

700 SERIES WORM GEAR SPEED REDUCERS

6



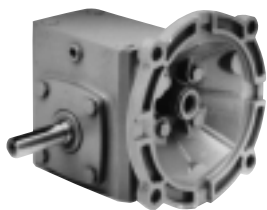


Figure 6.1

T

his is our introduction into Boston Gear's speed reducer line. Boston Gear has many types of speed reducers.

They are the 700 Series right angle worm gear and the 200, 600 and 800 Series helical speed reducers.

The purpose of an enclosed gear drive is to reduce the input speed coming from the prime mover, usually an AC or DC motor, to a slower speed output through a gear reduction.

The term "enclosed gear drive" comes from the fact that the gears are contained in some type of an enclosure with all the necessary lubricant. The enclosure protects the machine operator from injury.

Boston Gear has manufactured a line of stock off-the-shelf speed reducers since 1923, the latest of which is the expanded line of Boston's 700 Series. This lesson will acquaint you with the exclusive features of the 700 Series line, and provide you with the data you will need with regard to numbering systems, interchangeability and selection.

BOSTON GEAR 700 SERIES

Boston Gear's 700 Series worm gear speed reducers are available in a complete range of types and sizes. Designed especially for heavy-duty industrial applications, the high-pressure angle, integral worm and shaft of 700 Series models provide maximum torque ratings and power transmission efficiency. (See Figure 6.1)

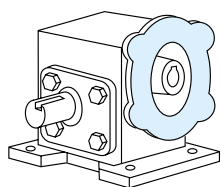
Now let's look at some of the unique features of the 700 Series. (See Figure 6.2)

There are four types of reducers in Boston's 700 Series:

- Basic reducer
- RF model (coupling type input)
- F model (quill type input) for use with N.E.M.A. "C" face mounted motors.
- Bost Mount-Hollow Output Bore

The 700 Series comes in eleven basic sizes:

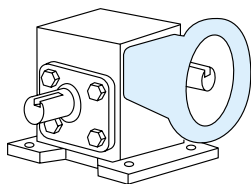
- Center distances range from 1" – 6 "
- Horsepower ratings range from 1/6 HP – 25 HP



QUILL TYPE

NEMA C-Face
Hollow input shaft with keyway to accept motor shaft and key.

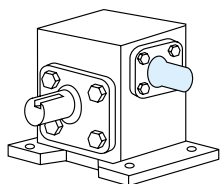
PREFIX — "F"



COUPLING TYPE

NEMA C-Face
Solid projecting input shaft with keyway.
Coupling shipped with reducer for motor shaft connection

PREFIX — "RF"



NO MOTOR FLANGE
Solid projecting input shaft with keyway and key.

NO PREFIX

HOLLOW SHAFT

Available in several sizes.
Keyway through the bore.

PREFIX — "S" or "H"
Before "F" or "RF" or just "S"
or "H" for no motor flange

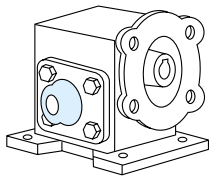


Figure 6.2

700 Series models are available from stock in the following ratios:

- Single reduction models, from 5:1 – 60:1 (6.3A, 6.3B)
- Double reduction models, from 100:1 – 3600:1. (6.4)

CONSTRUCTION FEATURES

(See Figure 6.5)

- A. Rugged housing of fine-grained, gear-quality cast iron provides maximum strength and durability. Greater rigidity and one-piece construction ensure precise alignment of the worm and gear. This housing construction also provides superior resistance to caustic washdown solutions, plus high heat dissipation and reduced noise level. Pipe plugs allow easy fill, level and drain in any mounting position.
- B. Housings are straddle-milled top and bottom for precise alignment of horizontal and vertical bases.
- C. Multi-position mounting flexibility – threaded bolt holes let you install 700 Series speed reducers in almost any position.
- D. Internal baffle assures positive leak-free venting.
- E. Large oil reservoir provides highly efficient heat dissipation and lubrication for longer operating life.
- F. High pressure angle on worm provides greater operating efficiency.
- G. Integral input worm and shaft design made from high-strength case-hardened alloy steel. Reduced sizes 710 through 726 have pre-lubricated bearings; 732 through 760 have tapered roller bearings. Double lip oil seals are standard.
- H. Super-finished oil seal diameters on both input and output shafts provide extended seal life.
- I. High strength steel output shaft assures capacity for high torque and overhung loads.
- J. High-strength bronze worm gear is straddle mounted between heavy-duty tapered roller bearings to increase thrust and overhung load capacities, sizes 713-760.



