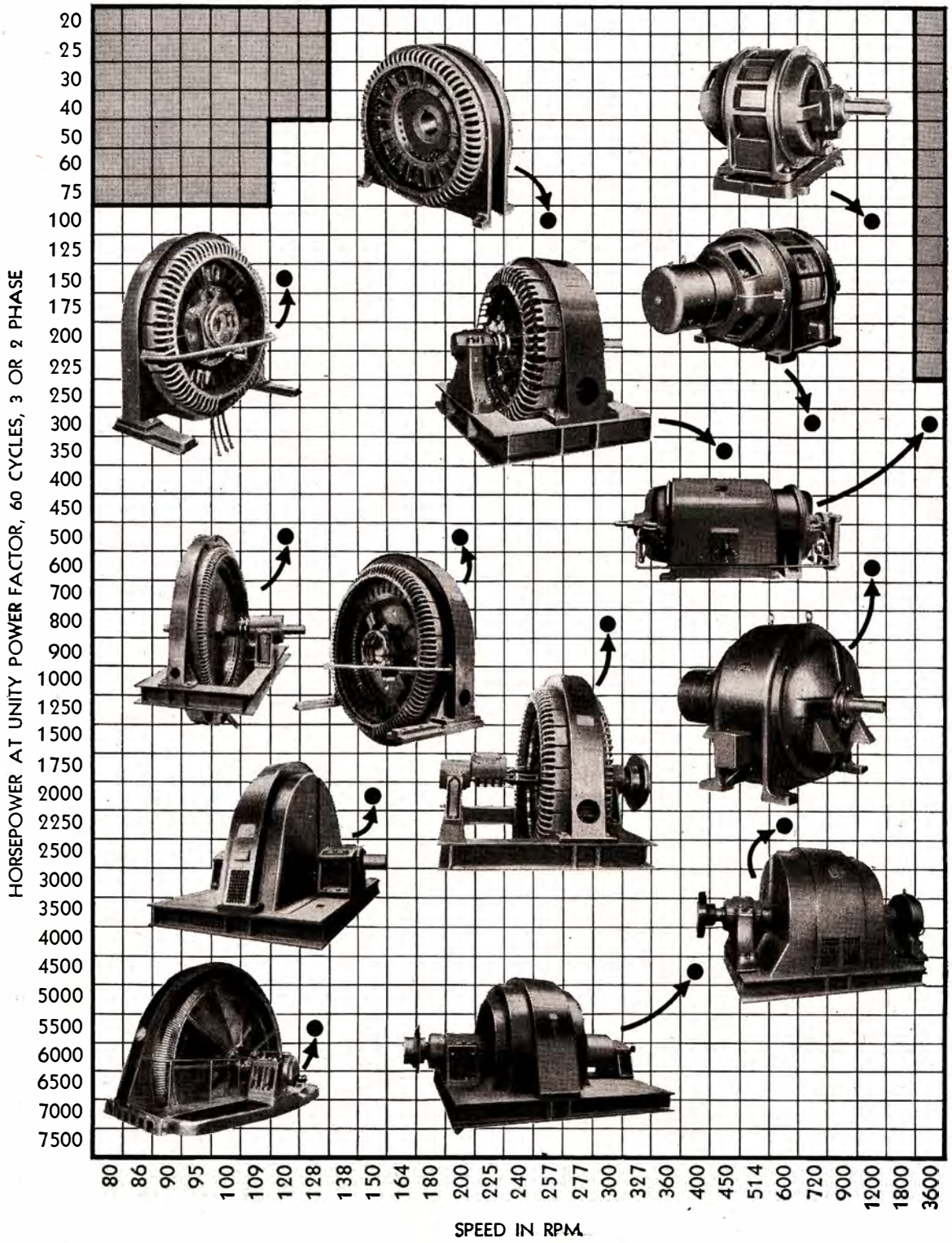


Fig. 4
Approximate power factor of high-speed synchronous-motors operating at partial loads with full-load excitation maintained

Rating Chart for General Electric Synchronous Motors

General Electric manufactures standard and special synchronous motors covering a wide range of ratings. This chart gives a general idea of the appearance of some of these many motors that can be built. A G-E synchronous-motor specialist will gladly assist in the selection of the drive best suited to your requirements.



HOW TO IDENTIFY MOTORS

THE following data and instructions will help you identify motors you have, will facilitate ordering duplicate motors or renewal parts, and will aid in correctly applying such motors to new applications.

Knowledge of the system used in identification of G-E motors also will help in correctly ordering or specifying new motors.

The information included is as follows:

I. Nomenclature of motors and generators.

In frames that have mounting dimensions standardized by the motor industry:

1. Type letters.
2. Frame numbers.

II. Nomenclature of motors and generators.

In frames not standardized by the motor industry:

1. Type letters.
2. Frame numbers.
3. Form letters.

III. Starting kva code letters on nameplates.

IV. Mounting-assembly symbols.

V. Information necessary for commercial identification.

VI. General information applying to fractional-hp motors, generators, and motor-generator sets.

General Electric has complete information on file for each motor shipped. This information is filed by model number. Always state model number when referring to a motor you have.

G-E ENGINEERING SERVICE

The Company builds a large number of different forms of motors and controllers to meet the varied requirements of service, either electrical, mechanical, or local. G-E salesmen and engineers are always glad to assist in selecting the particular type or form of motor that will best meet the conditions.

In applying motors either where the location involves unusual physical conditions, or where the machines to be driven require other than standard characteristics, it is respectfully suggested that the recommendations of the Company always be obtained, as to the type and form of motor best adapted to the especial conditions of the application.

In requesting such information, please be sure to give at least the following data.

1. Alternating or direct current available?
2. Voltage?
3. Frequency (if alternating current)?
4. What is the motor to drive?
   (If an individual machine—the manufacture and size.)
5. Belted or direct connected?
   (Pulley dimensions, if not standard.)
6. Gear or chain drive?
   Outboard bearing and shaft extension.
   Subbase, and by whom to be furnished.

GENERAL NOMENCLATURE OF G-E MOTORS AND GENERATORS

In general, motors and generators are identified in three ways; first, by model number which identifies a definite design—all machines with the same model number being identical both electrically and mechanically; second, by serial number (serial numbers are not used on certain small sizes) which identifies a motor or generator as an individual machine; third, by nomenclature (type, frame, or form) which is identification by family group, line, construction, or characteristics.

The system of nomenclature is divided into two groups; first, that used for the identification of machines built in frames that have mounting dimensions standardized by the industry; second, that used for the identification of machines built in frames the mounting dimensions of which are not standardized by the industry.

I—Nomenclature of Integral-hp G-E Motors and Generators

In Frames That Have Mounting Dimensions Standardized by the Motor Industry

The nomenclature for these motors and generators involves the use of type letters and frame numbers.

1—TYPE LETTERS

Type letters are intended to indicate a line of motors and generators which have the same general characteristics without special reference to the details of current supply, such as: voltage, frequency, or number of phases. Following are the type letters of the more popular lines of machines, together with descriptions of the general characteristics which these type letters designate:

B	Direct-current motors and generators.
K	Normal-starting-torque, normal-starting-current and low-starting-current, polyphase squirrel-cage induction motors.
KF	Normal-starting-torque, low-starting-current, polyphase squirrel-cage induction motors. In the Tri-Clad construction, the type letters KF are superseded by the type letter K with code letter stamped on the nameplate to indicate low starting kva per horsepower.
KG	High-starting-torque, low-starting-current, polyphase squirrel-cage induction motors.
KB	Normal-starting-torque, normal-starting-current and low-starting-current, polyphase squirrel-cage induction motors, especially designed for quiet operation.
KR	High-slip (high-starting-torque), relatively low-starting-current, polyphase squirrel-cage induction motors.
KE	High-slip, relatively low-starting-current, polyphase squirrel-cage induction motors, designed for quiet operation; elevator service.
M	Polyphase wound-rotor induction motors.
MB	Polyphase wound-rotor induction motors designed for quiet operation.
MR	High-torque wound-rotor motors for crane duty.
KC	Normal-torque, single-phase capacitor-motors.
KCJ	High-torque, single-phase capacitor-motors.
SCR	Repulsion-induction single-phase motors.
SCA	Repulsion-induction single-phase motors for reversing service.
SCE	Repulsion-induction single-phase motors, especially designed for elevator service.
SCH	High-starting-torque, repulsion-induction single-phase motors.
RB	Repulsion, brushing-shifting, adjustable-varying-speed single-phase motors.

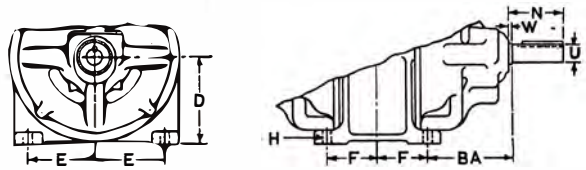
NOTE.—Effective November 1, 1940, all single-phase and polyphase motors (except wound-rotor motors) rated ½ hp and larger have, stamped on the nameplate, a code letter indicating starting current in terms of locked-rotor kva per horsepower as given in the table on the following page.

2—FRAME NUMBERS

The frame numbers of these motors and generators specifically identify their mounting dimensions—all machines having the same frame designation will have identical mounting dimensions, regardless of electrical characteristics, thereby providing interchangeability.

Following are the frame numbers used: 203, 204, 224, 225, 254, 284, 324, 326, 364, 365, 404, 405, 444, 445, 504, and 505.

1. The standardized frame number indicates a fixed set of mounting dimensions, which are dimensions D, E, F, BA, H, and the shaft extension, as shown in the illustration below.



2. The first two digits in the standardized frame numbers definitely fix the dimensions D, E, BA, H, U, and N minus W. In the case of horizontal motors with feet, the first two digits form a number which is four times dimension D, height from bottom of feet to center line of shaft. The third or last digit fixes the value of dimension F.

3. Motors of the same frame number, while they will have the common, standardized mounting dimensions, may differ in what are ordinarily less-essential dimensions (even over-all dimensions) with the different types of enclosures or with other mechanical modifications. Therefore, to obtain detailed dimensions of a given motor, the dimension print applicable to that specific construction should be consulted.

4. In order to provide a simple, standardized means of identification for variations from the standardized mounting dimensions, four letters have been standardized for use as frame suffix letters to denote variations as follows:

S—Standardized short shaft-extension for direct connection. (Does not apply to vertical machines.)

V—Vertical machine with standardized vertical mounting dimensions.

Y—Special mounting dimensions. (Special dimension information required for mounting applies to both horizontal and vertical machines.)

Z—All mounting dimensions standard, except shaft-extension. (Applies to both horizontal and vertical machines.)

Hence, the complete frame designation for a motor or generator having mounting dimensions differing from standard is made up of the frame number followed immediately by one or two of the above frame suffix letters; for example, 364S or 364VZ.

II—Nomenclature of G-E Motors and Generators In Frames Not Standardized by the Motor Industry

The nomenclature for these motors and generators involves the use of type letters, frame numbers, and in some cases, form letters. Type letters indicate the kind of motor and characteristics: the frame number indicates the mounting dimensions; and form letters, when used, indicate the frame construction and type of bearings. The combination of the type letter, frame number, construction features, and/or form letters determines the external dimensions of a given machine, and all must be used to obtain the proper dimension print.

1—TYPE LETTERS

CD	Direct-current motors and generators.
CDM	D-c motors and generators for marine service.
QS	Two-phase synchronous motors.
TS	Three-phase synchronous motors.
QSB	Two-phase synchronous motors especially designed for quiet operation.
TSB	Three-phase synchronous motors especially designed for quiet operation.
QSF	Two-phase synchronous motors, flywheel type.
TSF	Three-phase synchronous motors, flywheel type.

Induction Motors

Type and form letters previously used on induction motors in Frames 542 and larger, as well as loom motors in Frames 3914 to 3958, were changed as of May 1, 1940. These motors now have the same type and frame-suffix letters as Frames 203 to 505, standardized by the motor industry.

2—FRAME NUMBERS

Type letters are followed by frame numbers which indicate mounting dimensions.

A suffix letter is used in some cases with a frame number to indicate another series of frame designations.

The frame designation may be followed by the letter S to denote short shaft extension for direct drive; the letter Z to denote special shaft extension; and/or the letter Y to indicate special mounting dimensions requiring an outline drawing.

Following are the various frame "series" used:

1–99	D-c motors and generators
400–499	Induction motors
500	Induction motors
900	Synchronous motors and generators
1000–1990	D-c motors and generators
3000–3690	Induction motors, D.D.-O.
3900	Induction motors (loom)
5500	Induction motors (crane)
6000	Synchronous motors and generators
N6200–N6219	Induction motors, vertical, hollow-shaft or solid-shaft (normally K or KF)
N6300–N6319	Induction motors, vertical, hollow-shaft or solid-shaft (normally K or KF)
6320–6339	Induction motors, horizontal and vertical

3—FORM LETTERS

Frame numbers are followed by form letters to indicate (first) frame construction and (second) type of bearings. *Form letters in combination with frame numbers indicate external dimensions, and hence are a direct reference to the correct dimension print for any particular type.*

Form letters now used:

First (only one used). For both direct-current (Type CD, Fort Wayne only) and synchronous motors except as noted below.

- A Cast, steel-plate, or open box, horizontal frame.
- B Open, skeleton, horizontal frame; synchronous motors only.
- E Protected, closed box or steel-plate, horizontal frame with air intake and discharge openings; synchronous motors only.
- G Totally enclosed, horizontal frame, with or without corrugations.
- H Enclosed, ventilated, horizontal frame, with or without pipe or duct connection.
- K Round frame without feet, other than drawn-shell.
- L BM (Bureau of Mines) classification; direct-current motors only.
- M Rolled-plate, frame, rotating armature; synchronous motors only.
- R Totally enclosed, externally (fan) cooled, horizontal frame.
- V Open, vertical frame; synchronous motors only.
- W Enclosed, vertical frame, with or without ventilation.

Second (not used on vertical machines). For both direct-current (Type CD) and synchronous motors except as noted.

- A Ball bearings.
- D Waste-packed bearings; direct-current motors only.
- E Roller bearings.
- L Sleeve bearings.
- Y Special bearings.

III—Starting-kva Code Letters on Nameplates

In addition to the foregoing type and form letters, the following code letters are now used on all single-phase, polyphase squirrel-cage induction, and synchronous motors rated ½ hp and larger, to indicate the locked-rotor starting kva per hp.

Code Letter	Kva per Hp, Locked-rotor	Code Letter	Kva per Hp Locked-rotor
A	0.0 –3.14	J	7.10– 7.99
B	3.15–3.54	K	8.00– 8.99
C	3.55–3.99	L	9.00– 9.99
D	4.00–4.49	M	10.00–11.19
E	4.50–4.99	N	11.20–12.49
F	5.00–5.59	P	12.50–13.99
G	5.60–6.29	R	14.00 and up
H	6.30–7.09		

$$\text{Kva per hp} = \frac{E \times LRI \times K}{1000 \times hp} \text{ and}$$

$$LRI = \frac{\text{Kva per hp} \times hp \times 1000}{E \times K}$$

Where E = rated voltage
LRI = Locked-rotor current in amperes.
K = 1 for single-phase,
2 for two-phase,
1.73 for three-phase.

Code Letters Usually Applied to Ratings of Motors Normally Started on Full Voltage

Code Letters		E	F	G	H	J	K	L	M	N
Horsepower	3-phase		15 up	10–7½	5	3	2	1½	1	¾
	1-phase	5	3	1½			1	¾	½	

IV—Mounting-assembly Symbols for Wall- and Ceiling-mounted Motors

1. If motors are not for floor mounting, the order should state whether they are to be for wall mounting or ceiling suspension.
2. The following symbols should be used on orders to indicate the assembly reference:

Wall Mounting

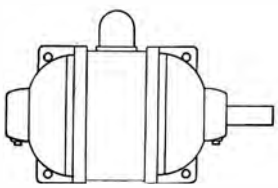
Assembly W-1	Assembly W-5
Assembly W-2	Assembly W-6
Assembly W-3	Assembly W-7
Assembly W-4	Assembly W-8

Ceiling Mounting

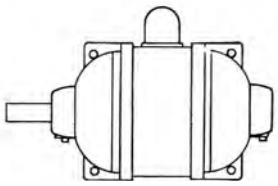
Assembly C-1	Assembly C-2

The word "assembly" should always precede the symbol to avoid confusion with other symbols.

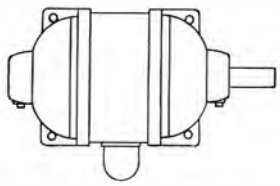
3. When motors are ordered according to a particular assembly symbol, the end shields are assembled so that the oil gages and grease fittings are properly installed for operation with the motor in the position shown. However, no attempt is made to locate these fittings on any particular side of the motor. In most cases, motor end shields are so drilled that the oil gages can be moved by the user to the desired side.



