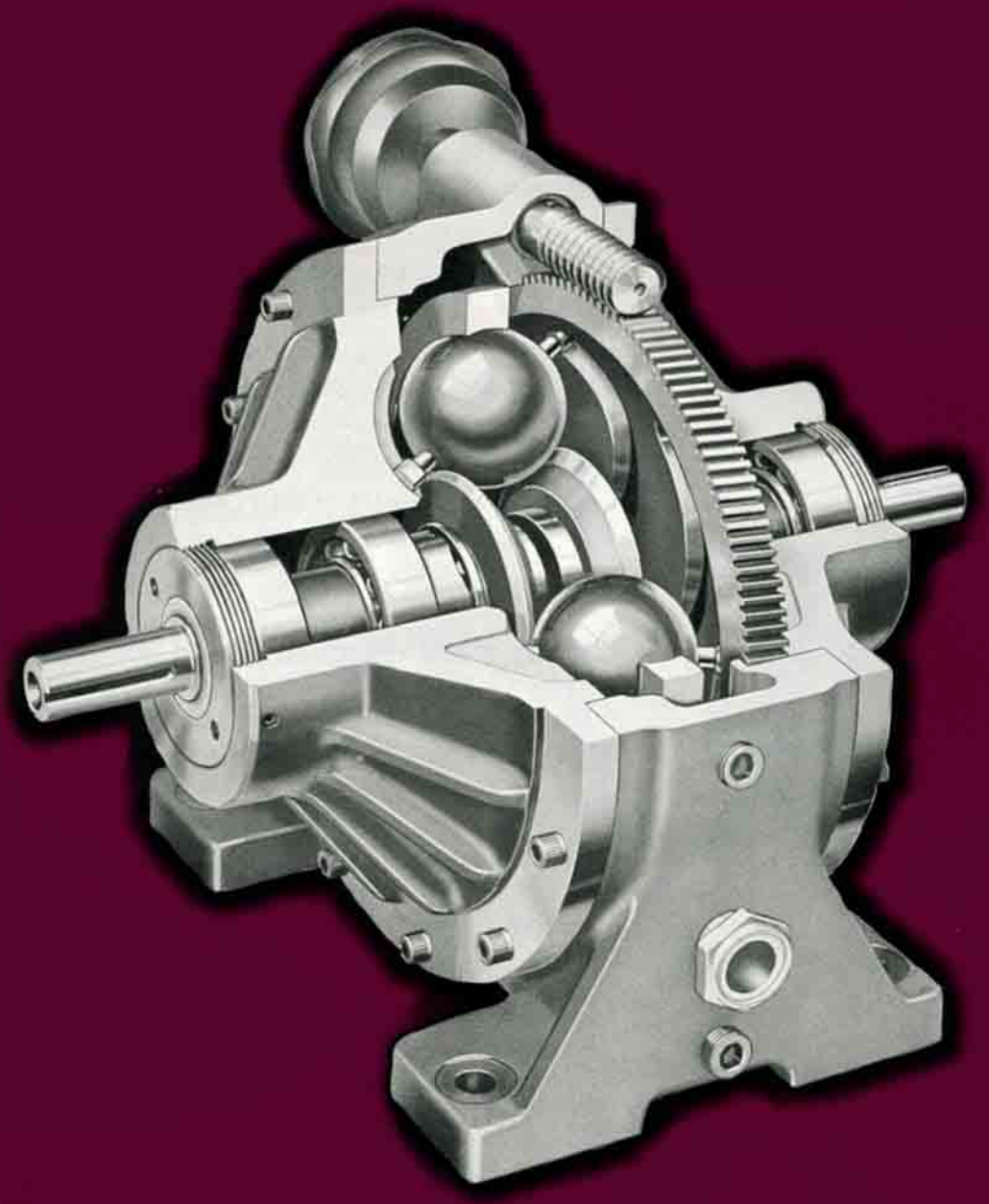
Cleveland Gear

SPEED VARIATORS



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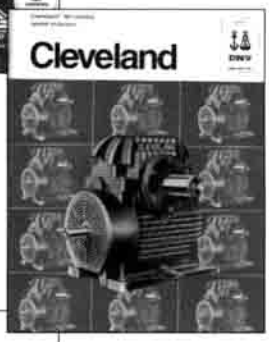
"MUSTS" FOR YOUR ENGINEERING DEPARTMENT

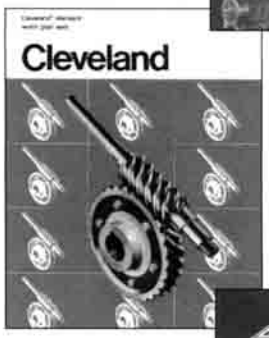
◄ Brochure # 900 - Capabilities Brochure

Summarizes Cleveland's capabilities and 86+ year tradition of gear flexibility, innovation, reliability and service.



◄ Catalog # 500 - Fan-Cooled Speed Reducers

Extensive data on selection, installation and maintenance, including design features, ratings and dimensions on all three types.



◄ Catalog # 600 - Open Gearing

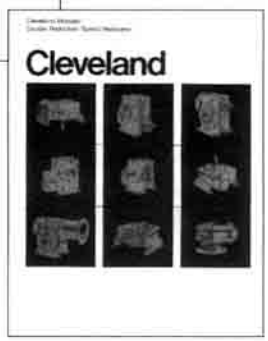
Includes application classifications and service factor tables, plus ratings tables, special designs, and worm and gear dimensions.

◄ Catalog # 400 - Modular Speed Reducers

Includes selection guidelines for Single and Double Reduction, rating, application and arrangement data, mounting adapters, accessories, lubrication and installation instructions.

◄ Catalog # 520D - E-Line Series-Single Reduction

Includes detailed data on features, applications and selection procedures for Single Reduction Fan-Cooled Speed Reducers.



◄ Catalog # 521B - E-Line Series-Double Reduction

Contains selection information, detailed specifications and mounting arrangements for these Double Reduction Speed Reducers.

CALL TOLL-FREE: 1-800-423-3169

Cleveland Speed Variators

PRECISION SPEED CHANGER and TORQUE CONVERTER

A rugged, dependable, precision made, all metal drive that combines the advantages of compact, in-line drive shafts with quiet and smooth operation. Output speeds are infinitely variable within a range of 9 to 1 from a constant speed input. Drive can be used with variable input, constant output. Cleveland Speed-Variators offer the following advantages:

• *WIDE SPEED RANGE*

Infinitely variable adjustment from 1/3 to 3 times the input speed — overall speed range of 9:1.

• *9 SIZES*

Ratings from fractional to 16 HP.

• *PRECISION SPEED HOLDING CHARACTERISTICS*

Under extreme no-load-to-full-load fluctuation, maximum output speed change is under 4%. Under uniform loading, output speed variation is less than 0.1%.

• *PRECISE REPEATABILITY*

Returns accurately to previous output speeds. Provides accuracy of repeatability within 0.1% with manual, vernier control.