F700 BASIC

Figure 6.3A



700 BASIC

Figure 6.3B



F/RFWA700 BASIC

Figure 6.4

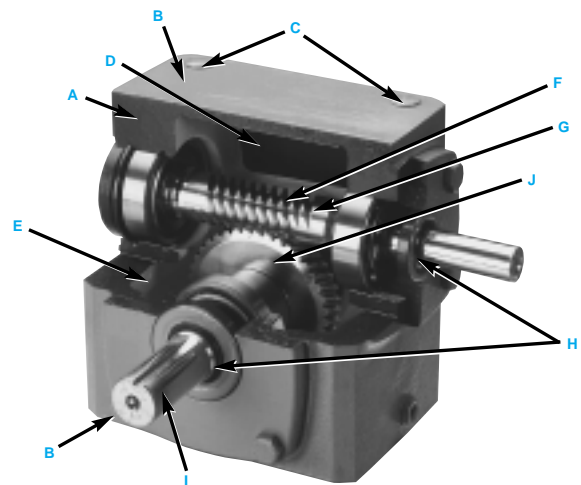


Figure 6.5



Figure 6.6



Figure 6.7

WORM GEAR

700 Series worm gears feature precision generated gear teeth for smooth, quiet operation. Thrust and overhung load capacities are enhanced by straddle mounting the high strength bronze worm gear between heavy duty tapered roller bearings.

SERIES 700 OPTIONS INCLUDE:

- Double oil seals on input and output shaft for special applications
- Fan kit for larger sizes to enhance cooling
- Riser blocks for increased motor clearance and extended reducer life
- Choice of vertical or horizontal bases
- Motor flange kit for standard NEMA C-face motors
- Reaction rod kit for hollow output shaft models
- BISSC approved white and stainless steel washdown units
- Multiple output bores available for Bostmount series

700 SERIES—DEFINITIONS AND TYPES

A geared speed reducer – like those in Boston Gear's 700 Series – is a packaged unit of gears, shafts and bearings assembled in a housing containing lubricant. A geared speed reducer is designed for both the reduction of speed and the transmission of power.

The 700 Series is available in both single-reduction and double-reduction models.

The basic difference in a single reduction and a double reduction speed reducer is the ratio. Single reduction (See Figure 6.6) speed reducers have a ratio range from 5:1 to 60:1. Double reduction can achieve higher reduction ratios (100:1-3600:1) by adding an additional single speed reducer to the input shaft of the primary gearbox. Therefore the ratios of the primary and secondary reducers are multiplied and the output speed is a product of the two. For example, the first reduction could be 50:1 and the second reduction could be 60:1. The end result would be a 300:1.

SINGLE REDUCTION: RF MODEL COUPLING TYPE AND F-MODEL QUILL TYPE

Boston Gear's coupling long flange (RF model) and quill short flange (F model) single-reduction speed reducers are available in reduction ratios ranging from 5:1 to 60:1, and will accommodate motor inputs from 1/6 to 20 hp. The RF model has a self-positioning, two-piece steel coupling input with a straddle-mounted double-bearing support, and is available with a standard NEMA C-face and coupling.

(See Figure 6.8) The F-type is designed with a hollow input shaft suitable for assembly with NEMA C-face motors. (See Figure 6.9)

DOUBLE-REDUCTION, RFW-MODEL COUPLING AND FW-MODEL QUILL TYPES

Boston Gear's coupling-type (RFW model) and quill-type (FW model) double-reduction speed reducers are available in reduction ratios ranging from 100:1 to 3,600:1, and will accommodate motor inputs from 1/6 to 5 hp. The RFW model, with its self-positioning, two-piece steel coupling, has a straddle-mounted double-bearing support and is available with a standard NEMA C-face and coupling.