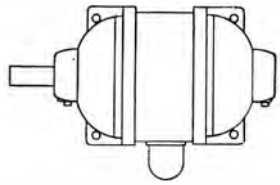
Assembly W-1



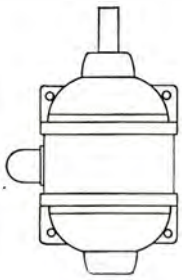
Assembly W-2



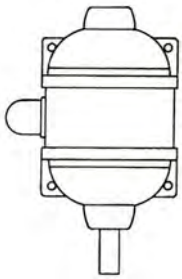
Assembly W-3



Assembly W-4



Assembly W-5



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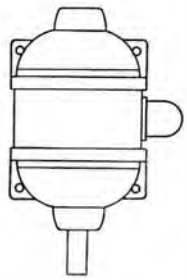
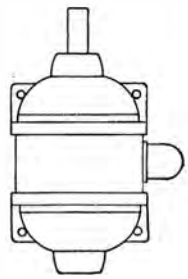
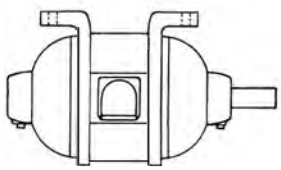


Assembly W-7

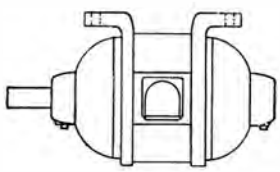


Assembly W-8

Wall mountings



Assembly C-1



Assembly C-2

Ceiling mountings

V—Information Necessary for Commercial Identification

For ordinary commercial purposes, the following information will identify all motors and generators:

Type letter or letters
Frame number (for frame numbers in which the various types and ratings of motors and generators are built, refer to the price pages of this catalog)
Form letter or letters, where used
Horsepower, kw, or kva
Speed
Voltage and, if a-c, frequency and number of phases of power supply
Temperature rise and time rating
Type of bearings
If d-c; shunt, series, or compound windings
Modifications; such as enclosures, special shaft extensions, etc.

NOTE: For identification of synchronous motors and generators, refer to the nearest G-E office.

While the above information is usually sufficient for commercial identification, it will not identify motors or generators for duplication insofar as exact performance and strict interchangeability of parts are concerned. In order to provide such identification (which is required when ordering renewal parts or duplicate machines), model numbers (or serial numbers, where used) are assigned, which identify every detail of the machine.

VI—General Information Applying to Fractional-hp Motors, Generators, and Motor-generator Sets

Definition

A fractional-horsepower motor is a motor built in a frame smaller than that having a continuous rating of 1 hp, open type, at 1700–1800 rpm. This includes motors rated for continuous duty at 1 hp, 3450 rpm; ¾ hp, 1725 rpm; ½ hp, 1140 rpm; ½ hp, 860 rpm; and smaller.

Scope

Motors listed in this catalog are for general-purpose applications and some special applications. In addition to the motors listed herein, specialty motors can also be furnished for certain applications where large-quantity production is anticipated. Refer all such requests to the nearest G-E office.

ORDERING DIRECTIONS

Replacement Motors

When requests are received for *special* replacement motors not in factory stock, obtain replacement motors from the manufacturer of the appliance or device on which this special motor was originally furnished. In the majority of cases, large manufacturers using G-E motors carry replacement motors in stock and better service can be rendered by referring to the manufacturer of the device or appliance, rather than by ordering a special motor to be built up in our factory. If you cannot obtain a replacement motor from this source, refer the order to G.E.

Listed Motors

Obtain motor model numbers and stock information or estimated time required for shipment from the Company. General-purpose motors of the following constructions are ordinarily in stock.

Sleeve-bearing, open and totally enclosed, solid- and resilient-base; ball-bearing, open and totally enclosed, solid-base; explosion-proof, sleeve- and ball-bearing, solid-base. In addition, special-service washing- and ironing-machine motors, fan-duty motors, etc., are also listed.

In placing order, specify:

1. Complete model number (if listed).
2. Type (First letters in model number, such as KH, K, etc.).
3. Frame (two numbers following type letters).
4. Horsepower, full-load speed, voltage, and frequency.
5. Type of base (solid or resilient).
6. Direction of rotation as viewed from end opposite the shaft extension. Motors are normally connected for counter-clockwise rotation, and will be furnished as stock in cases where motor can easily be reconnected for opposite rotation by purchaser.
7. Built-in overload device (40-diam frames only) or external Thermo-Tector (60- and 70-diam frames), if desired.

Order motors by description, giving complete information as listed above.

NOMENCLATURE

The first letters of the model number (such as KH, K, BC) represent the motor type. The two numbers following (such as 45, 63, etc.) represent the frame size. The frame size is followed by both letters and numbers used as exact model identification. When the model includes a built-in automatic-reset overload device (40-diam frames) or externally mounted Thermo-Tector (60- and 70-diam frames), the suffix X is added to the model number to represent automatic-reset overload device, and the suffix Y is added to represent manual-reset overload device.

HOW TO SELECT A-C CONTROL

What Methods of Starting Polyphase Induction Motors to Consider

THERE are two major considerations which should be made when a-c motor control is being selected. These are:

1. Shall the control be manually operated or magnetically operated?
2. Can motors be started at full voltage or must they be started at reduced voltage?

Manual control is generally more economical, but the convenience of push-button starting, or of safe automatic starting, makes magnetic control preferable.

Full-voltage starting of motors is generally the most economical method of starting. In addition, modern motors are all designed not only to withstand full-voltage starting, but also are designed with low starting current to permit their use on modern feeder lines without producing objectionable voltage regulation or annoying light flicker. For those conditions where limited line capacity necessitates the use of current-reducing controllers, the text on pages 119–124 will be useful.

Several alternative methods are available for reducing starting current and improving line-voltage conditions. Before examining in detail the accompanying curves which illustrate some of these other methods, the following important considerations should be fixed in mind:

1. A reduction in starting current is accompanied by a reduction in starting torque; therefore, it is essential to know something about the load-torque characteristics in determining if a given current limitation can be met. With all starting methods, the torque of a squirrel-cage motor varies as the square of the voltage applied to the motor terminals. The line current with the autotransformer method varies in the same manner, and it is convenient to remember that torque and line current are reduced at the same rate. With resistor or reactor starting, however, the starting current varies directly with the voltage at the motor terminals.
2. A question of economics is always involved and must be recognized when it is desired to reduce motor-starting current below normal full-voltage values. A manufacturer of electric equipment can usually supply a more desirable combination of motor and control (from the power company's viewpoint) than the buyer is willing to pay for.
3. The curves are a study only in absolute values of current. In general, conditions are most improved with the lowest obtainable values of current; but a given higher value of current may or may not cause more-objectionable light flicker, depending on the system capacity, the power factor of the distribution circuit, the power factor of the motor and the starting device, and the frequency of starting.
4. The curves are necessarily drawn for a particular motor, a particular load, and a particular inertia representing a common application. Certain generalizations which might be made from an examination of these curves could be inaccurate for a different set of conditions.

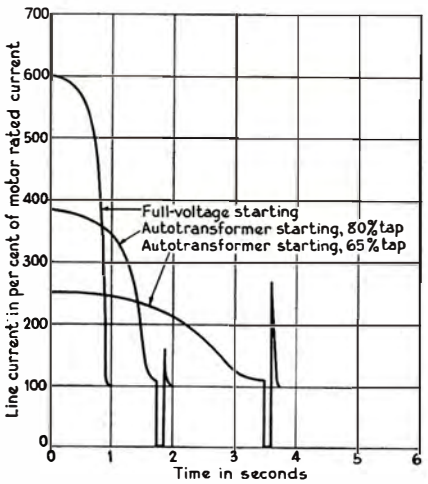


Fig. 1
Accelerating current of a squirrel-cage induction motor driving a loaded centrifugal pump

Fig. 1

Starting on the autotransformer taps reduces the accelerating torque, as is evident by the longer accelerating time. The lower the tap, the lower the initial inrush and the higher the peak at throw-over.

Fig. 2

Curve "B" does not represent a practical starting arrangement, because a similar current reduction could be obtained with a low-starting-current motor and a full-voltage starter at a lower cost. A resistor starter with a current characteristic of this kind is occasionally valuable where a reduction in the full-voltage starting current is not necessary, but it is desirable to prevent the sudden application of the full-voltage torque where this is high enough to damage the mechanical drive. Curve "B" does indicate, when considered in connection with curve "C," the progressively reduced accelerating torques in using higher values of series resistance. Note particularly the low-current peaks produced on transferring to line voltage with two-point resistor starters. Curve "D" illustrates the use of a four-point "increment"-type resistor starter to meet a restriction on the rate of increase of current in starting.

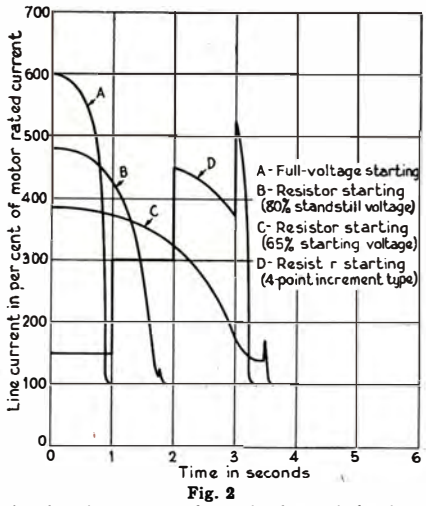


Fig. 2
Accelerating current of a squirrel-cage induction motor driving a loaded centrifugal pump

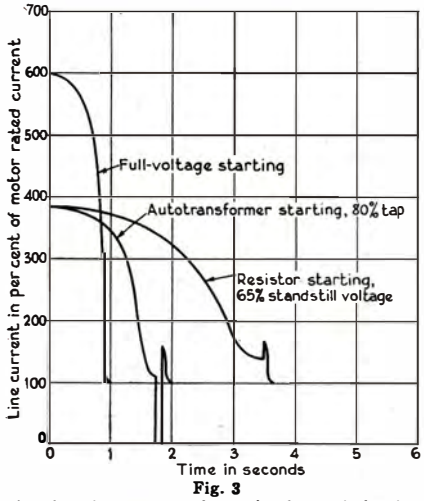


Fig. 3
Accelerating current of a squirrel-cage induction motor driving a loaded centrifugal pump

In this case, current increments of 150 per cent were permissible with one-second intervals between. At the end of two seconds, the voltage at the motor has been increased to 75 per cent normal where sufficient torque is available to start the load, as is indicated by the decrease in current during the third second. The resistor is completely short-circuited at the end of three seconds, causing line voltage to be applied to the motor for normal operation. Whether or not the load breaks away from rest before the resistor is completely short-circuited is usually considered unimportant under this type of starting-current restriction.

Fig. 3

These curves show a direct comparison of two characteristics already examined. The starting inrush from the line is the same with 80 per cent voltage on the motor through an autotransformer, or with 65 per cent voltage by means of a series resistor. With the autotransformer, the initial torque is 64 per cent; but with the resistor, it is only 42 per cent. The curves show this by the longer accelerating period with the resistor starter. Thus, more torque is produced per line ampere with the autotransformer starter than with the resistor starter.

Fig. 4

A smooth start by means of a series reactor impressing 50 per cent standstill voltage on the motor is shown here. The comparatively long accelerating time indicates a low value of accelerating torque, but the voltage at the motor terminals and the percentage of full-voltage torque gradually increase as full speed is approached, until the motor-terminal voltage reaches almost normal value before the reactor is short-circuited. A series resistor impressing only 50 per cent standstill voltage on the motor would give the same initial inrush, but a current peak on short-circuiting the resistor higher than the initial peak. For this type of load which has a rising speed-torque characteristic, a two-point reactor starter is definitely superior to a two-point resistor starter, but costs somewhat more.

Fig. 5

This characteristic indicates the possibilities of meeting unusually low accelerating-current restrictions by means of a wound-rotor motor and suitable control. The curve shows how the current can be kept within 200 per cent of normal by short-circuiting an external secondary resistor in three steps. By using six steps, the current could be kept within 150 per cent of normal. The cost of this type of motor and its associated control prevents wide use being made of valuable characteristics.

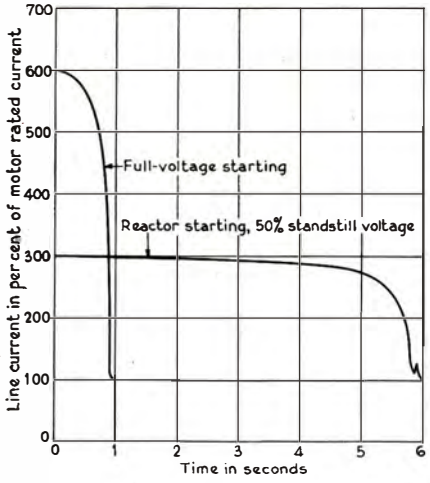


Fig. 4
Accelerating current of a squirrel-cage induction motor driving a loaded centrifugal pump

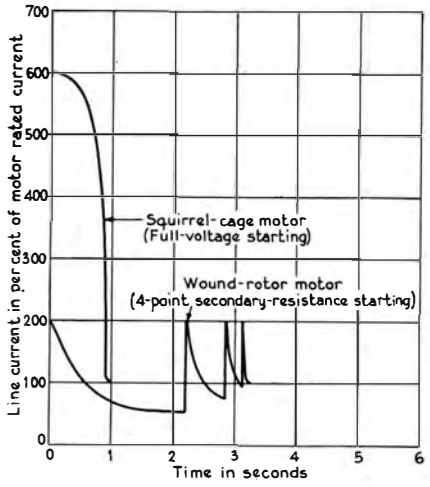


Fig. 5
Accelerating-current comparison of squirrel-cage and wound-rotor induction motors driving a loaded centrifugal pump

MOTOR STARTING ON SYSTEMS OF LIMITED POWER CAPACITY

In industrial plants, it is frequently desired to employ induction and synchronous motors which are so large that they may cause very noticeable disturbances to the line voltage at the time they are started. To prevent such disturbances from interfering with plant operation and to assure sufficient torque for starting requires not only proper selection of the motor and its control, but also of the generating, distributing, and voltage-regulating equipment of the plant.

This problem is important whenever the starting current of the motor is a sizable proportion of the rated output current of the generator or generators of the power supply. Thus, the problem may arise with both small and large installations, from small engine-driven generators for supplying air-compressor motors in isolated gasoline stations, to the largest plants, such as steel mills, in which motors of 5000 horsepower or larger must be started.

The information given in the following pages is designed to assist those charged with the responsibility of selection of proper plant electric equipment to best co-ordinate their choices of motors and control with selection and use of power-supply equipment.

TYPES OF POWER SUPPLY

An industrial plant may receive power from generating equipment forming a part of the plant, from the lines of a public-utility system, or from both.

Public-utility Supply

Since the load of an industrial plant is usually only a fraction of the total load on a public-utility system, it is only seldom that the starting current of a motor in a plant can cause a dip of more than a very few per cent in the system voltage, However, a small voltage dip may be important, since public-utility systems must adopt more stringent measures to avoid light flicker than are usually necessary for a factory. Power contracts usually contain phrases which limit the starting current permitted to be drawn by any motor in the plant supply.

In plants supplied by utility systems, it is ordinarily necessary to see that the starting-current limitations are met by selection of a suitable type of motor or by use of reduced-voltage-starting equipment.

When reduced-voltage starters are used to reduce the line current at start, care must be taken to see that the corresponding reduction in starting torque does not prevent successful starting.

Information concerning the full-voltage starting current and torque of a-c motors is readily available from manufacturers. The portion of Table I on page 124 headed "For 100% Line Voltage" indicates the reduction in current and torque applicable to various starting methods.

In relatively rare cases, the starting current, while not too large to comply with power-company requirements, may be large enough to cause an objectionable voltage drop in the transformers and feeders supplying the motor.

For example, a 100-hp motor having a full-voltage starting current of six times normal would cause a voltage drop of approximately 25 per cent through a 100-kva transformer. Severe voltage drops usually occur only when the motor is supplied by an unusually long feeder, or by a transformer only about as large as is required to supply the continuous load of the motor itself. Such cases should be referred to competent engineers for recommendations.

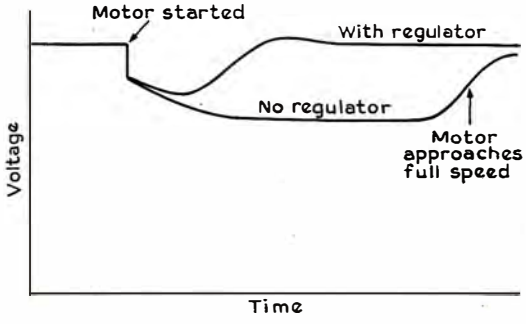
Systems of Limited Power-supply Capacity

When a plant is supplied by a generating station of only about such size as will supply the factory in question (for example, a factory supplying its own power or supplied by a relatively small utility system), the voltage disturbance caused by starting of a large motor may be quite severe, and may cause possible disturbance to the operation of motors or control, as well as inducing light flicker.

When the total kva capacity of the generators is not many times the horsepower rating of the motor to be started, attention must be given to the behavior of the generator voltage at the time of application of a motor-starting load.

NATURE OF VOLTAGE DISTURBANCES

The behavior of the voltage of an a-c generator when a motor-starting load is suddenly applied is illustrated below. At the instant the load is applied, the generator voltage drops. The amount of this instantaneous drop is not affected by the presence of a voltage regulator. After the sudden drop, the voltage continues to fall, although gradually. If no regulator is in use, the voltage will level off to a steady value at which it will remain until it rises as the motor approaches full speed. To be conservative, it is usually best to assume that the reduction in current as the motor approaches full speed does not affect the minimum voltage reached. The time at which this minimum voltage is closely approached may vary, depending on conditions, from about one half second to several seconds. The subsequent time at which the voltage returns toward normal is, of course, dependent on how quickly the motor accelerates its load.



Behavior of generator voltage when a motor-starting load is applied

If a voltage regulator is used, it arrests the fall of the voltage following the instantaneous drop, so that, although the voltage does fall somewhat after this drop, it does not fall as far as it would if there were no regulator. The time to reach minimum voltage with a regulator is ordinarily of the order of one half second or less.