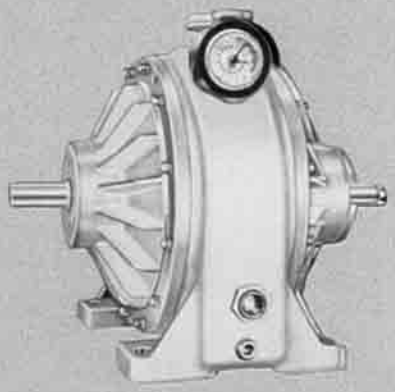
• *POSITIVE TRACTION — NO SLIP*

Torque compensators provide tractive force proportioned to load for positive, no-slip operation. Unit will stall an equally rated induction motor.

• *ALL METAL CONSTRUCTION*

Rolling contact, operating on the same principle as a ball bearing, assures long life. Extended operation at any fixed speed setting does not impair speed adjustment accuracy.

STANDARD UNIT



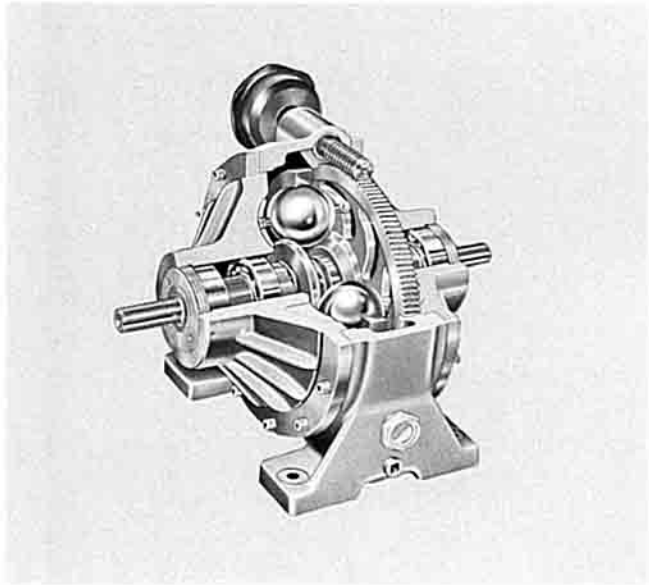
A compact drive with in-line shafts for use with line shafts, free-standing motors, or other prime movers. Adequate overhung capacity allows use of standard gear, belt, or chain drive methods to either input or output shafts. Output shaft rotation is in same direction as input shaft. Operation is either driving or holding-back modes.

MANUAL CONTROL

A manual handwheel speed control is standard equipment on all Cleveland Speed-Variators unless another control method is desired. An indicator dial provides a reference for speed adjustment that is suitable for most applications. This handwheel can also be furnished with a vernier indicator dial and control locking thumbscrew for those applications that demand accuracies to 0.1% repeatability.

SPEED VARIATOR DESIGN CONSIDERATIONS

HOW IT WORKS

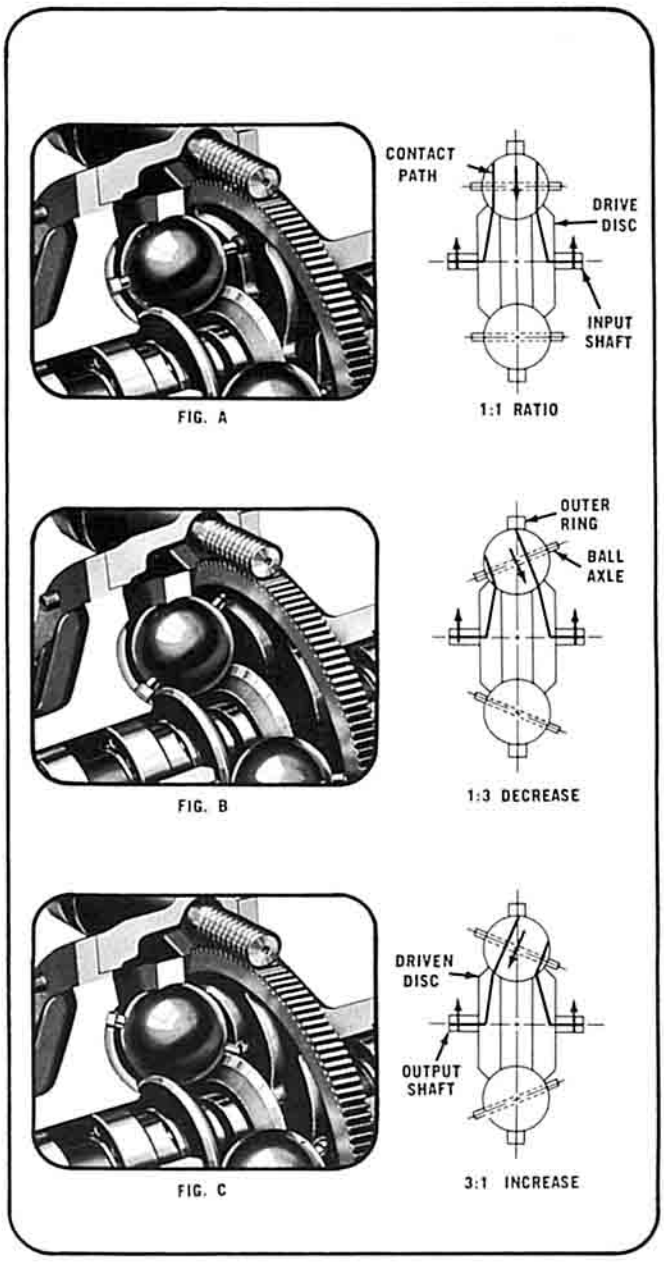


The Cleveland Speed Variator is a dependable, compact, mechanical drive that provides infinitely variable output speeds over a range of 9:1 from a constant speed source. As shown at the right, power is transmitted through the input shaft to a beveled drive disc in contact with the axle-mounted drive balls. Input shaft rotation causes the balls to rotate about their axles. Power is then transmitted from all rotating balls to the output shaft by a similar ball-disc contact on the output side. Both ends of each ball axle fit into radial slots in the housing, thereby preventing axles from revolving about the drive shafts. A free-floating outer ring provides a third contact support for the balls and rotates with them when the drive is in operation.

Output speed is determined by relative lengths of the contact paths on input and output sides of the balls. By tilting both axles and balls, relative lengths of the two contact paths are varied. In Figure "A", both contact paths are equal in length, thus giving a speed ratio of 1:1. In Figure "B", ball contact path on the input side is longer than on the output side — resulting in a decrease in output speed; conversely in Figure "C", an increase in speed results.

Tilting of the balls is accomplished by rotating a cam-slotted iris plate through which all ball axles project. Precise control of this speed adjustment is obtained by employing a worm drive to position the speed regulating iris plate mechanism.

The simple geometry of the rolling parts provides smooth, quiet, vibration-free operation over the Speed-Variator's entire 9:1 speed range.