The quill type is designed with a hollow input shaft suitable for assembly with NEMA C-face motors. (See Figure 6.10)

SINGLE-REDUCTION, BASIC TYPES

Boston Gear's basic single-reduction worm gear speed reducers serve all types of applications, and are available in reduction ratios ranging from 5:1 to 60:1 for motor inputs ranging from .07HP to 25HP. Multi-position mounting and a variety of shaft configurations allow installation in almost any position. Basic models feature positive-retained input shafts and bearing retainers; through-bore housings; and oversize roller and ball bearings. Options include: hollow output shafts; reaction rods; fan kits; riser blocks; vertical or horizontal bases; and double oil seals for input shafts. (See Figure 6.11)



Figure 6.8

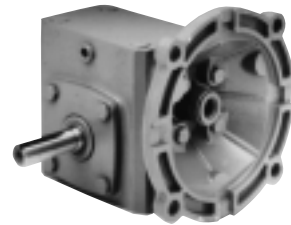


Figure 6.9



Figure 6.10



Figure 6.11



Figure 6.12

DOUBLE-REDUCTION, BASIC TYPES

Boston Gear's basic double-reduction speed reducers are designed for efficiency and reliability. They are available in reduction ratios from 100:1 to 3,600:1, and will accommodate motor inputs from .07 HP to 5.75 HP. Basic models have positive-retained input shafts and bearing retainers. Precision through-bore housings assure true shaft positioning with proper mating of worms and gears. A broad range of input/output shaft configurations and multi-position mounting provide flexible reducer positioning.

(See Figure 6.12)

SPEED REDUCERS—COMMONLY USED TERMS

As we have learned throughout our Power Transmission 101 course, the world of gears – like so many other businesses and industries – has its own “language”. Let's look at some of the terms you need to know to become more familiar with the Boston Gear line of speed reducers.

Axial Movement: Endwise movement of input or output shaft, sometimes called endplay, usually expressed in thousandths of an inch.

Efficiency: The output power of the reducer (as compared to the input power). It is usually stated as a percentage.

Example:

- Input HP = 1 (75/100) (100) = 75% Efficiency
- Output HP = .75

BACKLASH

Rotational movement of the output shaft when holding the input shaft stationary and rotating the output shaft alternately clockwise and counterclockwise. Backlash may be expressed in thousandths of an inch measured at a specific radius at the output shaft.

CENTER DISTANCE

On a single reduction speed reducer, center distance is the distance between the center lines of the input and output shafts. Shaft center lines may be parallel or at right angles to one another. The center distance of multiple stage reducers usually refers to the lowest speed stage.

THRUST LOAD

The thrust load is the force imposed on a shaft parallel to the shaft axis. Thrust load is often encountered on shafts driving mixers, fans, blowers and similar pieces of equipment. When a thrust load acts on a speed reducer, the thrust load rating of the reducer must be high enough for the shafts and bearings to absorb the load.

MECHANICAL RATING

The mechanical rating is the maximum power or torque that a speed reducer can transmit, based on the strength and durability of its components. Obviously, the reducer may be rated no higher than the strength or durability of its weakest component. Reducers typically have a safety margin of two to three times their mechanical ratings. Thus, a reducer can withstand momentary overloads of 200-300% of its mechanical rating during a startup or other brief overload situation.

THERMAL RATING

The thermal rating is the maximum power or torque that a speed reducer can transmit continuously, based on its ability to dissipate heat generated by friction.

PRIME MOVER

The prime mover is the machine that provides power to a drive. The most frequently encountered prime movers include electric motors, internal combustion engines, hydraulic motors, and air motors. The type of prime mover used can affect the speed reducer during operation. For example, an electric motor runs relatively smoothly in comparison to an internal combustion engine.

MOUNTING POSITION

The relationship of the input and output shaft relative to the floor line is called the mounting position.