After the minimum voltage has been reached, the regulator restores the voltage toward normal. On its return, the voltage may overshoot slightly or, if the load is a heavy one, the voltage may not return all the way to normal. At the low power factors involved in motor starting, a regulator will ordinarily restore generator voltage to normal if the total load kva drawn by the motor being started and by the initial load on the generator does not exceed the generator rating. If the regulator can do this, the time required does not usually exceed one or two seconds.

By reducing both the amount and duration of disturbances, use of a voltage regulator makes possible the starting of a motor of given size from a much smaller generator than could be used without a regulator. The cost of regulating equipment is only a small fraction of the increase in generator cost which would be required to obtain comparable performance without a regulator. Hence, voltage regulators are almost universally used with generators supplying industrial power.

LIMITATIONS TO ALLOWABLE DISTURBANCE

The extent to which the voltage may be permitted to drop and the value to which regulators, if present, must be able to restore the voltage, are determined by requirements of the equipment connected to the generator.

Light Flicker

Flicker places much more stringent limitations on voltage dip than do most other limiting conditions. The acceptability of light flicker is affected by the type of work being done in the lighted location, by the characteristics of the observer, and by both the magnitude and frequency of the voltage dips. Dips at a frequency of about 8 cycles per second, such as might be caused by a reciprocating compressor, are most noticeable and may be perceived even when they have a pulsation as small as about 0.5 per cent. If the dips are infrequent, a dip of 1 per cent in voltage may not be perceptible. Also, a dip which is perceptible may not be objectionable, and infrequent dips as great as 5 per cent or more may be acceptable.

It is not usually economical to attempt to eliminate light flicker entirely on limited-capacity systems. On the other hand, there is little agreement as to what constitutes acceptable flicker. Consequently, in each case where light flicker is a determining factor, it is desirable to define the requirements with respect to flicker in terms of voltage drop under specified conditions.

Motors in Operation

If the voltage dips to less than 70 per cent, there is a possibility that motors already operating on the system may stall. Also, if the motors are temporarily loaded above their ratings, as in the case of a special duty cycle, stalling or pull-out may occur at voltages that are not as low as 70 per cent.

Operation of Undervoltage Protection

The voltage disturbance should not be so severe as to cause undervoltage protection to disconnect the motor or to disconnect other equipment already operating. If the undervoltage protection is provided by a device to trip a circuit breaker, it may be of the time-delay type which permits the breaker to remain closed during momentary disturbances. If the protection is provided by the inherent characteristic of a contactor to drop out on undervoltage, the contactor will open almost immediately after the voltage falls to the drop-out value. (Some control equipments are provided with time-delay devices which permit a contactor to reclose within a certain time interval, but these are not always helpful, because they do not prevent disconnection during the disturbance.) Contactors are designed to pick up when the voltage is not less than 85 per cent. When picked up, most of them will hold in, even though the voltage dips to as low as about 65 per cent.

Torque Requirements

The starting torque which a motor develops is proportional to the square of the voltage at the motor terminals. Thus, at half voltage a motor will develop only one quarter of the torque it will develop at full voltage. The full-voltage starting torque is dependent on the motor design and is usually expressed in percentage of the torque delivered by the motor at full load, full speed. The torque required for starting is dependent on the type of load the motor drives. Therefore, for each motor application, regardless of the method of starting used, the voltage at the motor terminals must be above a certain value to make starting possible.

If the excitation of the generator is not changed, as by regulators or hand control, the minimum value to which the load reduces the voltage must not be so low as to be inadequate for starting the motor. To maintain sufficiently high minimum voltage without a regulator would ordinarily require so large a generator that the use of a regulator is nearly always justified.

When voltage regulators are used, the permissible minimum voltage is not limited by torque requirements. The motor will start if the regulator can restore the voltage to an adequate value.

Occasionally with high-speed motors driving loads which increase rapidly as the speed rises, such as 3600-rpm motors connected to centrifugal pumps, a power system or a starting method which can provide adequate voltage to cause the motor to break away from standstill may, nevertheless, not provide adequate voltage to accelerate the motor to its full speed. Such cases require special consideration.

Special Limitations

The presence of X-ray equipments, or of certain types of lamps that may go out on slight undervoltage, or of other special conditions, may determine the allowable minimum voltage.

METHODS OF STARTING

Common methods of motor starting are:

(1). Full-voltage starting

(2). Reduced-voltage autotransformer starting

(3). Resistor starting

(4). Reactor starting

(5). Secondary-resistance control (of wound-rotor motors.)

TYPES OF SQUIRREL-CAGE INDUCTION MOTORS

Use is commonly made of squirrel-cage induction motors of three types, designated as follows:

(1). Normal-starting-torque, normal-starting-current.
(2). Normal-starting-torque, low-starting-current.
(3). High-starting-torque, low-starting-current.

The selection of a motor of either the second or third of these types may help to meet the requirements of a particular system. Usually the reduction in starting current made possible by selecting a motor of either of these two types is less than the reduction obtainable by use of reduced-voltage starting.

INITIAL LOADS

If the generator is already carrying a load when a motor is started, this initial load will have an influence on the voltage dip. The extent of this influence will depend on the amount of this other load, on its power factor, and on its character (induction, synchronous, lighting, etc.). Initial loads may either accentuate voltage disturbances or reduce them. The effect of motors previously connected depends on the percentage of their ratings to which the motors are loaded. The effect of initial loads not exceeding about 25 per cent of the generator rating can ordinarily be neglected.

LINES, CABLES, AND TRANSFORMERS

Wherever appreciable, the voltage drop in lines, cables, and transformers connecting motors to generators should be given consideration. However, cable runs of not over 50 ft per 100 volts of circuit voltage may ordinarily be neglected.

MOTOR SYNCHRONIZATION

Because synchronous motors start and run as induction motors up to the time field is applied, their starting requirements during this period are similiar to those of induction motors. When, at the end of the starting period, synchronous motors are up to speed and directly connected to the line, and field excitation is applied, they must be able to pull into step with the system frequency.

To assist in the selection of synchronous motors, manufacturers publish values of pull-in torque. These values apply to synchronization at full voltage and specified values of load WR^2. Data are also published concerning the increase in pull-in torque which may be required when the load WR^2 exceeds the published normal value.

If the voltage at synchronization is less than the rated voltage of the motor, the synchronizing ability of the motor is reduced. The torque against which a motor will pull in a given WR^2 varies approximately as the square of the voltage. Thus, for a given WR^2, a motor with 95 per cent applied voltage will pull in against only 90 per cent as much torque as it would if full voltage were applied.

Just before synchronizing, a motor may draw about one half the current it would draw on full-voltage starting. For this current, the motor voltage just before synchronizing can be calculated for a given motor, if the system characteristics are known. A generator with a voltage regulator will ordinarily hold its normal voltage at the power factors involved in synchronization, if its output kva at the time does not exceed its kva rating. However, it may be necessary to calculate the voltage drop in lines, cables, or transformers supplying the motor to determine the voltage at the motor.

HOW TO SELECT EQUIPMENT

From the foregoing, it is obvious that there are many factors that may need consideration when selecting generating equipment, motors, and motor starters for operation on power systems of limited capacity. To aid in making proper selections, when the operating conditions are relatively simple, Table I has been prepared. In it are included the specific, but necessarily approximate, data needed in making the calculations that determine the selection of the equipment. *It should be especially noted that the data apply only for the operating conditions listed at the top of the table.*

How the table is utilized in solving typical problems is illustrated in the examples which follow.

Example 1

Determination of Starting Method and Minimum Generator Size

It is desired to start a squirrel-cage induction motor under the conditions listed for Table I and when:

Motor horsepower = 100 hp.
Full-voltage starting current = 6 times full-load current.
Full-voltage starting torque = 120 per cent of full-load, full-speed torque.
Starting torque required = 45 per cent of full-load, full-speed torque.

$$\text{Hence: } \frac{\text{Starting Torque}}{\text{Full-voltage Starting Torque}} = \frac{45}{120} = 0.375 \text{ (minimum allowable).}$$

From Table I, it will be noted that the use of an autotransformer-type starter set on the 65-per-cent tap would result in

$$\frac{\text{Starting Torque}}{\text{Full-voltage Starting Torque}} = 0.42.$$

Therefore, this type of starter and tap would make adequate starting torque available (after the voltage has returned to normal).

For this starter and tap, the minimum generator kva is also determined from Table I, as follows:

Since the full-voltage starting current of the motor was assumed to be six times its full-load current, the formula for K at the bottom of the table shows that K = 6.

In the column under the heading "K = 6," it will be noted that

$$\frac{\text{Minimum Gen. Kva}}{\text{Motor Hp Rating}} = 2.7.$$

Hence: Minimum Gen. Kva = $2.7 \times 100 = 270$

All the other listed standard types of starters and settings are seen to require more generating capacity or provide less torque than the method and setting chosen.

Example 2

Determination of Starting Method and Minimum Generator Size

Although the nature of the information sought in this example is the same as that in Example 1, this second example is included primarily to illustrate how

Table I: Characteristics of Motor-Starting Methods, Applying When:

Standard, 0.8-pf generators are used — Initial load on generators does not exceed 25%
Voltage regulators control all generators — Generator voltage does not fall below about 75%
Voltage drop from generators to motor is negligible.

NOTE: Under these conditions, regulators will restore motor voltage to substantially 100% for meeting starting-torque requirements.

Type of Starter (Settings given are the more common for each type)	FOR 100% LINE VOLTAGE		(Minimum Gen. Kva / Motor Hp Rating)			(Min. Gen. Kva / Full-voltage Starting Kva)
	(Motor Voltage / Rated Voltage)	(Available Starting Torque / Full-voltage Starting Torque)	K=4	K=6	K=8	
Full-voltage starter.	1.0	1.0	4.0	6.0	8.0	1.0
Autotransformer						
80% Tap	0.80	0.64	2.7	4.0	5.3	0.65
65% Tap	0.65	0.42	1.8	2.7	3.6	0.45
50% Tap	0.50	0.25	1.1	1.7	2.2	0.30
Resistor starter, single step. (Adjusted for motor voltage to be 80% of line voltage)	0.80	0.64	2.8	4.2	5.6	0.70
Reactor.						
50% Tap	0.50	0.25	2.0	3.0	4.0	0.50
45% Tap	0.45	0.20	1.8	2.7	3.6	0.45
37.5% Tap	0.375	0.14	1.5	2.2	3.0	0.40
Wound-rotor-motor multistep control. (Starting current limited to 150% of motor rated full-load current. Torque available during acceleration 100%)	1.0			1.0		

$$K = \frac{\text{Motor Full-voltage Starting Current}}{\text{Motor Full-load Current}}$$

NOTE: In some cases, when complete data are available, special study may show that satisfactory starting can be obtained using generator sizes smaller than those indicated in this table.

such a problem is solved when a different combination of data is used.

It is desired to start a squirrel-cage induction motor under the conditions listed for Table I and when:

Motor horsepower = 20 hp.
Full-voltage starting current = 380 amp.
Motor rated voltage = 220 volts, 3 phase.
Full-voltage starting torque = 150 per cent of full-load, full-speed torque.
Starting torque required = 100 per cent of full-load, full-speed torque.

$$\text{Hence: Full-voltage Starting Kva} = \frac{220 \times 380 \times \sqrt{3}}{1000} = 145.$$

$$\frac{\text{Starting Torque}}{\text{Full-voltage Starting Torque}} = \frac{100}{150} = 0.67 \text{ (minimum allowable)}.$$

From the table, it will be noted that a full-voltage starter would result in

$$\frac{\text{Starting Torque}}{\text{Full-voltage Starting Torque}} = 1.0.$$

Therefore, this type of starter would make adequate starting torque available (after the voltage has returned to normal).

The minimum generator kva is determined as follows from the last column of the table:

$$\frac{\text{Minimum Gen. Kva}}{\text{Full-voltage Starting Kva}} = 1.0.$$

Hence: Minimum Gen. Kva = 1.0 × 145 = 145.

This use of the last column is seen to be substantially equivalent to the use of the preceding three columns, except that it applies directly when the full-voltage starting kva is known and avoids any assumptions as to the ratio of motor full-load kva to hp.

Example 3

Selection of Type of Motor

It is desired to start a 50-hp, 440-volt, 1800-rpm squirrel-cage induction motor from a 312-kva generator under the conditions for Table I and when:

Starting torque required = 140 per cent of full-load, full-speed torque

The type of motor is selected by successive trials, using Table I as follows:

(1). For the first trial, assume a normal-starting-torque, normal-starting-current motor of the given rating. Published data on such a motor reveal that:

Full-voltage starting torque = 150 per cent of full-load, full-speed torque and that K = 7.3.

Since for this motor the full-voltage starting torque (150 per cent) is so little in excess of the required starting torque (140 per cent), it is immediately evident that a full-voltage starter should be used. In Table I, this selection is indicated by the fact that, for full-voltage starting,

$$\frac{\text{Starting Torque}}{\text{Full-voltage Starting Torque}} = 1.0.$$

The minimum generator kva for this trial selection of motor and starter is determined from Table I in the same manner as was followed in Example 1, except that, in the present example, the value of

$$\frac{\text{Minimum Gen. Kva}}{\text{Motor Hp Rating}}$$

for K = 7.3 must be obtained by direct interpolation between the values in the columns headed K = 6 and K = 8. Thus, in the present case

$$\frac{\text{Minimum Gen. Kva}}{\text{Motor Hp Rating}} = 7.3.$$

Hence: Minimum Gen. Kva = 7.3 × 50 = 365.

Since this minimum kva exceeds that which was stated to be available (312 kva), a second trial selection will be made, this time considering a type of motor having a lower starting current.

(2). For the second trial selection, assume a normal-starting-torque, low-starting-current motor of the given rating. For this motor, published data reveal that:

Full-voltage starting torque = 150 per cent of full-load, full-speed torque, and that K = 6.0.

By proceeding in the same manner as was followed in checking the foregoing trial selection (except that, since K = 6.0, no interpolation is necessary), it will be found that, as previously, a full-voltage starter is needed to assure adequate starting torque. However, the minimum generator kva is found to be only 300.

Therefore, the selection of this type of motor satisfies both the starting-torque and the generator-kva requirements.

HOW TO INSTALL MOTORS

WHETHER motors are mounted on machines or as separate drives in the factory, a motor that is convenient to handle and easy to install is a time and money saver. G-E motors have many features that have been thoughtfully included in their design to make the job of installing and starting motors for the first time as easy and convenient as possible—roomy conduit boxes; graphic connection plates; lubrication fixtures; strong, sturdy, closely machined feet; and many others.

Further, each motor is supplied with complete instructions for installing, wiring, and maintenance.

The following information is presented as further assistance on the fundamentals of good installation practice for motors. Data are included on:

How to locate and align motors.
How to select belts and pulleys.
What to consider—individual or group drive.
How to connect motors and what to check before starting motors.

HOW TO LOCATE AND ALIGN MOTORS

When contemplating the installation of motors and control, there are several general points to be considered. The most important items may be summarized as follows:

1. Location of the motor.
   (a) Arrange the drive to conserve floor space.
   (b) Make the motor and control accessible for inspection and repairs.
2. Atmospheric conditions.
   (a) See that the motor and control are well ventilated.
   (b) Do not install a standard motor where the ambient temperature is more than 40 C, or where the normal temperature rise is more than 40 C.
   (c) If motor or control is subject to extreme conditions of explosive, abrasive, or magnetic dust, dripping water, steam, acid, alkali, or moisture, it must be suitably protected.
3. Type of drive—The type of drive selected will restrict the location of the motor and, vice versa, the location of the motor will influence the type of drive selected.
4. Build a firm, strong, and rigid support for the motor.

Assuming now that the motor is properly located and the right kind of mounting has been built, the next step is properly to align the machine with its drive.

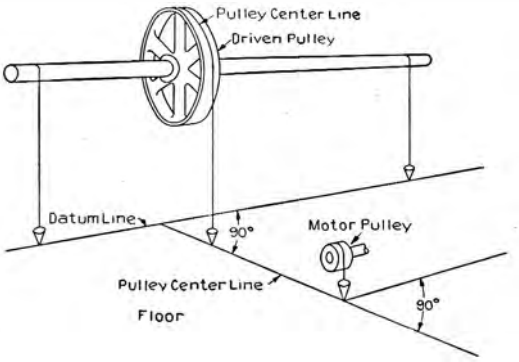
The tools usually used for aligning motors or line-shafting are the square, plumb bob, and level. Tool manufacturers also build combination squares and levels and similar tools that are a material aid in quickly and accurately aligning machinery.

The first step to be taken when aligning two machines is to see if they are level. It is possible for a machine to be out of line in more than one plane. If, by placing a level or plumb on the machine, it is found to be out a certain amount, the motor must then be mounted so that it will also be out a like amount.

Belt drive is a common form of mechanical transmission, but the principles involved and the methods used apply, in general, equally well for chain drive.

The illustration below shows a simple and easy method of aligning a motor pulley with the driven pulley. First, the crown or center line of the pulleys must be on the same center line, and, second, the motor shaft must be parallel to the driven shaft.

By using a plumb bob and drawing a datum line on the floor, a base of operation is established. Next, drop a plumb line from the center of the driven pulley to the floor. With a square, draw a line perpendicular to the datum line. Next, drop a plumb line from the center of the motor pulley and move the motor up or back until the plumb bob rests on the center line of the driven pulley. From the pulley center line, perpendiculars may



Method of aligning two pulleys

be drawn through the centers of the holes in the motor feet. A level should be used to see that the line shafting is level. If it is not, then the motor feet must be shimmed up so that the motor shaft and the line shaft will be "out of level" the same amount. Chain drive may be aligned in a similar manner.