TORQUE RESPONSIVE MECHANISM

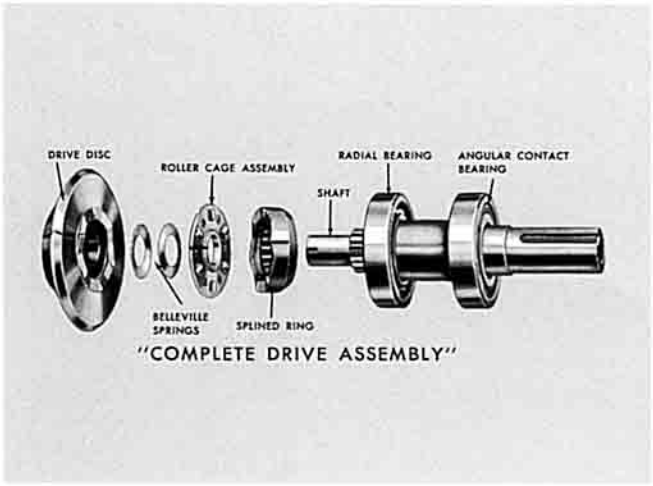


FIG. 1

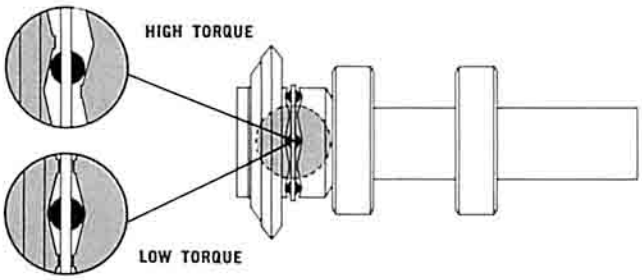


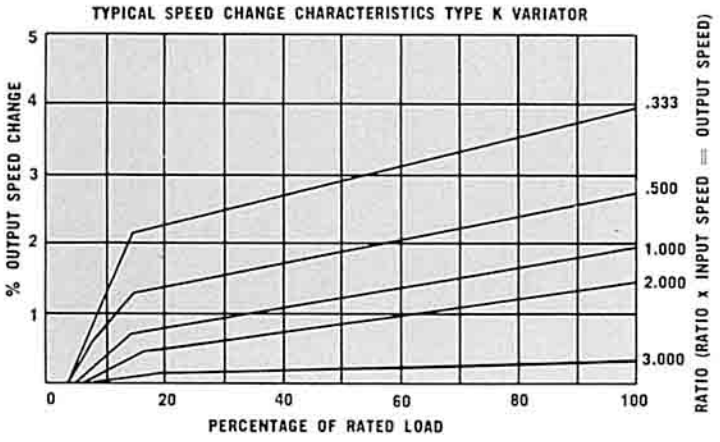
FIG. 2

A torque responsive mechanism (shown in Figure 1) is incorporated into both input and output shafts to provide traction proportioned to the amount of torque transmitted through the drive. These mechanisms insure traction at all times regardless of load, speed, or direction of rotation.

When torque is applied to either the drive shaft or the drive disc, it is transmitted from one to the other through 6 or 8 spherical rollers secured in a retainer and normally centered in the shallow "V" notches formed on the opposing faces of the splined ring and the drive disc. In transmitting this torque, the spherical rollers tend to ride up the sloping sides of the notches and force the splined ring and the drive disc farther apart (see Figure 2). *NOTE: SPLINED RINGS ARE FIXED TO THE DRIVE SHAFTS. DRIVE DISCS ARE NOT KEYED TO THE SHAFTS BUT HAVE A LIMITED FREEDOM OF MOVEMENT.* The thrust bearings in the end plates of the unit eliminate axial looseness; any actual widening of the space between the splined ring and the drive disc is limited by the stiffness of the whole structure. An axial pressure is established in the unit that is transmitted from one thrust bearing to the opposing one through the drive discs and balls. The axial pressure so created is proportional to the applied torque and is adequate to provide positive traction between the drive discs and the balls. This proportionality between torque and axial pressure is maintained even under severe overload and is completely independent of speed.

At the instant of starting the drive, a nominal axial pressure is required to insure that the drive discs and balls are in tractive contact. This is supplied by a series of Belleville springs. *THE SPEED VARIATOR WILL NOT SLIP — IT WILL STALL AN EQUALLY RATED INDUCTION MOTOR.*

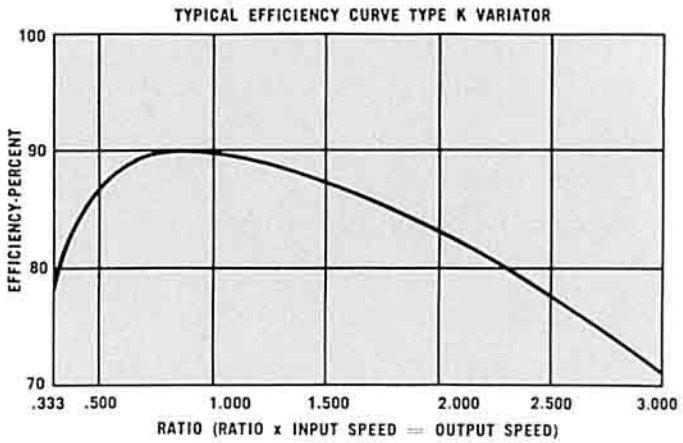
TYPICAL SPEED CHARACTERISTICS



The graph above shows the change in output speed with change in applied load as plotted for different ratio settings in the Variator.

Under a constant imposed load, the input-output speed ratio is remarkably steady, and the unit will operate for hours without variation.

EFFICIENCY



The efficiency of a typical Type K Variator is plotted on the above graph. In this case, the curve is representative of a standard Speed Variator operated at 1200 rpm input speed, with output speeds varying from 400 to 3600 rpm. Maximum efficiency is realized when input and output speeds are substantially equal.

SPEED VARIATOR DESIGN CONSIDERATIONS

IRIS PLATES AND THEIR EFFECT ON SPEED CONTROL

The speed ratio is determined by movement of the iris plate. This is accomplished by turning the control worm which engages teeth on the periphery of the iris plate. As several turns of the worm are required to cover the full speed range, very precise speed setting is attained. This can be done manually, or remote manually, or by electrical means. Pneumatic control is effected by an actuator which pushes and pulls the control worm in the manner of a rack and pinion. The curvature and length of the cam slots in the iris plate determine the pattern and range of speed control. Iris plate stops can be added to limit the output speed range.

The upper graphs shown here are plots of the output-input ratio as plotted against worm turns. The lower graphs are plotted against linear movement of the control worm, as with pneumatic control.

TYPE K—GEOMETRIC

This iris plate permits the full range of 9:1 speed change infinitely variable from ⅓ to 3 times input speed. For every increment of control worm movement, the ratio will vary by a fixed percentage of **OUTPUT** speed.

TYPE KL—LINEAR

This iris plate permits a speed range of 6:1 infinitely variable from ⅓ to 2 times input speed. For every increment of control worm movement, the ratio will vary by a fixed percentage of **INPUT** speed.

TYPE KA—LIMITED RANGE

This iris plate permits a speed range of approximately 75% to 125% of input speed. (See curves for actual range of each size).

With the limited range iris plate, more turns of the control worm are required to effect a given speed change than would be required with either the linear or geometric plates.