OUT-PUT RPM	RATIO	NON-FLANGED REDUCERS				SIZE
		GEAR CAPACITY			HP	
		OUTPUT TORQUE (LB.IN.)	INPUT	OUT-PUT		
350	5:1	99	.60	.55	710-5	
		202	1.25	1.11	713-5	
		281	1.74	1.56	715-5	
		337	2.08	1.88	718-5	
		540	3.35	2.99	721-5	
		675	4.16	3.75	724-5	
		900	5.57	5.00	726-5	
175	10:1	123	.37	.34	710-10	
		243	.75	.67	713-10	
		343	1.07	.96	715-10	
		460	1.43	1.28	718-10	
		690	2.14	1.91	721-10	
		968	3.00	2.69	724-10	
		1181	3.63	3.27	726-10	

Figure 6.13

INPUT HORSEPOWER

The amount of power applied to the input shaft of a reducer by the prime mover is input horsepower. It is often used as a basis for selecting power transmission components. Input horsepower appears in the rating tables or drive manufacturers' published data. (See Figure 6.13)

(Important: Input horsepower ratings represent the maximum amount of power that the reducer can handle safely.)

OUTPUT HORSEPOWER

The amount of power available at the output shaft of a reducer is the output horsepower. Due to losses caused by inefficiency, output horsepower is always less than input horsepower. (See Figure 6.13)

OVERHUNG LOAD

A force applied at right angles to the shaft, beyond its outermost bearing is the overhung load. Both the input and output shaft of a speed reducer can be subject to an overhung load. Such a force is a shaft bending under load resulting from a gear, pulley, sprocket or other external drive member. Besides the tendency to bend the shaft, the overhung load (the radial force on the shaft) is reacted to by the shaft in its bearings. Therefore, the overhung load creates loads that the bearings must be able to support without damage.

SERVICE FACTORS

A numbering system that identifies the loads that must be considered in selecting a speed reducer is the service factor. Service factors vary according to the type of service for which the reducer is to be used, the kind of prime mover involved and the duty cycle. The service factor can be a multiplier applied to the known load, which redefines the load in accordance with the conditions at which the drive will be used, or it can be a divisor applied to catalog reducer ratings, thus redefining the rating in accordance with drive conditions.

The service factor is usually applied to the speed reducer, but can also be applied to the nameplate rating of the prime mover.

REDUCTOR

Boston Gear's registered trademark for a speed reducer having a projecting input shaft suitable for mounting a coupling, sprocket, pulley or gear is a reductor.

(See Figure 6.14)

RATIOMOTOR™

Boston Gear's registered trademark for a motorized reducer consisting of a flanged reductor and face mounted motor assembly. A Ratiomotor is sometimes referred to as a gearmotor.

SELF LOCKING ABILITY

Boston 700 Series reducers, under no conditions should be considered to hold a load when at rest.

BACK-DRIVING

Is the converse of self-locking, depending upon reduction ratio and many other variables, it is difficult to predict the back-driving capability of a 700 Series reducer. Worm gear reducers are not intended to be used as speed increasers. Please consult the factory for back-driving applications.

SELECTING THE RIGHT SPEED REDUCER

In order to select the "right" motorized or non-motorized speed reducer for a given application, it is necessary to use the selection charts that are in your Worm Gear Drives catalog. You will find that the charts are similar to those we used in previous lessons on open gearing.

As is the case when selecting all power transmission equipment, you must know the following when selecting a speed reducer:

- Horsepower
- Torque
- Speed – RPM
- Service Factor



Figure 6.14

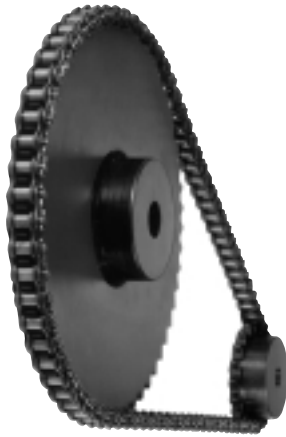


Figure 6.15

Note: When space or design will permit, selecting the use of an auxiliary drive between the speed reducer and the machine to be driven provides the following advantages:

- Cost savings on the complete drive
- A wider range of speed reduction
- Use of a smaller speed reducer
- Possible use of a smaller HP motor

These advantages occur because the use of an auxiliary drive between the speed reducer and the driven machine reduces the torque required at the output shaft of the speed reducer in direct proportion to the auxiliary drive ratio. More economical solutions will usually be provided by higher auxiliary drive reduction ratios, which normally should not exceed a 6:1 ratio.