With belt drive, a sliding base is nearly always used to allow for belt adjustment. Another method, therefore, is to use the following procedure when aligning two pulleys.

1. Place the motor on the base so that there will be an equal amount of adjustment in either direction, and firmly fasten the motor to the base by means of the four holding-down bolts.

2. Mount the motor pulley on the motor shaft.

3. Locate the base and motor in approximately the final position, as determined by the length of belt.

4. Stretch a string from the face of the driven pulley toward the face of the motor pulley.

5. Parallel the face of the motor pulley with this string.

6. Using a scratch pin, mark the end positions of the sliding base.

7. Extend these lines.

8. Move the base and motor away from the string an amount equal to one half the difference in face width of the two pulleys. Use the two extended lines as a guide to keep the base in its proper position.

9. The belt should now be placed on the pulleys to see if it operates satisfactorily. If it does not operate properly, the base may be shifted slightly until proper operation is obtained.

10. Finally, firmly fasten the base to the floor, ceiling, or side wall by means of lag screws or bolts.

HOW TO SELECT BELTS AND PULLEYS

APPLICATION OF BELT DRIVE

Where a speed reduction is involved in the transmission of power, and where it is not necessary to maintain an absolutely fixed ratio between driving and driven shaft, belting is usually the best form of drive to employ. It is simple, inexpensive, and efficient (between 85 and 95 per cent); it has the advantage of slipping slightly under heavy overloads; because of its elasticity and slip, it will absorb a portion of the shock of suddenly applied loads, and thus protect to some extent both motor and driven machine. Specially tanned or waterproofed leather belts, fabric belts, and rubber belts may be selected to meet practically any atmospheric conditions.

As indicated above, belting cannot be used where positive drive is imperative, that is, where the relative rpm of driving and driven shafts must remain unchanged. The upkeep for belting is usually higher than for other forms of transmission, though this cost can be materially reduced if the proper quality of belt is used and the belt is properly applied and cared for. The space required is somewhat greater than for some of the other forms of mechanical transmission.

SELECTION OF PULLEYS

Pulley Ratios

One of the first points to consider in connection with belt drive is the ratio involved. For good practice the following belt reductions should not be exceeded:

1/15-hp motor	15 to 1
1-hp motor	10 to 1
5-hp motor	8 to 1
10-hp motor	6 to 1
20-hp motor	5 to 1
50-hp motor	4 to 1

NOTE.—The values given above are the limiting values to be used with belting. For output-shaft speeds of 600 rpm and lower, we suggest that gear-motors be considered as offering a more economical, efficient, and generally more successful solution to problems involving low-speed drive.

Pulley Diameters

The following rules are given for determining pulley diameters and speeds:

1. $$\text{Diam of driven pulley} = \frac{\text{Diam of motor pulley} \times \text{full-load motor speed in rpm}}{\text{Rev per min (rpm) of driven pulley}}$$

2. $$\text{Diam of motor pulley} = \frac{\text{Diam of driven pulley} \times \text{rpm of driven pulley}}{\text{Full-load motor speed in rpm}}$$

3. $$\text{Rev per min of driven pulley} = \frac{\text{Diam of motor pulley} \times \text{full-load motor speed}}{\text{Diam of driven pulley}}$$

4. $$\text{Rev per min of motor} = \frac{\text{Diam of driven pulley} \times \text{speed of driven pulley}}{\text{Diam of motor pulley}}$$

The above formulas may be applied to any belt drive by substituting the terms "driver" and "rpm of driver" for "motor pulley" and "motor speed."

CAUTION.—The desired driven speed should be increased 2 per cent in above formulas to allow for belt slip.

It is desirable to utilize the standard pulleys furnished with the motors wherever possible. The use of special pulleys on electric motors is limited by mechanical dimensions, and by the permissible bearing pressure, which, for the transmission of a certain horsepower, increases as the pulley diameter decreases. The maximum pulley diameter is determined by mechanical dimensions. These are in addition to the usual requirements of proper belt speed and width to transmit the power involved.

Belt Speed

Belts should not be run at speeds above 5000 ft per min. Above this speed, there is not sufficient friction contact between belt and pulley, because of the effect of centrifugal force tending to "throw" the belt.

Table I on the following page gives the belt speed in feet per minute corresponding to various motor speeds and pulley diameters.

Table I—Belt Speeds

Full-load Speed of Motor in Rpm	PULLEY DIAMETERS IN INCHES										
	3½	4	4½	5	5½	6	7	8	9	10	11
	Belt Speed in Feet per Minute										
1750	1605	1835	2060	2290	2520	2750	3205	3670	4125	4580	5040
1450	1330	1520	1710	1900	2090	2275	2660	3040	3420	3800	4170
1150	1055	1205	1355	1505	1655	1810	2110	2410	2710	3010	3315
860	790	900	1015	1130	1240	1350	1575	1800	2030	2255	2480
690	....	725	815	905	995	1085	1265	1445	1625	1810	1990
575	....	....	680	755	830	905	1055	1205	1355	1505	1655

Full-load Speed of Motor in Rpm	PULLEY DIAMETERS IN INCHES										
	12	13	14	15	16	17	18	19	20	21	22
	Belt Speed in Feet per Minute										
1450	4560	4930									
1150	3615	3915	4220	4520	4820	5120					
860	2705	2930	3160	3380	3610	3835	4060	4280	4510	4740	4960
690	2170	2350	2530	2710	2890	3075	3250	3435	3615	3800	3980
575	1805	1955	2105	2260	2410	2560	2710	2860	3010	3160	3310

Full-load Speed of Motor in Rpm	PULLEY DIAMETERS IN INCHES										
	23	24	25	26	27	28	29	30	31	32	33
	Belt Speed in Feet per Minute										
690	4160	4340	4520	4700	4880	5060					
575	3460	3610	3760	3915	4060	4210	4360	4515	4665	4815	4965

The above table is based on the formula:

$$\text{Belt speed in feet per minute} = \frac{3.1416 \times \text{pulley diameter in inches} \times \text{rpm}}{12}$$

Horsepower Transmitted

The pulley must be large enough to transmit the horsepower, which ordinarily will not be the motor-horsepower rating, but a figure somewhat larger, to take care of possible overloads and peak loads. In ordinary applications, 125 per cent of the motor rating may be allowed for a safety factor in the usual sizes of motors.

In general, the product of the diameter and belt width of a *special* pulley should at least equal the product of the corresponding dimensions of the *standard* pulley recommended for that size and speed motor. Assuming that the diameters have been tentatively chosen as best for the desired purpose, the horsepower that can be transmitted will depend upon the pulley material, the belt width, its quality and number of plies, the distance between centers, and the relative angular location of the driving and driven pulley.

Table II shows the hp per in. of width transmitted by good leather belting running over paper pulleys with 180-degree arc of contact and no slip. For iron pulleys, multiply figures given by 0.62; for wood pulleys, multiply 0.41. (For belt speeds, see Table I.)

The figures shown in Table II are for "regular" single-ply and double-ply belts. The values for horsepower transmitted by "light" belts will be 80 per cent of values shown, and by "heavy" belts, 115 per cent of values shown.

Table II—Hp Transmitted per Inch of Width—Leather Belts

To obtain the horsepower transmitted by belts of any width, multiply the figure shown for the given belt speed by the width of the belt used.

Belt Speed, Ft per Min	Hp per Inch of Width	Belt Speed, Ft per Min	Hp per Inch of Width	Belt Speed, Ft per Min	Hp per Inch of Width	Belt Speed, Ft per Min	Hp per Inch of Width
Single-ply belting							
900	1.25	2000	2.78	3100	4.31	4200	5.84
1000	1.39	2100	2.92	3200	4.45	4300	5.98
1100	1.53	2200	3.06	3300	4.59	4400	6.12
1200	1.67	2300	3.20	3400	4.72	4500	6.26
1300	1.81	2400	3.33	3500	4.86	4600	6.40
1400	1.95	2500	3.47	3600	5.00	4700	6.54
1500	2.09	2600	3.61	3700	5.14	4800	6.68
1600	2.22	2700	3.75	3800	5.28	4900	6.82
1700	2.36	2800	3.89	3900	5.42	5000	6.96
1800	2.50	2900	4.03	4000	5.56	....	....
1900	2.64	3000	4.17	4100	5.70	....	....
Double-ply belting							
900	1.79	2000	3.97	3100	6.16	4200	8.34
1000	1.99	2100	4.17	3200	6.36	4300	8.54
1100	2.19	2200	4.37	3300	6.55	4400	8.74
1200	2.39	2300	4.57	3400	6.75	4500	8.94
1300	2.58	2400	4.77	3500	6.95	4600	9.13
1400	2.78	2500	4.97	3600	7.15	4700	9.33
1500	2.98	2600	5.16	3700	7.35	4800	9.53
1600	3.18	2700	5.36	3800	7.55	4900	9.73
1700	3.38	2800	5.56	3900	7.74	5000	9.93
1800	3.58	2900	5.76	4000	7.94	....	....
1900	3.78	3000	5.96	4100	8.14	....	....

Belt Width

For a given diameter, the minimum belt width is determined by the horsepower to be transmitted; the maximum width is limited by the possible overhang and the safe strain which may be placed on the bearing.

To obtain the belt width necessary to transmit a given horsepower, divide the horsepower which is to be transmitted by the figures given in Table II, if paper pulleys are used. For iron pulleys, multiply the quotient thus obtained by 1.6; for wood pulleys, by 2.4.

Stock sizes of belts increase in width by the following increments:

From ½- to 1-in. belt width, by ⅛ in.
From 1- to 4-in. belt width, by ¼ in.
From 4- to 7-in. belt width, by ½ in.
From 7- to 30-in. belt width, by 1 in.
From 30- to 56-in. belt width, by 2 in.
Above 56-in. belt width, by 4 in.

The foregoing represents average practice; stock sizes of different manufacturers may vary slightly from the figures given.

Pulley widths should exceed belt widths by following amounts.

Pulley Diameter in In.	Iron Pulley, In.	Paper Pulley, In.
Under 2	¼	¼
2 to 5	½	½
5 to 10	½	¾
10 to 20	½	1
20 to 24	¾	1
24 to 36	¾	1½
Above 36	¾	2

A good handy rule to remember is: A single-ply belt 1 in. wide, running at 1000 ft per min, will deliver approximately 1 hp (up to about 3000 rpm).

Round belts of 0.25 and 0.5 in. diameter are fully equal to single belts of 1 and 3 in. respectively.

Belt Slip

The effect of creepage and slip is to reduce the speed of the driven pulley and, consequently, the power transmitted. For commercial applications, it will be close enough to multiply the calculated speed of the driven shaft by 98 per cent, assuming 2 per cent slip. The diameter of the driven pulley should be slightly smaller than that calculated on the basis of no slip, in order to get a certain speed at the driven shaft. In other words, the speed of the driven shaft is reduced by slip unless compensated for by reducing the driven-pulley diameter a proportionate amount.

A small amount of belt slip is not harmful, but excessive slip is. Severe slippage burns the belt, quickly destroying its usefulness, while, at best, the belt surface is polished, so that the grip on the pulley is materially reduced. Belt slip can be detected by noting the condition of the pulley surface. When the belt is slipping, the pulley will have a very shiny appearance, as contrasted with the smooth, but rather dull, appearance it should have.

Excessive slip is caused by poorly designed drives, where the driving pulley is too small or the load too great; by running the belt too loose; or by not giving proper attention to the care of the belt.

Arc of Contact

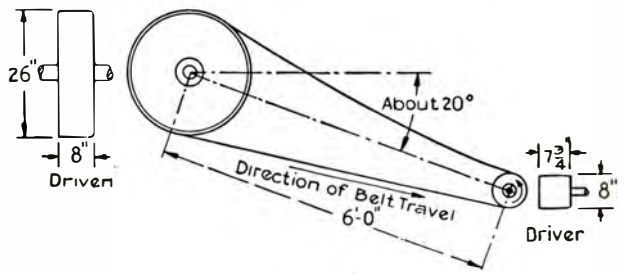
One of the factors affecting the amount of power that can be transmitted by a belt of given width is the arc of contact (the distance the belt wraps around the pulley). As this arc of contact decreases, the belt width must be increased to transmit the same horsepower with 2 per cent slip; Table II, however, allows a factor of safety sufficient to take care of installations which are in accordance with the recommendations for belt ratios and center distances given in this article. If it is necessary to exceed the limits given, it may be necessary to use a belt tightener.

ARRANGEMENT OF BELTS AND PULLEYS

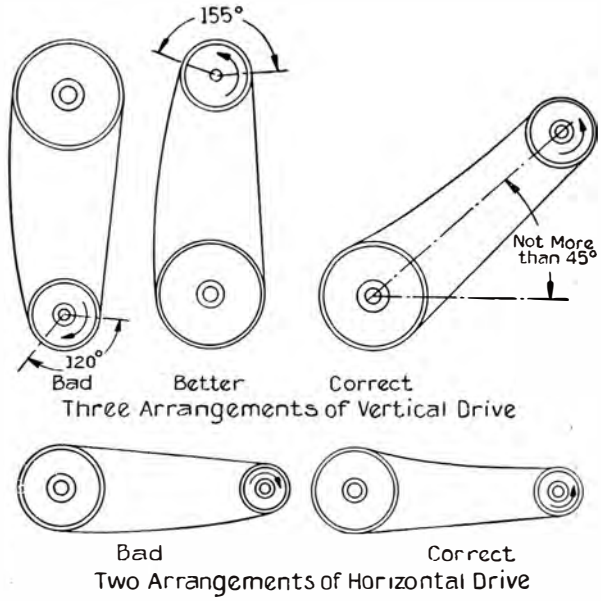
Direction of Drive

Horizontal drives are best. Under these conditions with the *lower* side of the belt driving, the sag of the upper side tends to increase the arc of contact. This sag should be about 1½ in. for every 10 ft of center distance between shafts. If too loose, the belt will have an unsteady flapping motion which will injure both belt and machinery; if too tight, the bearings will be worn and the belt quickly destroyed.

Vertical drives, the mounting of one pulley above another, should be avoided. This is particularly true where the lower pulley is the smaller.



Typical sketch of belt layout



Arrangement of belts

The effective tension and arc of contact are reduced in vertical drives so that the normal load cannot be carried. It is better if the angle of the belt with the floor does not exceed 45 degrees. Where several belts transmit power from a line shaft, it is advantageous, where possible, to locate the line shaft so that the bearing pressures can be equalized and reduced by alternating the direction of drive, first on one side, then on the other.

Center Distances

A short center distance is bad for two reasons: it means a shorter belt, so that flexure occurs at each cross section more frequently; the arc of contact on the smaller pulley frequently becomes so small that power can no longer be effectively transmitted. Two and a half times the diameter of the larger pulley should be the minimum center distance, with from three to five a better figure.

BELT TENSION

The belt tension should be slightly more than just enough to avoid belt slip on starting. Excessive belt tension puts abnormal load on the motor bearings and may cause bearing failure. New belts will generally be put on tighter, to compensate for the belt stretch obtained during the first few days of operation. A good check of belt tension is to put approximately ten pounds' pressure on the top of the belt, midway between the pulleys. With this pressure, the belt would be deflected approximately half an inch for short-center drives and three quarters of an inch for longer belt centers.

WHAT TO CONSIDER—INDIVIDUAL OR GROUP DRIVE

It is the purpose of this discussion to assist those contemplating the use of electric drive in arriving at a decision as to whether individual or group drive is the better for a given application. Unbiased transmission engineers hold the opinions that:

1. No hard-and-fast rules favoring one method or the other for every application can be made.
2. The particular factors involved are peculiar to each application and not common to all.
3. Each case should be decided only after carefully weighing the advantages and disadvantages of each method for that particular application.

For example, there may be a saving in operating expense with individual drive, which must be weighed against a possible saving in initial cost with group drive.

The problem of making a proper choice between the two methods is often obscured by the fact that, in existing installations, the types and sizes of motors or of transmission equipment have not always been correctly selected or properly installed. Neither type of drive will be fully successful unless carefully engineered. In the following discussion, it is assumed that equal engineering skill has been brought to bear on both sides of the question.

INITIAL COST

There is no doubt that considerable saving in the initial cost of the motor equipment can usually be made with group drive. For sizes below 5 hp, the cost per horsepower is greater than for the larger sizes. In general, a saving in investment will be realized with group drive:

(a) Where there are compact groups of constant-speed machines which will be required to run continuously or simultaneously.

(b) With compact groups of machines which, because of their diversity factor in operation, may be driven by a single motor of much smaller rating than the combined capacities of the motors required for individual drive.

That is, it is seldom that all machines in a group will be fully loaded at the same time, and a motor capable of carrying the average load of the group may therefore be selected, its overload capacity being sufficient to care for any short-time overload conditions.

(c) With groups of constant-speed machines, where heavy peak-load demands might require individual motors of a size considerably in excess of the average running load.

(d) When the motors required for individual drive are small.

(e) In changing over existing installations, where the line shafting is already installed.

Under certain conditions, however, the initial cost will usually be less with individual drive:

(a) Where machines are isolated, requiring long lines of shafting to combine with other groups, so that the cost of the transmission more than offsets the extra expense of individual motors.

(b) Where the roof construction will not safely support line shafting, or where the additional expense of making it sufficiently strong would be too great. Occasionally, it is possible to mount the line shafting on the ceiling of the room below and drive up through the floor. The holes cut through the floor to accomplish this purpose weaken the floor and increase the fire hazard so that this scheme is inadvisable; while on the first floor, with no basement underneath, it is impossible.