Approximate Torque Required to Rotate Control Worm at 1750 RPM, Variator Input Speed

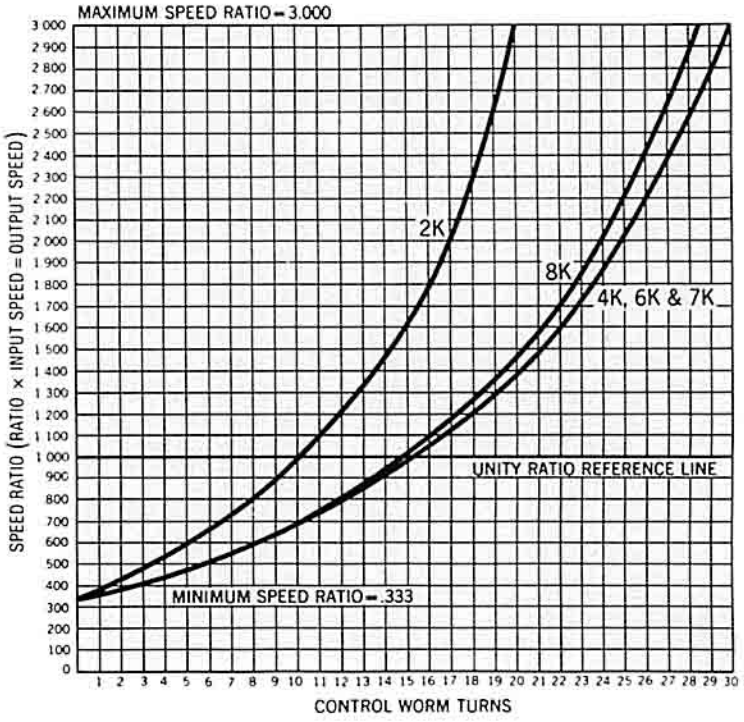
Unit Frame Size	Torque Required at Handwheel in Ounce Inches
2K	100
4K	125
6K	150
7K	180
8K	200

At low input speeds torque required to rotate control worm will increase—consult factory.

ROTATION

TYPE K — GEOMETRIC

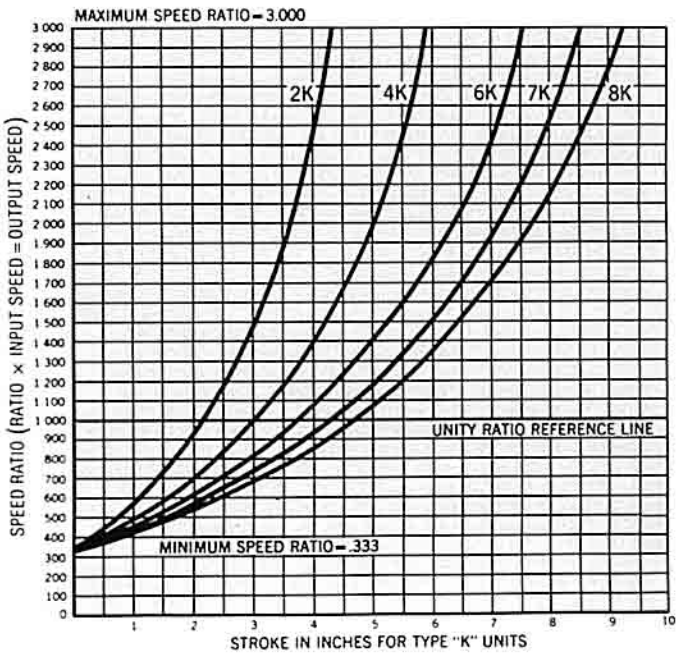
CONTROL CURVES FOR GEOMETRIC IRIS PLATES



LINEAR MOVEMENT

TYPE K — GEOMETRIC

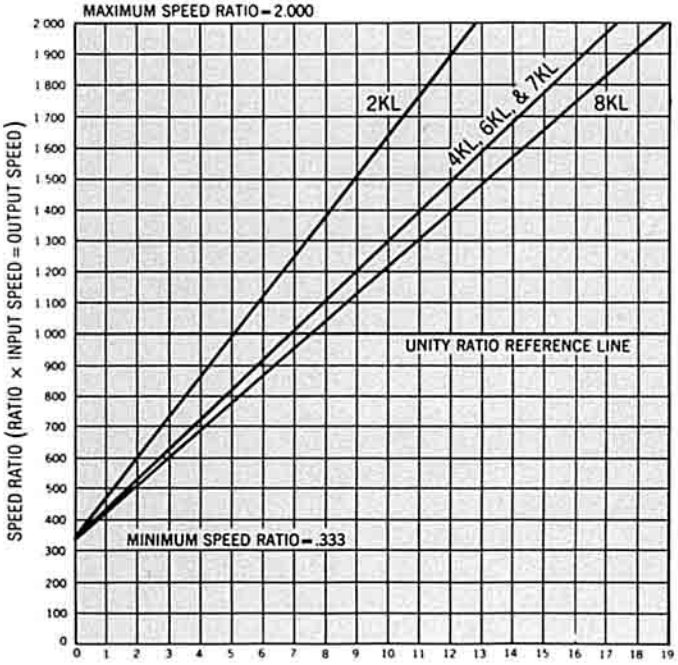
CONTROL CURVES FOR GEOMETRIC IRIS PLATES