Now let's begin our step-by-step selection process:

Step 1 – To determine the best auxiliary drive ratio to use, first multiply the maximum machine speed by six.

Step 2 – From the reducer selection charts listed in the Boston Gear 700 Series catalog, select the *next lower maximum operating speed* listed.

Step 3 – Divide the maximum operating speed by the maximum machine speed to obtain the proper auxiliary drive ratio.

Steps 4 – To calculate the torque of the speed reducer to be selected, divide the machine torque by the auxiliary drive ratio* you found above in Step 3.

(*Remember: Efficiency should also be included in output torque calculations. Use the following formula: Output torque = input torque x ratio x efficiency.)

Step 5 – Select the chain pitch and sprocket or spur gears. (See Figure 6.15)

Example:

- Output torque of speed reducer: 500 in lbs.
- Ratio of chain drive 3:1

- Approximate efficiency of chain drive: 95%

$OPT = 500 \times 3 \times 95\% = 1425$ inch pounds

ORDERING THE 700 SERIES

Keep the following information in mind when ordering a 700 Series speed reducer from Boston Gear.

- Reducers may be mounted in several positions relative to the floor line, with single or double output shafts. They also may be furnished motorized and non-motorized.

**700 SERIES REDUCERS:
MAXIMUM ALLOWABLE INPUT SPEEDS**

The maximum input speed (RPM) listed is for intermittent duty – 15-20 minutes running time – at maximum calculated output torque.

<i>Single Reduction</i>		<i>"W" Double Reduction</i>	
Size	Max. Input RPM	Size	Max. Input RPM
713	3600	713	3600
715	3600	718	3600
718	3600	721	3600
721	3600	726	3600
724	3600	732	3600
726	3600	738	3600
732	3600	752	3600
738	3200	760	3200
752	2500		
760	1750		

To calculate the allowable output torque rating of a reductor when input speed (RPM) is above 1750 RPM:

Step 1 – Calculate the output RPM of the reductor.

- Reductor output RPM = Input RPM ÷ Ratio

Step 2 – Determine the output torque.

Output Torque = 63025 x Output horsepower (HP) listed in the catalog for 1750 RPM ÷ Reductor output (RPM)

Example: Using the 700 Series catalog, calculate the maximum output torque rating of a 725-30 reductor, with an input speed at 3600 RPM.

Step 1: Reductor output RPM = Input RPM ÷ Ratio = 120

Step 2: Reductor output torque = 63025 x .91 ÷ 120 = 478 inch pounds

(**Note:** Noise level may increase when operating above 1750 RPM input.)

LUBRICATION

Boston Gear's synthetic lubrication recommendations – as well as AGMA recommendations – are shown below. Please keep in mind that *700 Series speed reducers are shipped without lubricant*. Prelubricated 700 Series reducers are available as a special option – and must be ordered as such. (See Chart 6.16)

ENCLOSED WORM GEAR REDUCERS

Ambient (Room) Temperature	Recommended Oil (Or Equivalent)	Viscosity Range SUS @100°F	Lubricant AGMA No.	ISO Viscosity Grade No. †
-30° to 225°F‡ (-34°C to 107°C)	Mobil SHC 634* Synthetic	1950/2150	—	320/460
40° to 90°F (4.4°C to 32.2°C)	Mobil 600W Cylinder Oil	1920/3200	7 or 7C	460
80° to 125°F (26.7°C to 51.7°C)	Mobil Extra Hecla Super Cylinder Oil	2850/3600	8 or 8C	680

Chart 6.16

AXIAL MOVEMENT – Endwise movement of input or output shafts, sometimes called endplay, is usually expressed in thousands of an inch.

EFFICIENCY – The amount of output power of the reducer as compared to the amount of input power. It is usually stated as a percentage.

Example:

$$\begin{aligned} \text{Input HP} &= 1 \\ \text{Output HP} &= .75 \end{aligned} \quad (75/100) \times (100) = 75\% \text{ Efficiency}$$

BACKLASH – Rotational movement of the output shaft when holding the input shaft stationary and rotating the output shaft alternately clockwise and counter clockwise. Backlash may be expressed in thousands of an inch measured at a specific radius at the output shaft.