OPERATING COST

Unless carefully maintained, the transmission equipment will decrease in efficiency on account of gradual misalignment of shafts, increased belt slippage, etc. These losses may be offset, in part at least, by the fact that the efficiency of a motor of large size used with group drive is better than that of the small-size motors used with individual drive.

There may be a power saving in favor of group drive:

(a) In shops where a maximum demand charge is made, based on the horsepower of the connected load.

(b) Where the efficiency and power factor (if there is a power-factor penalty clause) are high because of a nearer approach to full-load conditions.

This point is usually overstressed, as there are many plants equipped with individual drive with a power factor of around 80 per cent, while, in many plants with group drive, the power factor is low. In lining up machines for group drive, the assumption is automatically made that each of the machines will be operated most of the time, although probably not at capacity. There are many times, however, when possibly only two or three machines out of a group of six or eight are actually operating simultaneously.

There would be a power saving in favor of individual drive:

(a) Where many machines operate intermittently or at infrequent intervals.

(b) Where much overtime work involving only a few machines is carried on.

(c) Where long lines of shafting cause large transmission losses which can be eliminated by substitution of individual drive.

PRODUCTION

In many installations it is possible to increase production with individual motorized drive:

(a) By the use of individual magnetic control, whereby the workmen may remain in position to observe the progress of the work and, at the same time, have full control over the driving equipment.

(b) Where it is desired to obtain elaborate or specialized control, which may be expensive, cumbersome, or inefficient to accomplish by mechanical means. A good example of such a condition is in printing-press drive.

(c) By closer regulation of speed, through elimination of belt slip.

Every successive belt through which power is transmitted in group drive usually results in a drop in speed. In laying out installations, reasonable allowance is made for this slip, but, unless considerable attention is paid to maintenance of shaft alignment, belt tension, and load conditions, machines will frequently be found running under speed after being in operation any considerable length of time.

(d) Where some considerable portion of the time is required in set-up work, taking advantage of the more flexible control possible with an individually motorized equipment.

(e) Through less wholesale interruptions due to breakdowns. Many times, with individual drive, production may be temporarily diverted to other machines; with group drive, several machines are affected.

(f) Where arranging machines in line for line-shaft drive does not allow a logical arrangement of machines for production purposes. This is particularly important where a rearrangement of the machines is necessary from time to time to keep step with changing conditions.

(g) Where the size of the work is such that it is easier, or necessary, to use portable tools. In these cases, the tool is moved to the work, and a number of set-ups and changes in position of a large casting are avoided.

(h) By using certain special tools and motors particularly designed for specialized work.

The high-speed motors used in woodworking and grinding machinery are very good examples of this. Belt speeds in excess of 6000 ft per minute would often be necessary, which would result in very unsatisfactory operation. The combination of a fairly large amount of power per spindle and a very high speed is met here by individually motorized spindles, as well as by individually motorized machines.

WORKING CONDITIONS

It is generally admitted that working conditions are inherently better with individual drive than with group drive.

(a) There is less danger, particularly for the maintenance men, from belting, shafting, etc.

(b) The psychological effect of working near rapidly moving belts and pulleys is unquestionably bad, and has a tendency to increase fatigue, with consequent harmful effect on precision work.

(c) Better light and circulation of air are obtained. Lighting conditions are particularly important where artificial light is required, and overhead belting and shafting practically preclude the shadowless lighting so necessary to safety and to accurate work.

(d) There is no danger of belts working from loose to tight pulleys, causing unexpected starting of machines.

(e) In many cases, manipulation of the driven machine can be made safer for the operator.

Good examples are emergency stop-stations, located at important points about a machine where hazardous operations are performed; "safety-first" switches which may be locked in the "off" position, preventing their operation by unauthorized persons.

QUALITY OF PRODUCT

The effect of overhead shafting and rapidly moving belts and pulleys on precision work is discussed above under "Working Conditions."

There are other ways in which individual drive aids towards a product of better quality.

(a) Where the more precise speed maintenance results in a more uniform product (as in some textile, most grinding, and many woodworking operations).

(b) Where the product requires conditions of exceptional cleanliness, which are difficult to obtain with overhead shafting and belts.

MISCELLANEOUS CONSIDERATIONS

Under some circumstances, the use of group drive is almost automatically ruled out by the construction of the building or the nature of the work. Such conditions are found:

(a) In plants where fairly heavy work is done, requiring clear overhead space for traveling cranes. The convenience, and often the necessity, of this moving material will offset any advantages group drive may otherwise have.

(b) Where machines are installed under galleries where there is not sufficient overhead room for line shafting.

(c) Where automatic or remote control of a machine is desired, e.g., control for a pressure tank or sump pump.

(d) In plants where periodic tests are made on each machine to determine the amount of power being used. With individual drive and jack-type switches, such tests may be made without stopping a single machine; with group drive, a shutdown of all machines in the group would be necessary before completing the test.

SUMMARY

In general, it may be said that any compact group of machines which may be equipped with a motor of considerably smaller capacity than the combined capacities of the motors required for individual drive should be considered for group drive; any machine operating at a fairly constant load, not much below its maximum, should be equipped with individual drive.

The cost of maintenance will be little different as between the two methods. Whatever is saved on motor maintenance with group drive because of fewer and possibly more accessible motors, is likely to be used up in maintaining and inspecting line-shaft bearings, belts, pulleys, clutches, etc.

All power costs, including fixed charges, rarely make up more than 3 or 4 per cent of the cost of the finished product. Therefore, any savings along these lines, while not to be overlooked, are not relatively as important as some of the other factors.

The question of production is far more important. Any means whereby production can be increased, by speeding up the process, conserving the workmen's time, locating machines for improved sequence of operation, or making handling of the material easier, will in practically every instance overrule all other factors.

HOW TO CONNECT MOTORS AND WHAT TO CHECK BEFORE STARTING

A little extra care at the time of installation is a good investment. For example, trouble may be avoided by a look at the brushes of a direct-current or single-phase repulsion motor to make sure that they are seating properly on the commutator, and with the proper pressure. It is also always good practice to turn the motor over by hand before applying power for the first time, to be sure that it turns freely and that no foreign materials or objects have fallen into the motor during shipment or handling.

Lubrication

External plan view of sleeve-bearing housing

Many fractional-horsepower motors have waste-packed bearings with a full charge of oil in them when shipped. Integral-horsepower motors (one-horsepower and larger) are usually shipped without oil in the bearings. These are normally equipped with an oil filler gage shown at the right, which should be approximately three quarters full of oil with the motor stopped. In every case, make sure that the motor has its proper supply of bearing oil before power is applied.

For average indoor temperatures, a good grade of mineral oil with a viscosity (resistance to flowing) of 250 to 350 seconds Saybolt at 100 F should be used. However, oil with a viscosity of 150 to 200 seconds Saybolt at 100 F may be used for motors which are coupled directly to the load, having speeds between 1500 and 3600 rpm with possibly lower bearing temperatures. (For convenience, the above viscosities correspond respectively to SAE No. 20 and SAE No. 10.) Turbine oil should be used, not automobile oil.

Integral-horsepower polyphase and direct-current motors are often equipped with oil-ring bearings. When a motor with this type of bearing is first started, each bearing should be checked immediately, through the inspection opening shown above, to make sure that the ring is turning.

Ball-bearing housings are generally packed with grease when shipped, and hence require no lubrication at the time of installation. See "How to Grease Ball Bearings" on page 134 for information on maintenance of lubrication.

Pulley

Severe pounding, to drive a pulley or coupling on the motor shaft, may cause a bent shaft or damage to the bearings. A little care in removing paint from the shaft and light filing of any rough spots on the shaft, key, and pulley bore should eliminate the need for any severe pounding.

Electric Connections

On smaller motors, it is sometimes good policy to make the electric connections to the motor before bolting it into place. Thus, if any loose part falls into the motor, it may be easily removed. All connections should be made tightly enough so that the vibration of the equipment will not be able to loosen them. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape, and then with friction tape. Wires issuing from a conduit box, especially rubber-covered extension cords, should be held in some way so that there is no strain on the connections themselves. Usually a knot in the wire inside the conduit box, or the use of conduit-box fittings that grip the wire where it leaves the box, are the most convenient ways to obtain this strain relief. Many fractional-horsepower motors are equipped with terminal boxes that are made so that they will grip the wires issuing from them.

It is good practice to check the motor nameplate to make sure that the motor has the correct horsepower, voltage, and frequency rating for the job. The nameplate stamping should agree with the power supply available. If the motor is rated for two voltages, it is well to check that it is connected for the proper voltage. The proper connections may be shown on a motor terminal plate, in a diagram on the inside of the conduit-box cover, or in the instruction book that accompanies the motor. Typical connection diagrams are illustrated on the page following.

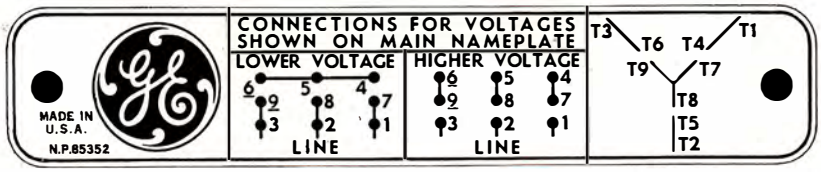
All motor and control wiring should be installed carefully in accordance with the National Electrical Code and any local requirements, and should have sufficient capacity to carry the full-load current with a maximum voltage drop of 2 per cent of the line voltage. Motor frames should be grounded in accordance with the Code.

Starting

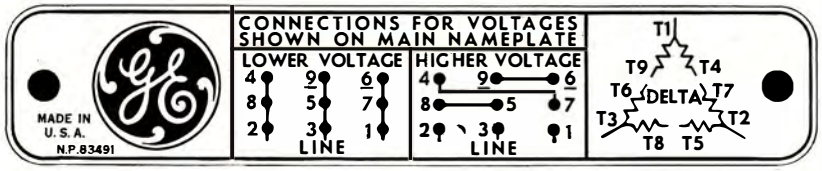
Leave the motor disconnected from the load for the initial start, if possible, particularly if direction of rotation is important to the driven apparatus. It is desirable to operate the motor without load for about an hour, if possible, to test for an unusual localized heating of the bearings or windings.

If direction of rotation is wrong, the instruction sheet accompanying the motor usually gives full instructions on how to correct. For three-phase motors, reverse any two leads. For two-phase motors, interchange lines of either phase.

Typical Connection Diagrams for Induction Motors

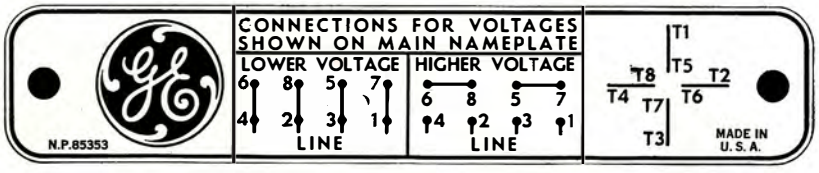


1Y 2Y



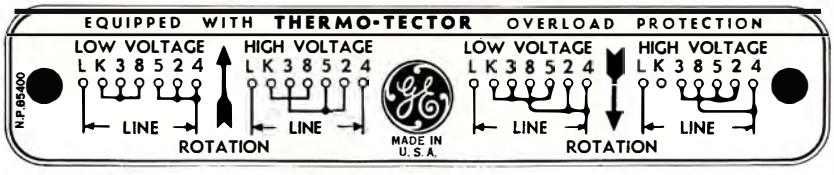
1△ 2△

For three-phase, dual-voltage squirrel-cage motors



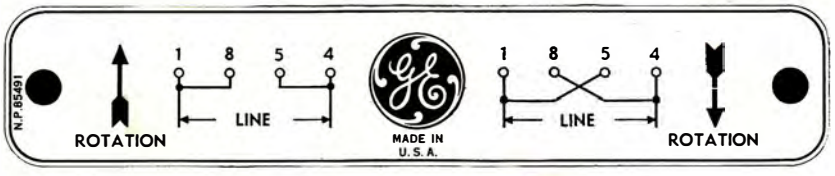
For two-phase, dual-voltage squirrel-cage motor

Without Thermo-Tector



With Thermo-Tector

For single-phase dual-voltage capacitor-motors, both rotations



Without Thermo-Tector

With Thermo-Tector

For single-phase, single-voltage capacitor-motors, both rotations

HOW TO SERVICE MOTORS

ELECTRIC motors have been made such reliable, faithful servants of industry that it is easy to forget them and to trust they will continue running without attention.

To follow such a policy, however, accelerates depreciation of investment and builds up possibilities of costly production interruptions. It is a relatively simple and profitable matter to service regularly the motors in your plant.

What to do? Establish a system for servicing. Regularly inspect each motor. Keep a record of its operation and the service given it. Check its mounting, coupling or belts, its temperature and current, its bearings and lubricant. Keep it clean inside and out. And, every once in a while, send it to a service shop for general overhaul. This will pay dividends in lower operating costs, longer useful motor life, and few, if any, repair-parts costs.

In addition to building-in servicing conveniences on G-E motors, instructions are given with each motor. Available for service are *G-E Record Cards*. These can be had *free* for the asking. Just write the nearest G-E service shop or office for card No. GES-1526, stating how many motors you have.

The following sections are presented as a further help in keeping motors running the longest time:

General Inspection.
How to Lubricate Motors.
How to Grease and Clean Ball-bearing Motors.
Additional Care for D-c Motors.
General Overhauling of Motors.
How to Care for Insulation.

GENERAL INSPECTION

The purpose of maintenance work is to insure continuous satisfactory operation of the equipment. It is important, therefore, in such work that all possible causes of future trouble be found and corrected. The inspection of the motor should be made with particular attention to minor weaknesses which may be indications of future trouble.

Become acquainted with the sounds made by a motor when it is starting, running, and stopping correctly. As part of the maintenance inspection, note the sounds made by the motor under these conditions. Rough commutators, faulty operation of centrifugal mechanisms on single-phase motors, dry bearings, and many other faults can be detected by "educated" ears.

Make sure that the motor mounting bolts are all tight. A loose mounting bolt can cause considerable noise and a service call. Check the motor pulley setscrews. Loose pulley setscrews can result in the pulley "creeping" off the motor shaft, with possible damage to the condenser. Sometimes pulleys creep even with tight setscrews. In such cases, the trouble probably comes from the use of only one setscrew, an oversize pulley bore or keyway, or a loose key.

In a similar way, the senses of smell, sight, and touch can give warning of possible faulty operation. For example, overheated insulation has a peculiar sharp odor—easily identified if one is acquainted with it. Noticing this, you can check the causes of overheating more carefully. A quick glance at a motor arranged for automatic belt tightening will show if the belt has stretched enough to require adjustment of the motor away from the driven machine. Feeling of the motor and its bearings may lead to a check on overheating. This will only be an indication—excessive heating should be checked with a thermometer.

When servicing a motor, go over it with a dry cloth so that its continued, bright, new appearance will be a credit to your plant.

A guide for maintenance, in abbreviated form, follows:

1—Check lubrication, and oil motor.
2—Inspect brushes, brush contact surfaces, and brush springs.
3—Inspect commutator.
4—Check the machine operator on his experience with motor since your last inspection.
5—Look, listen, smell, and feel for indications of possible trouble, with the motor starting, stopping, running, and standing still.
6—Clean the condenser.
7—Wipe off the motor.

HOW TO LUBRICATE MOTORS

The designs of bearings and bearing housings of motors have been wonderfully improved in the past few years. The point has now been reached where the bearings of modern motors, whether sleeve, ball, or roller, require only very infrequent attention.

This advance in the art is not yet fully appreciated, for, while there may have been some necessity for more frequent attention in the case of older designs with housings less tight than on modern machines, oiling and greasing of new motors is quite often entrusted to uninformed and careless attendants, with the result that oil or grease is copiously and frequently applied to the outside as well as the inside of bearing housings. Some of the excess lubricant is carried into the machine and lodges on the windings, where it catches dirt and thereby hastens ultimate failure.

If the proper amount of a suitable lubricant is applied before starting, there should be no need to refill the housings for several months, even in dusty places.

How to Grease Ball-bearing Motors*

Equipped with Pressure-relief Greasing System

Determining the correct amount of lubricant in ball bearings is one of the most important problems in motor maintenance. Too much lubricant in these bearings can cause heating and other bad effects, just as will too little lubrication. Many motors have ball bearings arranged to be greased with a pressure gun. The following procedure, developed by General Electric and based on several years' experience, has been used with excellent results on such motors. Preferably, motors should be greased while they are in operation.

Only a high grade of grease, having the following general characteristics, should be used for ball-bearing lubrication:

1. Consistency a little stiffer than that of vaseline, maintained over the operating-temperature range.
2. Melting point preferably over 150 C.
3. Freedom from separation of oil and soap under operating and storage conditions.
4. Freedom from abrasive matter, acid, and alkali.

For the convenience of G-E motor users, General Electric can supply the proper grease in cans of convenient sizes or in drums.

1. Make sure that no dirt gets into the bearing with the grease—wipe pressure-gun fitting, bearing housing, and relief plug clean.

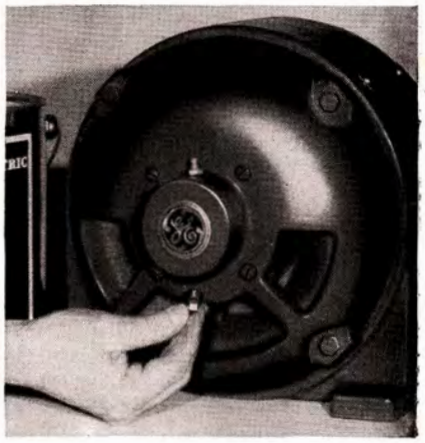
2. Always remove the relief plug from the bottom of the bearing before using the grease gun. This prevents putting excessive pressure inside the bearing housing which might rupture the bearing seals.