vs RATIO

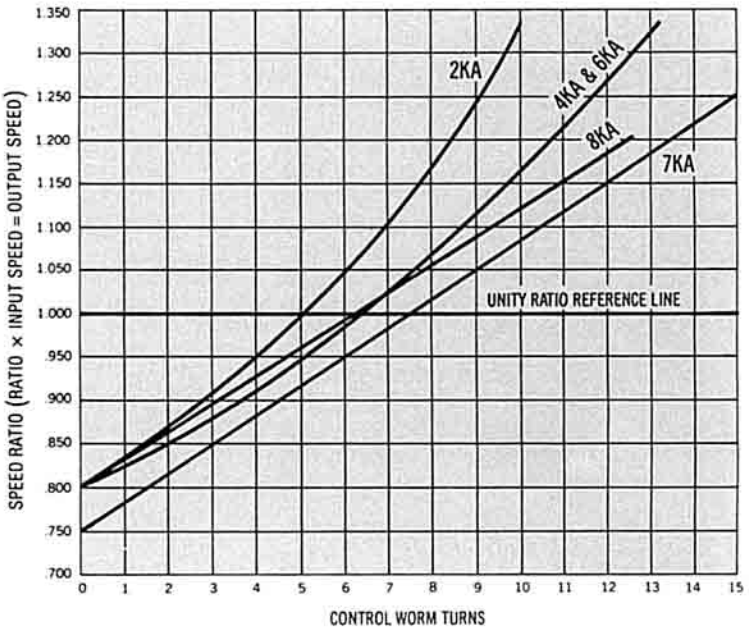
TYPE KL — LINEAR

CONTROL CURVES FOR LINEAR IRIS PLATES



TYPE KA—LIMITED RANGE

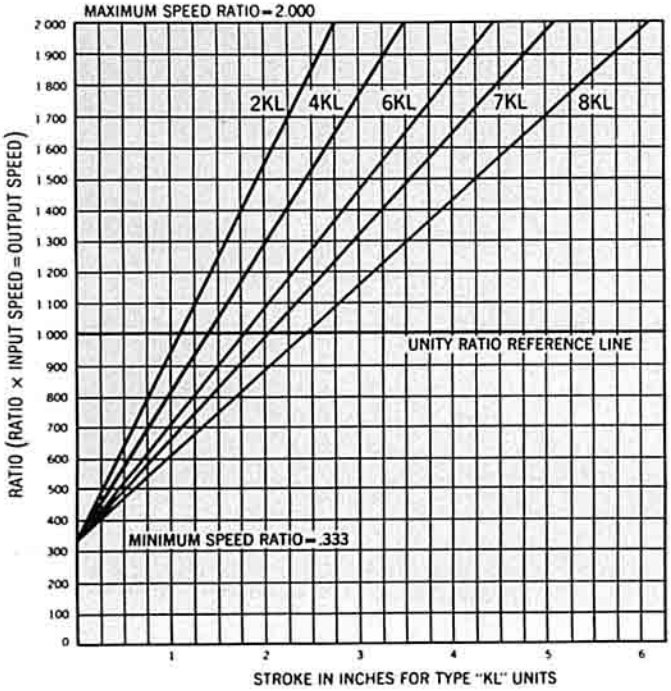
CONTROL CURVES FOR LIMITED RANGE IRIS PLATES



vs RATIO

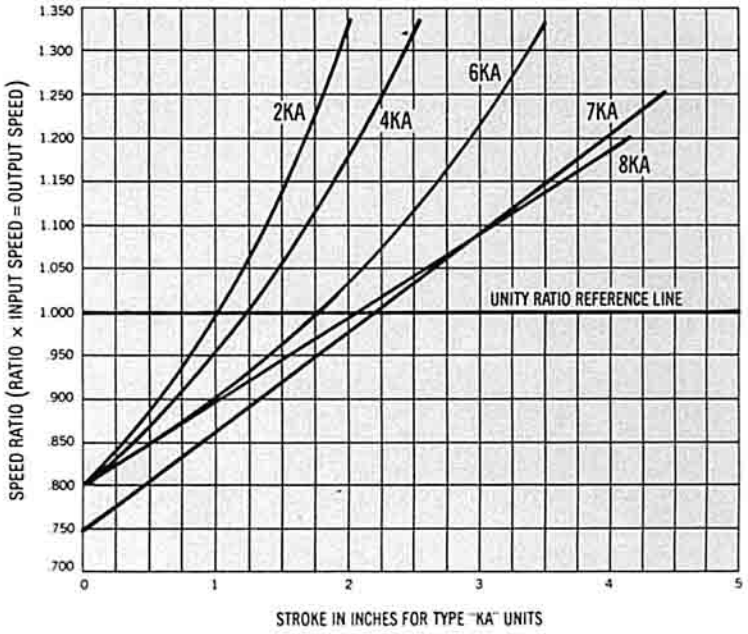
TYPE KL—LINEAR

CONTROL CURVES FOR LINEAR IRIS PLATES



TYPE KA—LIMITED RANGE

CONTROL CURVES FOR LIMITED RANGE IRIS PLATES



SELECTING A CLEVELAND SPEED VARIATOR

Selection of the proper Cleveland Speed Variator for any application depends on several factors which must be considered to assure long service life of the unit.

Rating tables for "CONSTANT HORSEPOWER" applications and for "CONSTANT TORQUE" applications appear on the following pages. Ratings in these tables are suitable for those applications that involve uniform load conditions, 8 to 10 hours daily service and no more than 10 starts per day.

For 10 to 24 hours per day service, a factor of 1.3 should be applied to the calculated load the Variator will drive. Consult factory for appropriate service factor on other operating and loading conditions.

NOTE: Rating tables; within limits as shown; are appropriate for all three variator speed controls; Type K, KL and KA iris plates. Special ratings are available from the factory for operating conditions such as: limited speed range constant horsepower applications, constant torque applications for speed range not shown, or variable input speed operations.

For economical application of the Speed Variator, input speeds should be as close as possible to standard motor speeds (1150 to 1750 RPM).

For those applications involving brakes, clutches, cyclic loading or plug reversals, consult factory for application engineering assistance.

Never select a motor having a larger horsepower rating than the Speed Variator to which it is to be connected.

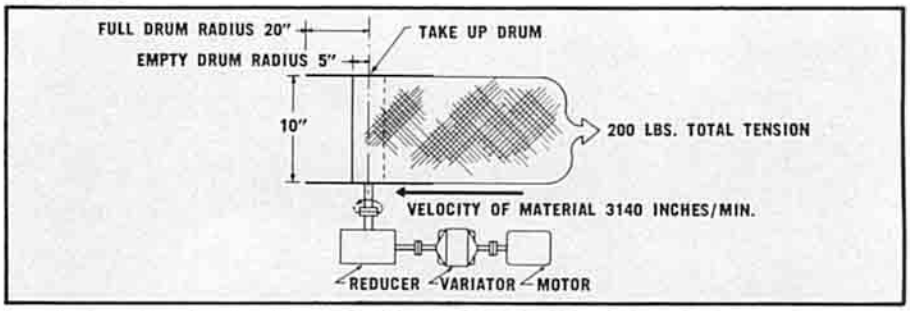
Never operate a variator at input speeds above 2000 RPM without consulting the factory.

For additional information concerning proper operation and use of the Cleveland Speed Variator see page 18.

Free engineering assistance is available to help you select a Cleveland Speed Variator that will exactly meet your variable speed drive requirements. Consult factory or your nearest sales representative.

CONSTANT HORSEPOWER APPLICATION

EXAMPLE:



A typical application involving "CONSTANT HORSEPOWER" would be a take-up reel on a paper machine. Constant paper tension and feed rate must be maintained. As the material builds up on the reel, rotational speed of the reel must decrease as the torque arm increases.

The following calculations explain how horsepower remains constant throughout a 4 to 1 speed range.

Velocity of material—3,140 inches/minute
Total material tension—200 lbs.
Minimum drum radius—5 inches
Maximum drum radius—20 inches

EMPTY DRUM (HIGH SPEED) HORSEPOWER CALCULATIONS

DRUM CIRCUMFERENCE $= 2 \pi R$
$= 2 \times 3.14 \times 5$ INCHES
$= 31.4$ INCHES/REVOLUTION

$$\text{DRUM RPM} = \frac{\text{VELOCITY OF MATERIAL}}{\text{CIRCUMFERENCE}} = \frac{3{,}140 \text{ INCHES/MINUTE}}{31.4 \text{ INCHES/REVOLUTION}} = 100 \text{ RPM}$$

TORQUE = TENSION x MOMENT ARM
$= 200$ LBS. $\times$ 5 INCHES
$= 1{,}000$ INCH LBS.

$$\text{HORSEPOWER} = \frac{\text{TORQUE} \times \text{RPM}}{63{,}000} = \frac{1{,}000 \times 100}{63{,}000} = 1.59 \text{ HP required}$$