CENTER DISTANCE – On a single reduction reducer, this is the distance between the center lines of the input and output shafts. Shaft center lines may be parallel or at right angles to one another. The center distance of multiple stage reducers usually refers to the lowest speed stage (last reduction).

THRUST LOAD – Forces imposed on a shaft parallel to the shaft axis. Such a force is called a thrust load. It is often encountered on shafts driving mixers, fans, blowers and similar machines. When a thrust load acts on a speed reducer, you must be sure that the thrust load rating of the reducer is high enough that it's shafts and bearings can absorb the load.

MECHANICAL RATING – The maximum power or torque that a speed reducer can transmit, based on the strength and durability of its components, is its mechanical rating. Obviously, the reducer may be rated no higher than the strength or durability of its weakest component. Reducers typically have a safety margin of two to three on their mechanical ratings. Thus, a reducer can withstand momentary overloads of 200-300% of its mechanical rating during a startup or other brief overload situations.

THERMAL RATING – The maximum power or torque that a speed reducer can transmit continuously, based on its ability to dissipate heat generated by friction, is called its thermal rating.

PRIME MOVER – The machine that provides power to a drive is its prime mover. The most frequently encountered prime movers include electric motors, internal combustion engines, hydraulic motors and air motors. The type of prime mover used can affect the speed reducer during operation. For example, an electric motor runs relatively smoothly in comparison to an internal combustion engine.

MOUNTING POSITION – The relationship of the input and output shafts relative to the floor line.

INPUT HORSEPOWER – The amount of power applied to the input shaft of a reducer by the prime mover is its input horsepower. It is often used as a selection basis for power transmission components, and it appears in the rating tables of drive manufacturer's published data. Remember that input horsepower ratings represent the maximum amount of power that the reducer can safely handle.

OUTPUT HORSEPOWER – The amount of power available at the output shaft of a reducer is its output horsepower. Due to losses caused by inefficiency, output horsepower is always less than input horsepower.

OVERHUNG LOAD – The input or the output shaft of a speed reducer can be subject to an overhung load; that is, to a force applied at right angles to the shaft, beyond its outermost bearing. Such a force is a shaft bending load resulting from a gear, pulley, sprocket or other external drive member. Besides the tendency to bend the shaft, the overhung load (that is, the radial force on the shaft) is reacted to by the shaft in its bearings. Therefore, the overhung load creates loads that the bearings must be able to support without damage.

SERVICE FACTORS – Numbers which modify the loads which must be considered in selecting a speed reducer are called service factors. They vary with the type of service in which the reducer is to be used, the kind of prime mover involved and the duty cycle. The service factor can be a multiplier applied to the known load, which redefines the load in accordance with the conditions at which the drive will be used, or it can be a divisor applied to catalog reducer ratings, thus redefining the rating in accordance with drive conditions. The service factor is usually applied to the speed reducer, but can also be applied to the name plate rating of the prime mover.

REDUCTOR® – Boston Gear's registered trademark for a speed reducer having a projecting input shaft suitable for mounting a coupling, sprocket, pulley or gear.

FLANGED REDUCTOR – Boston Gear's name for a reductor furnished with an input flange suitable for attaching a face mounted motor.

RATIOMOTOR® – Boston Gear's registered trademark for a motorized reducer consisting of a flanged reductor and face mounted motor assembled, sometimes referred to as a gearmotor.

SELF-LOCKING ABILITY – Boston 700 Series reducers, under no conditions should be considered to hold a load when at rest.

BACK-DRIVING – This is the converse of self-locking. Depending upon ratio and many variables, it is difficult to predict the back-driving capability of a 700 Series reducer. Worm gear reducers are not intended to be used as speed increasers. Consult factory for back-driving applications.

Keypoints

- Boston Gear has right angle speed reducers in ratios from 5:1 to 3600:1
- Boston Gear has 4 different styles in 11 basic sizes. In 1" to 6" center distance
- 700 Series are made for industrial applications
- Boston Gear also carries a complete family of washdown speed reducers in both white epoxy coated stainless steel coated
- Boston Gear was the first to manufacture a multiply mounting right angle worm gear speed reducer

Quiz

CLICK HERE or visit <http://www.bostongear.com/quiz> to take the quiz