3. With a clean screw driver or similar tool, free the relief hole of any hardened grease, so that any excess grease will run freely from the bearing.

4. With the motor running, add grease with a hand-operated pressure gun, until it begins to flow from the relief hole. This tends to purge housing of old grease. If it might prove dangerous to lubricate the motor while running, follow this procedure with the motor at standstill.

5. Allow the motor to run long enough after adding grease to permit the rotating parts of the bearing to expel all excess grease from the housing. This very important step prevents over-greasing the bearing.

6. Stop the motor and replace the relief plug tightly with a wrench.



* For all motors where relief plug is not accessible, this procedure may be slightly modified. See Publication GEJ-942.

How to Clean Ball Bearings on Motors*

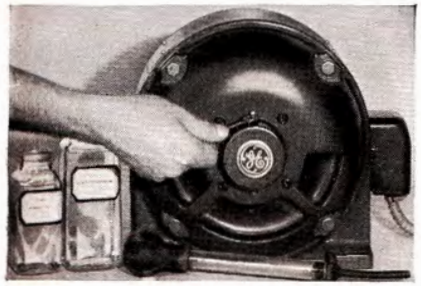
Equipped with Pressure-relief Greasing System

The pressure-relief method of greasing motors on the preceding page tends to purge the bearing housing of used grease. Complete cleaning of bearings, therefore, is required at infrequent intervals only. When the motor is disassembled for overhauling, it is easy to wash the bearings with a grease solvent, such as carbon tetrachloride. When the bearings are not disassembled, they can be cleaned by the following method.

For a thorough and convenient flushing, use some solvent, such as a light mineral oil heated to a temperature of 165 F, or carbon tetrachloride. The latter is noninflammable, does not require heating, and dissolves grease more quickly than hot oil. When using carbon tetrachloride, however, be careful to remove all traces of it from the bearing housing and do not allow it to remain in contact with insulated windings in case of accidental splashing. Also, be careful of the toxic fumes of carbon tetrachloride.

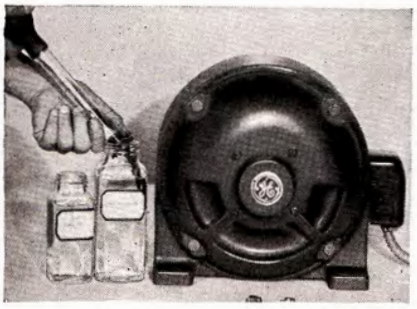
This method permits the cleaning of all standard motors operating at an angle not exceeding 15 degrees from the horizontal (except totally enclosed, fan-cooled motors) without disassembly. The bearings and housings of vertical motors cannot be cleaned, except by a complete motor disassembly.

For totally enclosed, fan-cooled motors, the bearing at the pulley end may be flushed as described. To clean the fan-end bearing, first remove the fan cover and fan in order to make accessible the drain plug at the bottom of the housing. This procedure can be conveniently carried out whenever a general reconditioning of the motor is made.



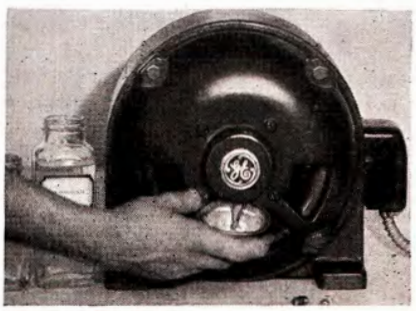
1. ◀ Wipe clean the housing, pressure-gun, and relief fittings, and then remove both fittings. Every care should be taken to keep dirt out of the bearings, both when greasing and cleaning them. A bit of abrasive once in a bearing may not be removed even with the most thorough cleaning. Afterwards, it may become dislodged and get between the bearing surfaces with serious results.

2. ▶ With a clean screw driver or a similar tool, free the pressure-fitting hole in the top of the bearing housing of hardened grease.

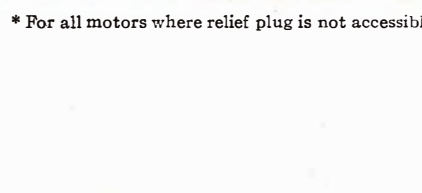


3. ◀ Also, free the relief-plug hole in the bottom of the housing from old grease to permit easy expulsion of the old grease during the cleaning process after the solvent is added.

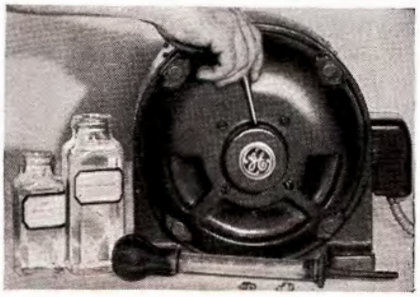
4. ▶ Fill a syringe with grease solvent and inject some of it into the bearing housing through the pressure-fitting hole, while the motor is running.

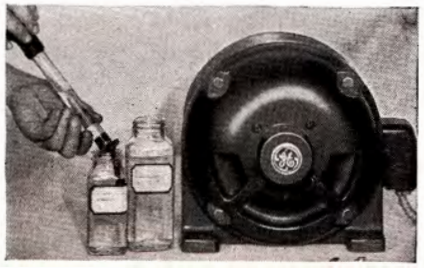


5. ◀ As the grease becomes thinned by the solvent, it will drain out through the relief hole. Continue to add solvent until it drains out quite clear.



6. ◀ Replace the relief plug and inject solvent until it can be seen splashing in the filling hole. Allow the solvent to churn for a few minutes. Remove relief plug and drain. Repeat the churning operation until the solvent runs clean.





7. ▲ If carbon tetrachloride has been used for flushing, replace the relief plug and inject a small amount of light lubricating oil. Allow it to churn for a minute or two before draining off. This will flush out the solvent. To complete the job, grease the bearing, using the method previously described.

* For all motors where relief plug is not accessible, this procedure may be slightly modified. See Publication GEJ-942.

OILING SLEEVE BEARINGS

The simplest, and most important, part of motor maintenance is lubrication. The type of oil has been covered under "What to Check before Starting," page 131. Check the oil level, on motors equipped with an oil filler gage on the side of the bearing housing, with the motor stopped. The oil filler gage should be approximately three quarters full. Is the oil dirty? If so, drain it off by removing the drain plug, usually located in the bottom or side of the bearing housing. Then flush the bearing with clean oil until the outcoming oil is clean. In fractional-horsepower motors, there may be no means of checking the oil level, as all the oil may be held in the waste packing. In such cases, a good general rule for normal motor service is to add thirty to seventy drops of oil at the end of the first year and to re-oil at the end of each subsequent one thousand hours of motor operation.

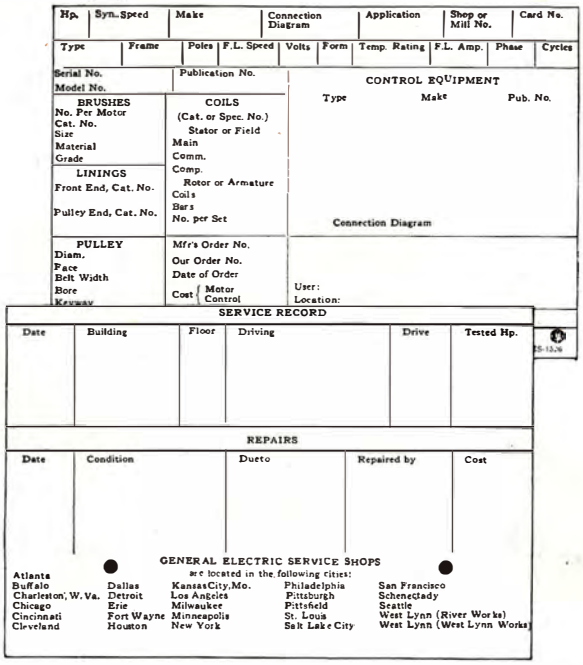
Most fractional-horsepower motors built today require lubrication about once a year. Small fan and agitator motors will often require more frequent lubrication, with three-month intervals between oilings as a fair general guide. Motors rated one horsepower and larger will require lubrication about every six months under ordinary operating conditions. In all cases, it will be desirable to check the motor lubrication more frequently when such procedure is conveniently possible, especially during the first few weeks of operation.

CLEANING SLEEVE BEARINGS

Sleeve-bearing housings are provided with liberal settling chambers into which dust, dirt, and oil sludge collect. The only cleaning necessary is to remove the drain plug and drain the oil, which will flush out most of the settled material with it.

NOTE: Frames 203, 204, 224, and 225 do not have drain plugs, and may be flushed through the oil filler gage. After draining, seal the threads of the drain plug with an oil-sealing compound (such as G-E No. 1201 Glyptal), and refill the oil reservoir.

Whenever the motor is disassembled for general cleaning, the bearing housing may be washed out with a solvent such as carbon tetrachloride. Dry the bearing lining and cover the shaft with a film of oil before assembling.



Card records on every motor in the plant save money. Recordings made after inspection and service indicate any motor requiring excessive expense, and causes can be corrected before an emergency occurs.

ADDITIONAL CARE FOR D-C MOTORS

To insure efficient operation and maximum production, inspection and servicing should be systematic. Frequency of inspection and degree of thoroughness vary, and will have to be determined by the maintenance engineer. They will be governed by (1) the importance of the motors in the production scheme (that is, if the motor fails, will the "whole works be shut down"?), (2) percentage of time the motor operates, (3) nature of service, (4) environment.

Brush inspection is important. The first essential requirement for the satisfactory operation of brushes is free movement of brushes in holders. Uniform brush pressure is necessary to assure equal current distribution. Adjustment of brush holders should be set so that the face of the holder is approximately $\frac{1}{8}$ inch up from the commutator; any distance greater than $\frac{1}{8}$ inch will cause brushes to wedge, resulting in chattering and excessive sparking.

It is essential that the correct grade of brush for a specific application be used, and recommendation as to the correct grade of brush should be obtained from the motor manufacturer only. Broken brushes imply two possibilities: incorrect brush grade, or mechanical defects (such as unbalanced or eccentric commutator). To eliminate brush breaking, both factors should be corrected.

Check the brushes to make sure that they will not wear down too far before your next inspection. Keep an extra set of brushes available, at the installations or in the service truck, so that replacement can be made when needed. Sand in new brushes, and run the motor without load as long as possible, as covered under "Installation." It is false economy to use brushes down to the absolute-minimum length before replacement. Cases have been known where brushes have worn down until the metal, where the pigtail connects to the brush, was touching the commutator. This, of course, was causing damage to the commutator.

Make sure that each brush surface, in contact with the commutator, has the polished finish that indicates good contact and that the polish covers essentially

all of this surface of the brush. Check the freedom of motion of each brush in the brush holder. When replacing a brush, be sure to put it in the same brush holder and in its original position. It has been found helpful to scratch a mark on one side of the brush, when removing it, so that it will be replaced properly.

Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and excessive sparking. Excessive heating may have annealed the springs, in which case they should be replaced and the cause of heating corrected. Larger motors have means for adjusting the spring pressure. The pressure should be 2 to 2½ lb per sq in. of area of brush contact with the commutator.

Commutator

Inspect the commutator for color and condition. It should be clean, smooth, and a polished-brown color where the brushes ride on it. A bluish color indicates overheating of the commutator. Roughness of the commutator should be removed by sandpapering or stoning. Never use emery cloth or an emery stone. For this operation, run the motor without load. If sandpaper is used, wrap it partly around a wood block. The stone is essentially a piece of grindstone, known to the trade as a commutator stone. Press the stone or sandpaper against the commutator with moderate pressure with the motor running without load, and move it back and forth across the commutator surface. *Use care not to come in contact with live parts.* If the commutator is very rough, the armature should be taken out and the commutator turned down in a lathe. When this is done, it is usually necessary also to cut back the insulation between the commutator bars slightly. After turning down the commutator, the brushes should be sanded and run in as described previously. This is not necessary after light sandpapering or stoning. Motors which raise the brushes after starting may be considered satisfactory with somewhat poorer appearance of commutators and brushes than should be expected where the brushes ride the commutator continuously.

If the commutator is found to be dirty, when the motor is inspected, it should be wiped clean with a piece of canvas or other cloth that is free from lint.

GENERAL OVERHAULING OF MOTORS

Motors should generally be given a thorough overhauling at intervals of five years or so. Such a practice should be beneficial in avoiding breakdowns and in extending the useful life of the equipment. Where periodic overhauling is practiced, the following notes may be helpful.

The motor air gap, between the rotor and stator, is checked with feelers for uniformity. Small clearance at the bottom may indicate worn bearings. When the air gap of a sleeve-bearing motor, as measured with a tapered air-gap gage, is less than the minimum value given in the table below, the bearing linings may need replacement:

Approximate Minimum Air Gap

Frame Number	Minimum Air Gap in In.
203 to 326 incl	0.008
364 to 559 incl	0.014
561 to 579 incl	0.020

The motor is taken apart and inspected thoroughly. Measurement of the bearings and journals may indicate need for new bearing linings. The waste is removed from waste-packed bearings and rearranged, or replaced, so that any glaze on the wool is removed from its point of contact with the shaft. Any gummy deposit on the wool indicates that the wool should be replaced. All lubricant should be cleaned out of the bearings and a fresh supply put in when the motor is reassembled.

Carbon tetrachloride, or any of the several available nonexplosive cleaning solvents, should be used in cleaning the rotor and stator, to avoid explosion and fire hazards. Note particularly that these solvents are heavier than air, so that there is danger of suffocation to men using them. They should be used in the open air or where there is exceptionally good ventilation.

The rotors should be cleaned with a solvent to remove any accumulated dirt, after which any rust should be removed with fine sandpaper (not emery paper). When clean and dry, the rotors should be coated with a good grade of clear varnish or lacquer to protect them from moisture. To prevent injury to the bearings, they should be completely protected with a clean rag when the motor is disassembled.

The rotors of wound-rotor motors should be given the same treatment as the stators. In addition, soldered joints and binding cords should be inspected and any weakness remedied. Commutators should be turned down and the insulation between segments cut back, with a narrow hack-saw blade or file, to a depth of approximately 0.020 in.

The stator bore should be cleaned of dirt with a solvent, and any rust should be removed with fine sandpaper (not emery paper). Care should be taken during this operation not to damage the top sticks or end turns of the stator winding. When dry, any remaining dirt in the bore should be wiped out with a cloth or brushed out with a soft brush. A hand bellows or dry compressed air at low pressure (25 to 50 lb) may be used, but care should be exercised not to blow dirt or chips into the stator winding.

HOW TO CARE FOR INSULATION

Motors in Transit, in Storage, or Idle

Motors should be stored in a dry, clean place until ready for installation. Heat should be supplied, especially for large high-voltage machines, to protect against alternate freezing and thawing. This is equally applicable to spare coils.

Motors that have been long in transit in moist atmosphere, or have been idle for an extended period without heat to prevent the accumulation of moisture, should be thoroughly dried out before being placed in service. Machines may also become wet by accident, or they may "sweat" as a result of a difference in their temperature and that of the surrounding air, just as cold-water pipes "sweat" in a warm, humid atmosphere. This condition is, of course, very injurious and should be prevented, particularly in the case of large or important motors, by keeping them slightly warm at all times. Current at a low voltage can be passed through the windings, electric heaters can be used, or even steam pipes can be utilized for protective purposes. In the case of extended idle periods, tarpaulins may be stretched over the motor and a small heater put inside to maintain the proper temperature.

Drying Out

If a motor has become wet from any cause whatever, it should be dried out thoroughly before being operated again. The most effective method is to pass current through the windings, using a voltage low enough to be safe for the winding in its moist condition. For 2200-volt motors, 220 volts is usually satisfactory for circulating this drying-out current. Thermometers should be placed on the windings to see that they are being heated uniformly. Temperatures should not exceed 90 C (Class A insulation). Applying the heat internally in this manner drives out all moisture, and is particularly effective on high-voltage motors, where the insulation is comparatively thick.

Heat may be applied externally by placing heating units around or in the machine, covering with canvas or otherwise enclosing it, leaving a vent at the top to permit moisture to escape. In doing this, it is essential that there be a circulation of warm air over all the surfaces to be dried. The air should be allowed to escape as soon as it has absorbed moisture. Therefore, the heaters should be so placed and baffles so arranged as to get a natural draft; or small fans may be used to force circulation. Twelve-inch fans set to blow air across the fronts of "glow heaters" and then into the lower part of a machine from opposite sides, and so on up around the windings and out the top, will produce excellent results. The temperature of the winding should not be allowed to exceed 100 C for Class A insulated motors. Smaller machines may conveniently be placed in ovens, the same temperature limits being observed.

Insulation Resistance Tests

The time required for complete drying-out depends considerably on the size and voltage of the motor. Insulation resistance measurements should be taken at intervals of four or five hours until a fairly constant value is reached. This value should at least equal the recommended AIEE standard, which is

$$\text{Megohms} = \frac{\text{Rated Voltage of the Machine}}{\frac{\text{Rating in Kva}}{100} + 1000}$$

The insulation resistance of dry motors in good condition is considerably higher than this value.

A more convenient way to measure this resistance is through the use of a megohmmeter, although if a 500-volt d-c source is available, readings can be taken with a voltmeter. The ungrounded side of the system should be connected to all the motor terminals through the voltmeter, the opposite or grounded side being connected directly to the motor frame. The insulation resistance is found by

$$R = r\left(\frac{E}{V} - 1\right)$$

where R = insulation resistance in ohms
E = line voltage (d-c)
V = voltmeter reading
r = resistance of voltmeter.