FULL DRUM (LOW SPEED) HORSEPOWER CALCULATIONS

DRUM CIRCUMFERENCE $= 2 \pi R$
$= 2 \times 3.14 \times 20$ INCHES
$= 125.6$ INCHES/REVOLUTION

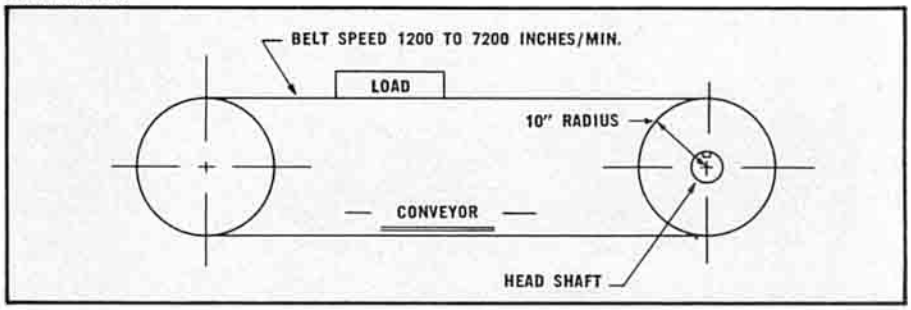
$$\text{DRUM RPM} = \frac{\text{VELOCITY OF MATERIAL}}{\text{CIRCUMFERENCE}} = \frac{3{,}140 \text{ INCHES/MINUTE}}{125.6 \text{ INCHES/REVOLUTION}} = 25 \text{ RPM}$$

TORQUE = TENSION x MOMENT ARM
$= 200$ LBS. $\times$ 20 INCHES
$= 4{,}000$ INCH LBS.

$$\text{HORSEPOWER} = \frac{\text{TORQUE} \times \text{RPM}}{63{,}000} = \frac{4{,}000 \times 25}{63{,}000} = 1.59 \text{ HP required}$$

CONSTANT TORQUE APPLICATION

EXAMPLE:



A typical application involving "CONSTANT TORQUE" would be a transfer conveyor. Constant loading is present but variable speed is required.

The following calculations explain how horsepower varies and torque remains constant through a 6:1 speed range.

LOW SPEED HORSEPOWER CALCULATIONS HEAD SHAFT

DRUM CIRCUMFERENCE $= 2 \pi R$
$= 2 \times 3.14 \times 10$ INCHES
$= 62.8$ INCHES/REVOLUTION

$$\text{HEAD SHAFT RPM} = \frac{\text{BELT SPEED}}{\text{CIRCUMFERENCE OF HEAD SHAFT DRUM}} = \frac{1200 \text{ INCHES/MINUTE}}{62.8 \text{ INCHES/REVOLUTION}} = 19.1 \text{ RPM}$$

ASSUME 100 LBS. FORCE REQUIRED TO MOVE CONVEYOR
TORQUE = FORCE x LEVER ARM
$= 100$ LBS. $\times$ 10 INCHES
$= 1{,}000$ INCH LBS.

$$\text{HORSEPOWER} = \frac{\text{TORQUE} \times \text{RPM}}{63{,}000} = \frac{1{,}000 \times 19.1}{63{,}000} = .30 \text{ HP required}$$

HIGH SPEED HORSEPOWER CALCULATIONS HEAD SHAFT

DRUM CIRCUMFERENCE = SAME AS FOR LOW SPEED

$$\text{HEAD SHAFT RPM} = \frac{\text{BELT SPEED}}{\text{CIRCUMFERENCE OF HEAD SHAFT DRUM}} = \frac{7200}{62.8} = 114.6 \text{ RPM}$$

TORQUE = SAME AS FOR LOW SPEED

$$\text{HORSEPOWER} = \frac{\text{TORQUE} \times \text{RPM}}{63{,}000} = \frac{1{,}000 \times 114.6}{63{,}000} = 1.8 \text{ HP required}$$

RATING TABLES

CONSTANT HORSEPOWER APPLICATIONS (9:1 MAX. SPEED RANGE)

UNIT SIZE*	INPUT R.P.M.					
	1800	1500	1200	1000	900	750
2K3	.60	.55	.45	.40	.35	.30
2K4	.75	.65	.55	.50	.45	.40
2K6	1.0	.9	.75	.65	.60	.55
4K4	1.7	1.5	1.25	1.1	1.0	.9
4K6	2.3	2.0	1.7	1.5	1.3	1.2
6K4	3.4	3.0	2.5	2.2	2.0	1.75
7K4	5.5	4.5	4.0	3.5	3.0	2.75
7K6F**	7.5	6.5	5.5	4.7	4.3	3.9
8K6F**	12	10	8.5	7.5	7.0	6.0

*Unit Size: The first number indicates "frame size", the letter following identifies the type of iris plate (K, KL or KA) and the last number indicates the number of drive balls.

**These sizes are fan cooled as indicated by the letter "F". For input speeds of 600 RPM and lower the fan is omitted and high oil level provided.

For input speeds below 750 RPM the HP rating is proportional to the input speed.