In using the voltmeter method, the connection to the frame should always be made through a fuse of not more than 10 amperes in size. The circuit should be tested, and the side showing a complete or partial ground then connected to the frame through the fuse.

Obviously, the insulation resistance varies over a wide range, depending upon moisture, temperature, cleanliness, etc., but it is a good indication of the general condition of the insulation and its ability to stand the operating voltage. Such readings should be taken before a high-potential test, to determine whether the insulation is ready for such a test, and afterwards to make sure that the high potential has not injured the insulation.

High-potential Tests

High-potential tests should be made after drying out, or after repairs, to check the dielectric strength of the insulation. New windings should successfully stand a high-potential test of twice normal voltage plus 1000. Motors that have been in operation for some time should be tested, *after thorough cleaning and drying*, using a voltage of about 150 per cent of normal voltage, applied for one minute.

Small high-potential testing sets are available for such work and are of such capacity that very little damage will result from a breakdown during the test.

Periodic Inspection

A systematic and periodic inspection of motors is necessary to insure best operation. Of course, some machines are installed where conditions are ideal, where dust, dirt, and moisture are not present to an appreciable degree; but most motors are located where some sort of dirt accumulates in the windings, lowering the insulation resistance and cutting down creepage distances. Steel-mill dusts are usually highly conductive, if not abrasive, and lessen creepage distances. Other dusts are highly abrasive and actually

cut the insulation in being carried through by the ventilating air. Fine cast-iron dust quickly penetrates most insulating materials. Hence the desirability of cleaning the motors periodically. If conditions are extremely severe, open motors might require a certain amount of cleaning each day. For less-severe conditions, weekly inspection and partial cleaning are desirable. Most machines require periodically a complete overhauling and thorough cleaning.

For the weekly cleaning, the motor should be blown out, using moderate-pressure, dry, compressed air (or about 25 to 30 lb per sq in. pressure). Where conducting and abrasive dusts are present, even lower pressure may be necessary, and suction is to be preferred, as damage can easily be caused by blowing the dust and metal chips into the insulation. On most d-c motors and large a-c motors, the windings are usually fairly accessible, and the air can be properly directed to prevent such damage.

On the larger a-c machines, the air ducts should be blown out so that the ventilating air can pass through as intended.

On large machines, insulation resistance readings should be taken in the manner heretofore indicated. As long as the readings are consistent, the condition of the insulation would ordinarily be considered good. Low readings would indicate increased current leakage to ground, or to other conductors, owing to one of perhaps several causes, such as deteriorated insulation, moisture, dirty or corroded terminals, etc.

Cleaning

Smaller motors, the windings of which are not particularly accessible, should be taken apart.

First, the heavy dirt and grease should be removed with a heavy, stiff brush, wooden or fiber scrapers, and cloths. Rifle-cleaning bristle brushes can be used in the air ducts. Dry dust and dirt may be blown off, using *dry* compressed air at moderate pressure, for example, 25- to 30-lb pressure at the point of application, taking care to blow the dirt out from the winding. As stated before, if the dirt and dust are metallic, conducting, or abrasive, air pressure may drive the material into the insulation and damage it. Hence, for such conditions, pressure is not so satisfactory as a suction system. If compressed air at low pressure is used, care must be taken to direct it properly so that the dust will not cause damage and will not be pocketed in the various corners.

Grease, oil, and sticky dirt are easily removed by applying cleaning liquids like carbon tetrachloride (Pyrene, Carbona), gasoline, or naphtha. All of these liquids evaporate quickly and, if not applied too generously, will not soak or injure the insulation. Carbon tetrachloride is best and is recommended because it is noninflammable.

In case one of the other liquids must be used, it should be applied out-of-doors or in a well-ventilated room. It must be remembered that gasoline or naphtha vapor is heavier than air and will flow into pits, basements, etc., and may remain there for hours or even days. The casual smoker, a spark from a hammer or chisel, or even from a shoe nail, may cause a serious explosion. Therefore, proper ventilation of the room is essential and may require specially piped ventilating fans. In using carbon tetrachloride, the explosion hazard is obviated, but some ventilation is required to remove the vapor, which might affect the safety and comfort of the workmen.

There are several good methods of applying the cleansing liquid. A cloth, saturated in the liquid, may be used to wipe the coils. A paint brush, dipped in carbon tetrachloride, is handy to get into corners and crevices, and between small coils. Care should be taken not to soak the insulation, as would be the case if coils or small machines were dipped into the liquid.

Probably the best method of applying the liquid is to spray it on. A spray gun, paint-spraying appliance, or an ordinary blow torch is often used with good results, although the latter device is likely to give a heavier spray than desirable.

An atomizer will give excellent results, using a pressure of about 80 lb if the insulation is in good condition, or 40 to 50 lb if the insulation is old. The atomizer should be held not more than 5 or 6 inches away from the coils.

While the insulation will dry quickly at ordinary room temperature after such cleaning methods, it is highly desirable to heat it to drive off all moisture before applying varnish. This heating or drying-out process has already been discussed and, therefore, need only be mentioned here.

If the motor can be spared from service long enough, the insulation should be dried out by heating to from 90 to 100 C. While the motor is warm, a high-grade insulating varnish should be applied. For severe acid, alkali, or moisture conditions, a black plastic baking varnish is best, while, for conditions where oil or dusts are present, a clear or yellow varnish should be used.

The varnish may be sprayed or brushed on. For small stators or rotors, it is best to dip the windings into the varnish, cleaning off the adjacent metal parts afterwards by using a solvent of the varnish. After applying the varnish, the best results are obtained by baking for 6 to 7 hours at about 100 C. Experience with particular conditions of operation, or the condition of the insulation, may indicate the desirability of applying a second coat of the same varnish, followed again by 6 to 7 hours of baking at 100 C.

If the machine must be put back in service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the quick-drying black or clear varnishes which dry in a few hours at ordinary room temperatures.

Testing

Insulation resistance readings should be taken, as explained previously, to determine whether the winding is in satisfactory condition for applying a high-potential test. After this test, it is good practice to run the motor without load for a short time, to make certain that everything has been connected, assembled, and adjusted properly.

HELPFUL MOTOR INFORMATION

TO ASSIST in checking problems or answering questions on motor operation, installation, or application, the following information is included in this catalog.

Definitions of terms commonly used in describing motors and control.
Approximate full-load speeds and currents.
Synchronous speeds possible at various frequencies.
Standard direction of rotation of G-E motors and generators.
Miscellaneous formulas and data.
Table for selecting wire and fuse sizes for motor branch circuits.
Table of fuse intervals permissible.
List of G-E motor publications.
Lists of G-E Sales Offices, Service Shops, and Warehouses.

DEFINITIONS

PROTECTION OF MACHINES

Open Machine

An open machine is a self-ventilated machine having no restriction to ventilation other than that necessitated by mechanical construction.

Dripproof Machine

A dripproof machine is one in which the ventilating openings are so constructed that drops of liquid or solid particles falling on the machine at any angle not greater than 15 degrees from the vertical cannot enter the machine, either directly or by striking and running along a horizontal or inwardly inclined surface.

Dripproof, Fully Protected Machine

A dripproof, fully protected machine is a dripproof motor whose ventilating openings are protected by a wire screen.

Totally Enclosed Machine

A totally enclosed machine is one so enclosed as to prevent exchange of air between the inside and the outside of the case, but not sufficiently enclosed to be termed airtight.

Totally Enclosed, Fan-cooled Machine

A totally enclosed, fan-cooled machine is a totally enclosed machine equipped for exterior cooling by means of a fan or fans, integral with the machine but external to the enclosing parts.

Explosion-proof Machine

An explosion-proof machine is one in an enclosing case which is designed and constructed to withstand an explosion of a specified gas which may occur within it, and to prevent the ignition of the specified gas surrounding the motor by sparks, flashes, or explosions of the specified gas, which may occur within the machine casing.

Separately Ventilated Machine

A separately ventilated machine is one which has its ventilating air supplied by an independent fan or blower external to the machine.

Enclosed, Self-ventilated Machine

An enclosed, self-ventilated machine is a machine having openings for the admission and discharge of the ventilating air, which is circulated by means integral with the machine, the machine being otherwise totally enclosed. These openings are so arranged that inlet and outlet ducts or pipes may be connected to them.

NOTE: Such ducts or pipes, if used, must have ample section and be so arranged as to furnish the specified volume of air to the machine; otherwise, the ventilation will not be sufficient.

Enclosed, Separately Ventilated Machine

An enclosed, separately ventilated machine is a machine having openings for the admission and discharge of the ventilating air, which is circulated by means external to and not a part of the machine, the machine being otherwise totally enclosed. These openings are so arranged that inlet and outlet duct pipes may be connected to them.

DUTY AND SERVICE

Continuous Duty

Continuous duty is a requirement of service that demands operation at a substantially constant load for an indefinitely long time.

Intermittent Duty

Intermittent duty is a requirement of service that demands operation for alternate periods of (1) load and no load; or (2) load and rest; or (3) load, no load, and rest.

RATING

Ambient Temperature

Ambient temperature is the temperature of the air or water which, coming into contact with the heated parts of a machine, carries off their heat. (See MG-50–64.)

NOTE.—Ambient temperature is commonly known as "room temperature" in connection with air-cooled apparatus not provided with artificial ventilation.

Service Factor

A service factor of a general-purpose motor is a multiplier which, applied to the normal horsepower rating, indicates a permissible loading which may be carried under the conditions specified for the service factor.

Rated Load

Rated load shall mean horsepower output for motors, kilowatt output for direct-current generators, and kilovolt-ampere output for alternating-current generators.

Time Ratings

(1) Many machines are operated on a cycle of duty which repeats itself with more or less regularity. The heating of machines operating under such conditions is equivalent to a continuous run for a certain specified time. The standard duration of load tests, or time ratings, for machines operating on such ratings shall be as follows:

(a) 5 min, to and including 30 hp.
(b) 15 min, to and including 50 hp.
(c) 30 min, to and including 60 hp.
(d) 60 min.
(e) continuous.

(2) Of the foregoing ratings, the first four are commonly known as short-time ratings. In every case, the short-time load test shall commence only when the windings and other parts of the machine are within 5 C of the room temperature at the time of starting the test.

Time Rating

Time rating is the period of a test run within which the specified conditions of load and temperature rise shall not be exceeded.

Full-load Torque

The full-load torque of a motor is the torque necessary to produce its rated horsepower at full-load speed. In pounds at one foot radius, it is equal to the horsepower times 5250, divided by the full-load speed.

Locked-rotor Torque

The locked-rotor torque of a motor is the minimum torque which it will develop at rest for all angular positions of the rotor, with rated voltage applied at rated frequency.

Pull-up Torque

The pull-up torque of a motor is the minimum torque developed by the motor during the period of acceleration from rest to full speed with rated voltage applied at rated frequency.

Breakdown Torque

The breakdown torque of a motor is the maximum torque which it will develop with rated voltage applied at rated frequency, without an abrupt drop in speed.

Pull-out Torque

The pull-out torque of a synchronous motor is the maximum sustained torque which the motor will develop at synchronous speed for one minute, with rated voltage applied at rated frequency and with normal excitation.

Pull-in Torque

The pull-in torque of a synchronous motor is the maximum constant torque under which the motor will pull its connected inertia load into synchronism, at rated voltage and frequency, when its field excitation is applied.

The speed to which a motor will bring its load depends on the power required to drive it, and whether the motor can pull the load into step from this speed, depends on the inertia of the revolving parts, so that the pull-in torque cannot be determined without knowing the WR^2 as well as the torque of the load.

Locked-rotor Current

The locked-rotor current of a squirrel-cage induction or other internally short-circuited motor is the current taken from the line with the rotor locked and with rated voltage and frequency applied to the motor.

The locked-rotor current of a motor and starter is the current taken from the line with the rotor locked, with the starting device in the starting position, and with rated voltage and frequency applied.

Secondary Voltage—Wound-rotor Motors

The secondary voltage of wound-rotor motors is the open-circuit voltage at standstill, measured across the slip rings.

Regulation—Direct-current Generators

The regulation of a d-c generator is usually stated by giving the numerical values of the voltage at no-load and rated load and, in some cases, it is advisable to state regulation at intermediate loads. The regulation of d-c generators refers to changes in voltage corresponding to gradual changes in load, and does not relate to the comparatively large momentary fluctuations in voltage that frequently accompany instantaneous changes in load.

GENERAL CLASSIFICATION

General-purpose Motors

(a) A general-purpose motor is any motor of 200 hp or less and 450 rpm or more, having a continuous rating, and designed, listed, or offered in standard ratings for use without restriction to a particular application.

(b) A general-purpose synchronous motor is any motor rated 200 hp or less at 1.0 power factor, or 150 hp or less at 0.8 power factor, and speeds higher than 450 rpm, having a continuous time rating, and designed, listed, or offered in standard ratings for use without restriction to a particular application.

Special-purpose Motors

A special-purpose motor is an industrial power motor specifically designated and listed for a particular power application where the load requirements and duty cycle are definitely known.

Fractional-horsepower Motor

A fractional-horsepower motor is a motor built on a frame smaller than that having a continuous rating of 1 hp, open-type, at 1700-1800 rpm.

Large Power Motor

A large power motor is a motor built in a frame having a continuous rating of 1 hp, open-type, at 1700-1800 rpm, or in a larger frame.

SPEED CLASSIFICATION

Rated Speed of Motors

The rated speed of an alternating-current general-purpose motor is defined as the full-load speed stamped on the nameplate.

Constant-speed Motor

A constant-speed motor has a speed which at normal operation is constant or practically constant. For example, a synchronous motor, an induction motor with small slip, or an ordinary direct-current shunt-wound motor.

Varying-speed Motor

A varying-speed motor has a speed which varies with the load, ordinarily decreasing when the load increases; such as a series motor, or an induction motor with large slip.

Adjustable-speed Motor

An adjustable-speed motor has a speed which can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load, such as a shunt motor with field-resistance control designed for a considerable range of speed adjustment.

Adjustable-varying-speed Motor

An adjustable-varying-speed motor has a speed which can be adjusted gradually, but when once adjusted for a given load will vary in considerable degree with change in load; such as a compound-wound direct-current motor adjusted by field control, or a wound-rotor induction motor with rheostatic speed control.

Multispeed Motor

A multispeed motor can be operated at any one of two or more definite speeds, each being practically independent of the load. For example, a direct-current motor with two armature windings, or an induction motor with windings capable of various pole groupings.

MISCELLANEOUS

Front of a Machine

The front of a normal motor or generator is the end opposite the coupling or driving pulley.

Back of a Machine

The back of a normal motor or generator is the end which carries the coupling or driving pulley.

Undervoltage Protection

The effect of a device operative, on the reduction or failure of voltage, to cause and maintain the interruption of power to the main circuit.

Undervoltage Release

The effect of a device operative, on the reduction or failure of voltage, to cause the interruption of power to the main circuit, but not preventing the re-establishment of the main circuit on return of voltage.

Oil Circuit Breaker vs. Oil Switch

Officially adopted definitions distinguish an oil circuit breaker from an oil switch as a device which will open the circuit under a flow of current, while the latter is intended to open the circuit only when "dead," i.e., not carrying current. This distinction is observed throughout this catalog.

Air Circuit Breaker vs. Oil Circuit Breaker

To avoid misunderstanding or confusion of terms, it will be necessary to state, especially in telegrams whether oil circuit breakers or air circuit breakers are desired.

The term "air" will be used to distinguish carbon-break and magnetic-blowout types of circuit breakers from oil circuit breakers.

APPROXIMATE FULL-LOAD SPEEDS OF MOTORS

The full-load speed of alternating-current induction motors varies slightly with changes in line voltage, and rises as the load decreases.

The approximate average full-load speeds of 60-cycle induction motors and corresponding direct-current-motor speeds are shown in the table at the right.

No. Poles	Synchronous Speeds, Rpm	FULL-LOAD SPEEDS, RPM				
		Type K	Type KG	Type M	Type KC	Direct-current Motors
2	3600	3470	....	3520	3500	3500
4	1800	1750	1740	1720	1760	1750
6	1200	1160	1150	1140	1160	1150
8	900	870	865	855	870	850
10	720	695	690	690	....	690
12	600	575	570	575	....	575

APPROXIMATE FULL-LOAD CURRENTS OF MOTORS

The following data are approximate full-load currents for motors of various types, frequencies, and speeds. They have been compiled from average values for representative motors of their respective classes. Variations of 10 per cent above or below the values given may be expected.