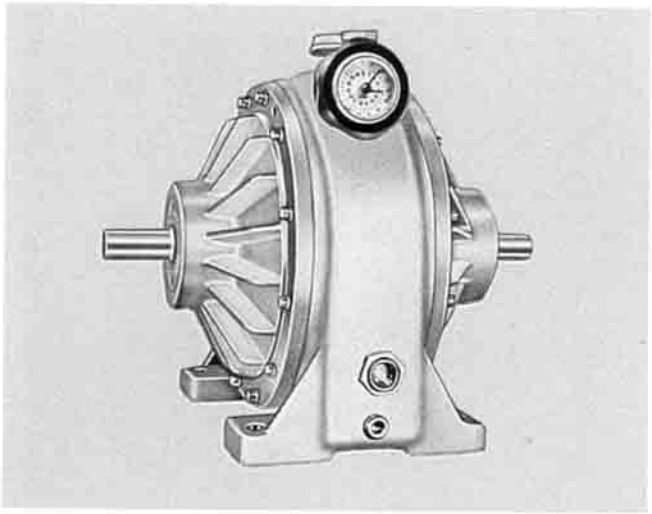
CONSTANT TORQUE APPLICATIONS

UNIT SIZE		SPEED RANGE	1800 RPM INPUT			1500 RPM INPUT			1200 RPM INPUT			1000 RPM INPUT		
			MAX. OUTPUT R.P.M.	OUTPUT TORQUE IN. LBS.	EQUIV. INPUT* H.P.	MAX. OUTPUT R.P.M.	OUTPUT TORQUE IN. LBS.	EQUIV. INPUT* H.P.	MAX. OUTPUT R.P.M.	OUTPUT TORQUE IN. LBS.	EQUIV. INPUT* H.P.	MAX. OUTPUT R.P.M.	OUTPUT TORQUE IN. LBS.	EQUIV. INPUT* H.P.
2K3		9 X 1	5400	6	.70	4500	6.4	.61	3600	6.8	.52	3000	7	.45
		6 X 1	3600	12	.82	3000	13	.72	2400	13	.61	2000	14	.53
		4 X 1	2400	17	.72	2000	18	.63	1600	19	.53	1333	20	.46
		3 X 1	1800	23	.72	1500	24	.63	1200	25	.53	1000	27	.46
2K4		9 X 1	5400	7.5	.86	4500	7.5	.74	3600	8	.63	3000	8.5	.55
		6 X 1	3600	15	1.05	3000	16	.92	2400	17	.77	2000	17.5	.67
		4 X 1	2400	25	1.1	2000	27	.95	1600	28	.80	1333	30	.70
		3 X 1	1800	34	1.1	1500	36	.95	1200	38	.80	1000	40	.70
2K6		9 X 1	5400	10	1.1	4500	11	1.0	3600	12	.91	3000	12	.79
		6 X 1	3600	20	1.3	3000	21	1.2	2400	22	1.0	2000	23	.87
		4 X 1	2400	34	1.4	2000	35	1.2	1600	38	1.0	1333	39	.91
		3 X 1	1800	45	1.4	1500	47	1.2	1200	50	1.0	1000	52	.91
4K4		9 X 1	5400	16	1.9	4500	17	1.6	3600	18	1.4	3000	19	1.2
		6 X 1	3600	32	2.2	3000	34	1.9	2400	36	1.6	2000	38	1.4
		4 X 1	2400	55	2.3	2000	57	2.0	1600	61	1.7	1333	63	1.5
		3 X 1	1800	73	2.3	1500	77	2.0	1200	81	1.7	1000	85	1.5
4K6		9 X 1	5400	22	2.5	4500	23	2.2	3600	24	1.8	3000	25	1.6
		6 X 1	3600	45	3.1	3000	47	2.7	2400	50	2.3	2000	52	1.9
		4 X 1	2400	75	3.2	2000	79	2.8	1600	84	2.3	1333	87	2.0
		3 X 1	1800	100	3.2	1500	105	2.8	1200	111	2.3	1000	116	2.0
6K4		9 X 1	5400	33	3.8	4500	34	3.3	3600	36	2.8	3000	38	2.4
		6 X 1	3600	65	4.5	3000	68	3.9	2400	72	3.3	2000	75	2.8
		4 X 1	2400	110	4.6	2000	115	4.0	1600	122	3.4	1333	127	2.9
		3 X 1	1800	146	4.6	1500	153	4.0	1200	162	3.4	1000	169	2.9
7K4		9 X 1	5400	53	6.1	4500	55	5.3	3600	58	4.4	3000	61	3.8
		6 X 1	3600	105	7.2	3000	110	6.3	2400	116	5.3	2000	121	4.6
		4 X 1	2400	177	7.5	2000	185	6.5	1600	196	5.5	1333	205	4.8
		3 X 1	1800	235	7.5	1500	246	6.5	1200	260	5.5	1000	272	4.8
7K6	FAN COOLED	9 X 1	5400	72	8.2	4500	76	7.2	3600	80	6.0	3000	84	5.3
		6 X 1	3600	142	9.8	3000	149	8.5	2400	157	7.2	2000	164	6.2
		4 X 1	2400	236	10	2000	247	8.7	1600	261	7.3	1333	273	6.4
		3 X 1	1800	315	10	1500	330	8.7	1200	349	7.3	1000	365	6.4
8K6		9 X 1	5400	116	13	4500	121	11.5	3600	128	9.7	3000	134	8.5
		6 X 1	3600	228	15	3000	239	13.7	2400	253	11.5	2000	264	10
		4 X 1	2400	328	16	2000	403	14.2	1600	426	12	1333	445	10.4
		3 X 1	1800	512	16	1500	537	14.2	1200	568	12	1000	593	10.4

*Maximum input power required to produce the constant torque rating when the variator is operated at maximum output R.P.M.

NOTE: For input speeds below 1000 R.P.M., use the torque ratings shown for 1000 R.P.M.

STANDARD SPEED VARIATOR DIMENSIONS

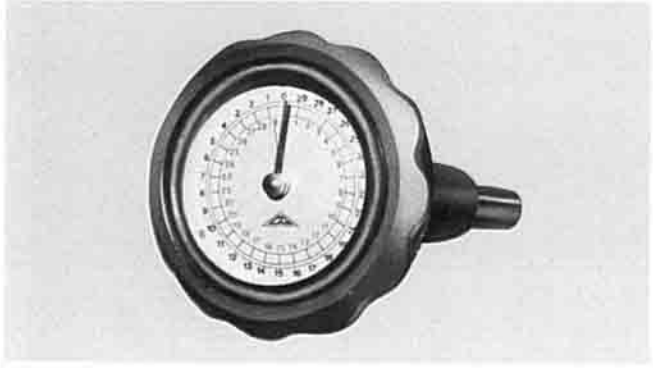


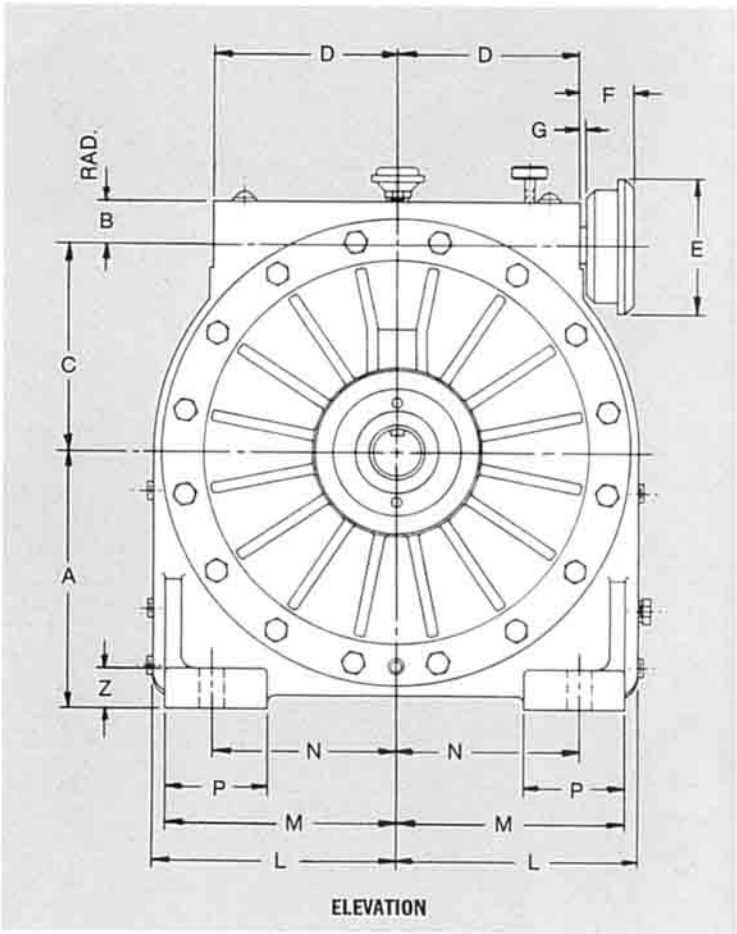
The Cleveland Speed Variator is available in nine standard sizes, the dimensions of which are given on these pages. Note that the two largest sizes are available as fan cooled models for use when high loading may elevate operating temperatures.