Hp of Motor	Full-load Current—Amperes																			
	DIRECT-CURRENT MOTORS		ALTERNATING-CURRENT MOTORS																	
			Single-phase Type SCR Motors		Three-phase															
					Induction Motors								Synchronous Motors							
					Squirrel-cage				Wound-rotor				1.0-power-factor				0.8-power-factor			
	115-volt	230-volt	110-volt	220-volt	220-volt	440-volt	550-volt	2200-volt	220-volt	440-volt	550-volt	2200-volt	220-volt	440-volt	550-volt	2200-volt	220-volt	440-volt	550-volt	2200-volt
⅙	2.0	1.0			0.90	0.45	0.36													
¼	2.6	1.3			1.16	.58	.48													
⅓	3.2	1.6			1.4	.70	.56													
½	4.6	2.3	8.0	4.0	1.9	.95	.76													
¾	6.4	3.2	10.6	5.3	2.6	1.3	1.04													
1	8.2	4.1	12.8	6.4	3.4	1.7	1.36	.....	5.4	2.7	2.2									
1½	12.4	6.2	17.6	8.8	5.0	2.5	2.0	.....	6.8	3.4	2.7									
2	16.2	8.1	22	11	6.2	3.1	2.5	.....	8.0	4.0	3.2									
3	24	12	31	15.5	9.0	4.5	3.6	.....	10.5	5.3	4.2									
5	40	20	48	24	14.5	7.2	5.7	.....	16	8.0	6.4									
7½	60	30	68	34	21	10.5	7.3	.....	23	11.5	9.2									
10	78	39	90	45	26	13.5	11	.....	29	14.5	10.5									
15	114	57	.....	.....	40	20	16	.....	42	21	17									
20	150	75	.....	.....	52	26	21	.....	54	27	23	.....	46	23	18.5	4.6	62	31	25	6.2
25	186	93	.....	.....	65	32	26	7.0	68	34	27	7.7	58	29	23	5.8	74	37	30	7.4
30	225	112	.....	.....	78	39	31	8.1	80	40	32	8.8	68	34	27	6.8	88	44	35	8.8
40	295	147	.....	.....	102	51	41	10.5	104	52	42	11	88	44	35	8.8	115	57	46	11.5
50	365	182	.....	.....	126	63	51	12.5	128	64	51	13.5	110	55	44	11	140	70	56	14
60	.....	218	.....	.....	152	76	60	15	154	77	62	15.5	130	65	52	13	170	84	67	17
75	.....	270	.....	.....	188	94	75	18.5	188	94	75	19	162	81	65	16	210	104	83	21
100	.....	355	.....	.....	250	125	100	24.5	250	125	100	25	216	108	86	22	280	140	112	28
125	.....	445	.....	.....	310	155	125	30	310	155	125	31	268	134	107	27	340	170	136	34
150	.....	530	.....	.....	370	185	145	36	370	185	145	37	320	160	128	32	410	205	164	41
200	.....	700	.....	.....	490	245	195	49	490	245	195	49	420	210	168	42	540	270	216	54

Synchronous Speeds Possible at Various Frequencies

Poles	60 Cycles	50 Cycles	40 Cycles	25 Cycles	Poles	60 Cycles	50 Cycles	40 Cycles	25 Cycles
2	3600	3000	2400	1500	56	128.6	107.2	85.7	
4	1800	1500	1200	750	58	124.1	103.5	82.8	
6	1200	1000	800	500	60	120	100	80	
8	900	750	600	375	62	116.1	96.8	77.4	
10	720	600	480	300	64	112.5	93.7	75	
12	600	500	400	250	66	109	90.8	72.7	
14	514.2	428.6	343	214.3	68	105.9	88.2	70.6	
16	450	375	300	187.5	70	102.8	85.7		
18	400	333.3	266.6	166.6	72	100	83.3		
20	360	300	240	150	74	97.3	81		
22	327.2	272.7	218.1	136.3	76	94.7	78.9		
24	300	250	200	125	78	92.3	76.9		
26	277	230.8	184.5	115.4	80	90	75		
28	257.1	214.2	171.5	107.1	82	87.8	73.2		
30	240	200	160	100	84	85.7	71.4		
32	225	187.5	150	93.7	86	83.7			
34	212	176.5	141.1	88.2	88	81.8			
36	200	166.6	133.3	83.3	90	80			
38	189.5	157.9	126.3	78.9	92	78.3			
40	180	150	120	75	94	76.6			
42	171.5	142.8	114.2	71.4	96	75			
44	163.5	136.3	109		98	73.5			
46	156.6	130.5	104.3		100	72			
48	150	125	100						
50	144	120	96						
52	138.5	115.4	92.3						
54	133.3	111.1	88.9						

Lower speeds are limited by cost, rather than by design.

STANDARD DIRECTION OF ROTATION

G-E Motors and Generators

The following rules govern direction of rotation, clockwise or counterclockwise, of G-E generators and motors. These rules are the standards of the Company and are followed in all cases.

Standard Direction of Rotation

	Rotation	Viewed From	See Paragraph
Generators (except gas-engine-driven generators, and in motor-generators)	Clockwise	A	1
Induction motor-generator sets (except sets with motors not having conduit boxes)	Clockwise	C	3
Standard nonreversing d-c motors	Counterclockwise	A	1
Synchronous motors with direct-connected exciters	Counterclockwise	A	1
Generators—gas-engine-driven	Counterclockwise	A	1
Single-phase motors	Counterclockwise	A	1
Synchronous motor-generator sets and induction motor-generator sets with motors not having conduit boxes	Counterclockwise	B	2

In all cases, the observer will stand at the designated end of the machine, facing the machine in line with the shaft.

1. *End A.* The direction of rotation of standard motors and generators will be determined by viewing the end opposite the driven end of generators, and opposite the driving end of motors.

2. *End B.* The direction of rotation of synchronous motor-generator sets, induction motor-generator sets with motors not having conduit boxes, and frequency changers, will be determined by that of the driving motor. When there are one or more generators on each end of the driving motor, the direction of rotation will be determined by viewing the motor from the connection end of the stator coils.

3. *End C.* The direction of rotation of induction motor-generator sets will be determined by that of the generator. When there are one or more generators on each end of the driving motor, the direction will be determined by viewing the set from the end which places the conduit boxes on the left-hand side.

Polyphase induction motors, except certain high-speed motors which are equipped with unidirectional fans, are suitable for either direction of rotation, which can be reversed by interchanging two leads. High-speed motors, with unidirectional fans, must be ordered for the desired direction of rotation.

MISCELLANEOUS FORMULAS AND DATA

STORED ENERGY IN FLYWHEEL

Ft-lb energy stored in flywheel = $E = \frac{1}{2}(Wv^2/g)$

In which E = Ft-lb stored energy
W = Weight of flywheel in lb
v = Velocity of radius of gyration in ft per sec
g = Acceleration due to gravity (32.2 ft per sec)

TORQUE-HP FORMULA

$$\text{Torque} = \frac{\text{Hp} \times 5250}{\text{rpm}}$$

PRONY-BRAKE-TEST FORMULA

$$\text{Hp} = \frac{2 \times 3.1416 \times \text{Lever in ft} \times \text{lb} \times \text{rpm}}{33{,}000}$$

CENTRIFUGAL FORCE

F = centrifugal force in pounds
W = weight of revolving body in pounds
r = distance from the axis of motion to the center of gravity of the body in feet
g = acceleration due to gravity (32.2 ft per sec)
N = number of revolutions per minute
v = velocity in feet per second

$$F = \frac{W v^2}{g r} = .00034\, W r N^2$$

CONVERSION FORMULA FOR CENTIGRADE AND FAHRENHEIT THERMOMETER SCALES

$$\frac{C}{100} = \frac{F - 32}{180}$$

In which C = Temperature in deg centigrade
F = Temperature in deg Fahrenheit

OHM'S LAW

The strength of the current in any circuit is directly proportional to the electromotive force in that circuit and inversely proportional to the resistance of that circuit, i.e., is equal to the quotient arising from dividing the electromotive force by the resistance.

Let E = electromotive force in volts
R = resistance in ohms
I = strength of current in amperes

Then $$I = \frac{E}{R},\ R = \frac{E}{I},\ E = IR$$

EXAMPLE.—The electromotive force of a circuit is 110 volts, and its resistance is 55 ohms; what is the strength of current?

SOLUTION.—$E = 110$ volts. $R = 55$ ohms

$$I = \frac{E}{R} = \frac{110}{55} = 2 \text{ amperes}$$

The ohm, ampere, and volt are defined in terms of one another as follows: Ohm, the resistance of a conductor through which a current of 1 ampere will pass when the electromotive force is 1 volt. Ampere, the quantity of current which will flow through a resistance of 1 ohm when the electromotive force is 1 volt. Volt, the electromotive force required to cause 1 ampere to flow through a resistance of 1 ohm.

WIRE AND CABLE DATA

1 circular mil is the area of a circle with 0.001-inch diameter = 0.000,000,7854.

A circle one inch in diameter has an area of 1,000,000 circular mils.

1,000,000 circular mils = 0.7854 square inch.

Stranded cable (without hemp core), on account of cords between wires, is 15 per cent larger in diameter than solid conductor for the same circular mils.

A diameter of standard cable of 1.15 inches = 1,000,000 circular mils.

Conversely—

A one-inch stranded cable = 87 per cent of 1,000,000 circular mils, or 870,000 circular mils.

These ratios hold for any stranding of any size wires found in commercial cable.

Conductor Sizes and Overcurrent Protection for Motors

Extracted from National Electrical Code, Table 20, pages 316-319

Full-load Current Rating of Motor, Amperes	MINIMUM-SIZE CONDUCTOR IN RACEWAYS Awg AND MCM			FOR RUNNING PROTECTION OF MOTORS		MAXIMUM ALLOWABLE RATING OF BRANCH-CIRCUIT FUSES			
	Type R	Type RP	Type RH	Maximum Rating of N.E.C. Fuses, Amp	Maximum Setting of Time-limit Protective Device, Amp	**With Code Letters** Single-phase, squirrel-cage, and synchronous. Full-voltage, resistor and reactor starting, Code letters F to R inclusive. **Without Code Letters** Same as above.	**With Code Letters** Single-phase, squirrel-cage, and synchronous. Full-voltage, resistor or reactor starting, Code letters B to E inclusive. Autotransformer starting, Code letters F to R inclusive. **Without Code Letters** Squirrel-cage and synchronous, autotransformer starting, High-reactance squirrel-cage. (Both not more than 30 amperes.)	**With Code Letters** Squirrel-cage and synchronous. Autotransformer starting. Code letters B to E inclusive. **Without Code Letters** Squirrel-cage and synchronous. Autotransformer starting, High-reactance squirrel cage. (Both more than 30 amperes.)	**With Code Letters** All motors. Code letter A. **Without Code Letters** D-c and wound-rotor motors.
1	14	14	14	2	1.25	15	15	15	15
2	14	14	14	3	2.50	15	15	15	15
3	14	14	14	4	3.75	15	15	15	15
4	14	14	14	6	5.0	15	15	15	15
5	14	14	14	8	6.25	15	15	15	15
6	14	14	14	8	7.50	20	15	15	15
7	14	14	14	10	8.75	25	20	15	15
8	14	14	14	10	10.0	25	20	20	25
9	14	14	14	12	11.25	30	25	20	15
10	14	14	14	15	12.50	30	25	20	15
11	14	14	14	15	13.75	35	30	25	20
12	14	14	14	15	15.00	40	30	25	20
13	12	14	14	20	16.25	40	35	30	20
14	12	14	14	20	17.50	45	35	30	25
15	12	12	14	20	18.75	45	40	30	25
16	12	12	14	20	20.00	50	40	35	25
17	10	12	14	25	21.25	60	45	35	30
18	10	12	12	25	22.50	60	45	40	30
19	10	10	12	25	23.75	60	50	40	30
20	10	10	12	25	25.0	60	50	40	30
22	8	10	10	30	27.50	70	60	45	35
24	8	10	10	30	30.00	80	60	50	40
26	8	8	10	35	32.50	80	70	60	40
28	8	8	10	35	35.00	90	70	60	45
30	6	8	8	40	37.50	90	70	60	45
32	6	8	8	40	40.00	100	80	70	50
34	6	6	8	45	42.50	110	90	70	60
36	6	6	8	45	45.00	110	90	80	60
38	5	6	8	50	47.50	125	100	80	60
40	5	6	6	50	50.00	125	100	80	60
42	5	6	6	50	52.50	125	110	90	70
44	4	5	6	60	55.0	125	110	90	70
46	4	5	6	60	57.50	150	125	100	70
48	4	5	6	60	60.00	150	125	100	80
50	3	5	6	60	62.50	150	125	100	80
52	3	4	6	70	65.0	175	150	110	80
54	3	4	5	70	67.50	175	150	110	90
56	2	4	5	70	70.00	175	150	120	90
58	2	3	5	70	72.50	175	150	120	90
60	2	3	5	80	75.00	200	150	120	90
62	2	3	4	80	77.50	200	175	125	100
64	2	3	4	80	80.00	200	175	150	100
66	1	3	4	80	82.50	200	175	150	100
68	1	2	4	90	85.00	225	175	150	110
70	1	2	3	90	87.50	225	175	150	110
72	1	2	3	90	90.00	225	200	150	110
74	0	2	3	90	92.50	225	200	150	125
76	0	2	3	100	95.00	250	200	175	125
78	0	1	3	100	97.50	250	200	175	125
80	0	1	2	100	100.00	250	200	175	125
82	0	1	2	110	102.50	250	225	175	125
84	0	1	2	110	105.00	250	225	175	150
86	00	1	2	110	107.50	300	225	175	150
88	00	1	2	110	110.00	300	225	200	150
90	00	0	2	110	112.50	300	225	200	150
92	00	0	2	125	115.00	300	250	200	150
94	00	0	1	125	117.50	300	250	200	150

Time Intervals within Which National Electrical Code Standard Enclosed Fuses Must Blow on 150 Per Cent Rated Current

Rating of Fuse, Amperes	Max Allowable Time, Min	Rating of Fuse, Amperes	Max Allowable Time, Min
0–30	1	101–200	6
31–60	2	201–400	12
61–100	4	401–600	15

FUSING CURRENTS OF COMMERCIAL FUSE WIRE

These values given below are approximate, since the fusing current is determined by the proportion and kinds of alloys used, kind and form of terminal, length of fuse, and other factors.

Nearest Size, Awg	Diameter, In.	Fusing Current, Amp	Nearest Size, Awg	Diameter, In.	Fusing Current, Amp
30	0.010	1.7	10	0.100	54.1
24	0.020	4.9	9	0.110	63.1
20	0.030	9.0	8	0.130	81.1
19	0.035	11.3	7	0.140	90.6
18	0.040	13.3	7	0.150	100.5
16	0.050	19.8	6	0.160	110.7
14	0.060	25.4	5	0.180	132.1
13	0.070	32.0	4	0.200	154.7
12	0.080	39.1			

PARTIAL LIST OF G-E MOTOR PUBLICATIONS

Motors, General

Consolidated Prices and Data GEA-2739

Polyphase Induction Motors

Type K, Open, Squirrel-cage
- Tri-Clad, Frames 203–326 ..... GEA-3580
- General-purpose, Frames 364–505 ..... GEA-3535
- General-purpose, Frames 542–579 ..... GEA-1807
- Dripproof for Power Stations, 100 to 1500 hp GEA-3475

Type KF, Open, Squirrel-cage
- General-purpose, Frames 364–505 ..... GEA-3535
- 3600 and 3000 Rpm, 125 Hp and Larger GEA-978
- General-purpose, Frames 542–579 ..... GEA-1807

Type KG, Open, Squirrel-cage
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- General-purpose, Frames 364–605 ..... GEA-3535
- General-purpose, Frames 542–579 ..... GEA-1807
- Valv-amp Rotors GEA-3347
- Dripproof for Power Stations, 100 to 1500 Hp GEA-3475
- Air-conditioning and Refrigeration Compressors GEA-3479

Type KR, Open, Squirrel-cage
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- General-purpose, Frames 364–505 ..... GEA-3535

Type M, Open, Wound-rotor
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- Steel-mill Main-roll Drives GEA-789

Type BTA Motors GEA-712

Multispeed Induction Motors GEA-1884

Splashproof Induction Motors
- Tri-Clad, Frames 203–326 ..... GEA-3595
- General-purpose, Frames 364 and Larger GEA-1619

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- Totally Enclosed, Fan-cooled GEA-1326
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- Explosion-proof GEA-1341
- Inert-gas-filled for Hazardous Gas Locations GEA-3109

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- Vertical Solid-shaft Motors GEA-1412

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- Vertical Hollow-shaft Motors GEA-1368
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- Pacific, G-E Motorized, Speed Reducers GEA-1870
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- Type KC, Capacitor GEA-2420
- Type KC, Capacitor GEA-2915
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- Hermetically Sealed Compressor Motors GEA-3474

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- Jet-pump Motors GEA-3465

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- Type CD Exciters GEA-432
- Type B Exciters GEA-1607

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- Type KR, General-purpose, Frame 364–505 ..... GEA-3535
- Type KR, Totally Enclosed GEA-1366
- Type MR, Frames 204–505 ..... GEA-2714

D-c Crane and Hoist Motors
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- Type CO D-c Totally Enclosed Motors GEA-380
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- Induction Motor-generators GEA-1598
- Induction Motor-generator Sets GEA-394

Synchronous Motor-generator Sets GEA-1945

SUBJECT INDEX

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Akron, Ohio ... 335 South Main Street
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Detroit, Mich. ... 700 Antoinette Street
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El Paso, Texas ... 109 North Oregon Street
Erie, Pa. ... 10 East Twelfth Street
Evansville, Ind. ... 123 Northwest Fourth Street
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Fort Worth, Texas ... 408 West Seventh Street
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Jacksonville, Fla. ... 237 West Forsyth Street
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Spokane, Wash. ... 421 Riverside Avenue
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West Lynn, Mass. ... 920 Western Avenue

Special service divisions are also maintained at the following Works of the Company: Erie, Pa.; Ft. Wayne, Ind.; Pittsfield, Mass.; Schenectady, N. Y.; and West Lynn, Mass. (West Lynn Works).

May, 1942 (7M)
Filing No. 8030
Plastic Binding U.S. Patent No. 1970285
License No. 87, Schenectady, N. Y.
PRINTED BY THE MAQUA COMPANY, SCHENECTADY, N. Y.

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