A standard Speed Variator is equipped with a direct-acting manual control handwheel. This has a clear impact resistant lens that is water tight for adverse environments. (See photo below). The handwheel has an easy to read scale and has a dual scale to allow it to be mounted on either side of the unit. (See Arrangements #1 and #2, opposite page). A locking thumbscrew is supplied to maintain speed setting.

The manual handwheel is equipped with two hands on the dial. The larger black hand indicates direct movement of the control worm. The smaller red hand indicates the number of turns the control worm has advanced from the extreme low output speed setting. Also, a direction label on the variator housing indicates what direction the handwheel must be turned to increase or decrease the output speed. Speed is increased by turning the handwheel clockwise for Arrangement #1 and counter-clockwise for Arrangement #2.

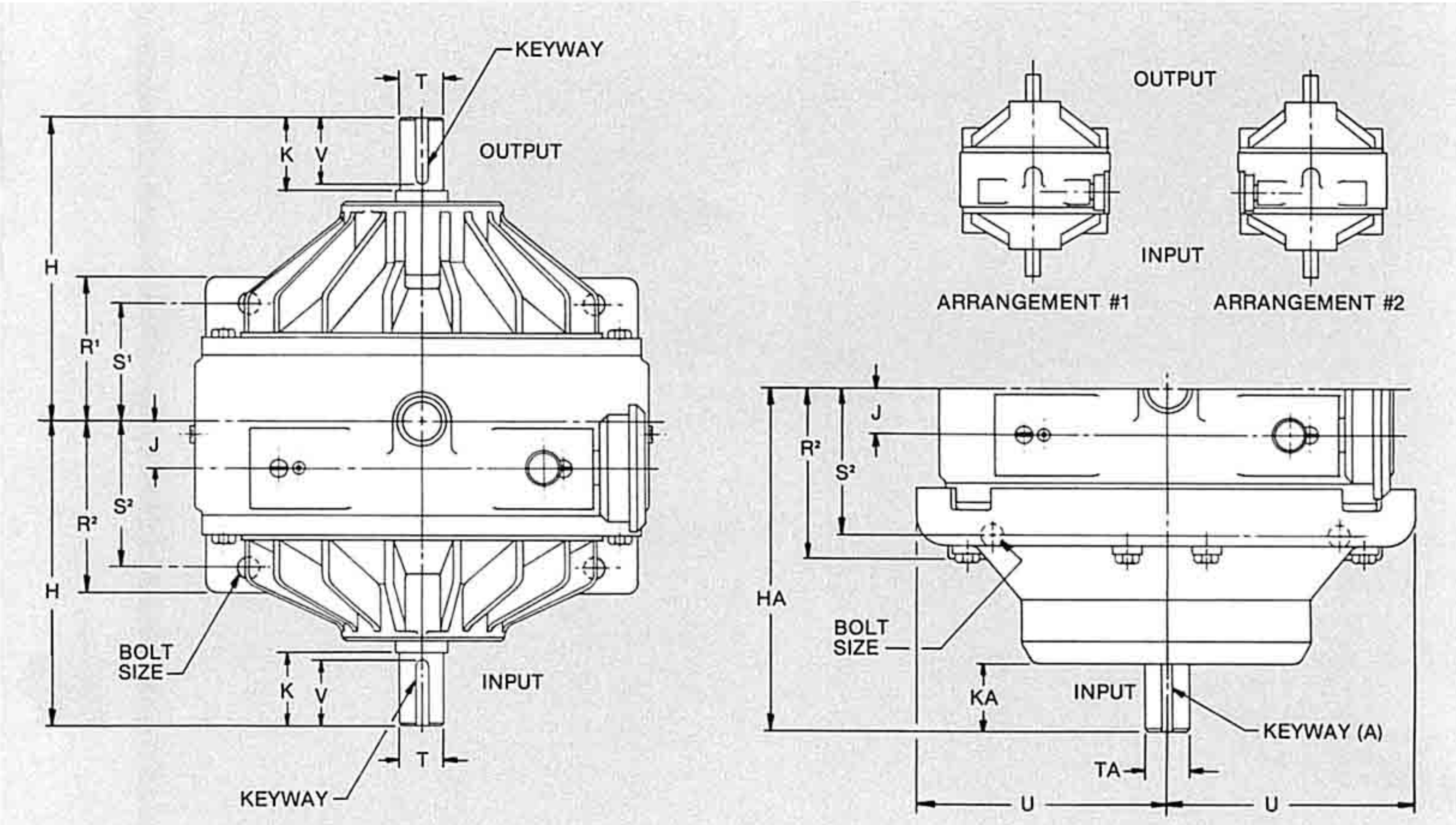
For remote manual control of the Variator, see page 14.





ELEVATION

UNIT FRAME SIZE		APPROX. SHIP. WT. LBS.	A +.000 −.005	B	C	D	E	F	G
2K3	NO FAN	75	5.000	.94	3.653	3.62	2.95	1.43	.14
2K4		80	5.000	.94	3.653	3.62	2.95	1.43	.14
2K6		85	5.000	.94	3.653	3.62	2.95	1.43	.14
4K4		130	5.500	.88	4.575	3.75	2.95	1.43	.14
4K6		135	5.500	.88	4.575	3.75	2.95	1.43	.14
6K4		240	7.000	1.19	5.860	5.88	4.33	1.79	.26
7K4		360	8.250	1.38	6.690	5.88	4.33	1.79	.26
7K6		365	8.250	1.38	6.690	5.88	4.33	1.79	.26
8K6		590	9.750	1.44	7.996	7.25	4.33	1.79	.26
7K6F	FAN COOLED	370	8.250	1.38	6.690	5.88	4.33	1.79	.26
8K6F		595	9.750	1.44	7.996	7.25	4.33	1.79	.26



PLAN VIEW — NO FAN **PLAN VIEW — FAN COOLED**

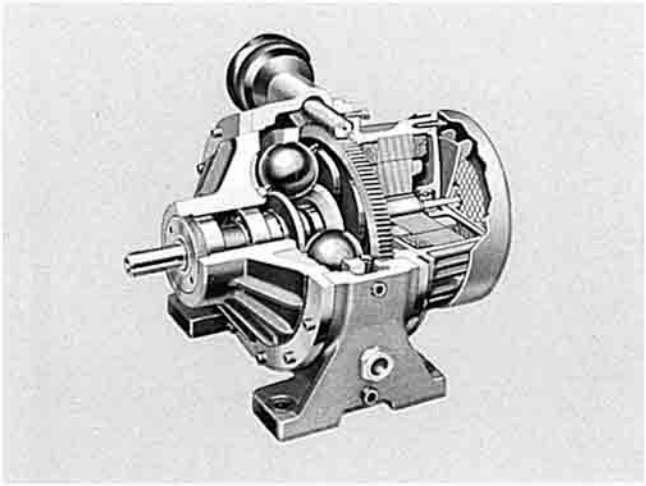
STANDARD DIMENSIONS IN INCHES																				
H	HA	J	K	KA	L	M	N	P	R_1	R_2	S_1	S_2	T +.0000 −.0005	TA +.0000 −.0005	U	V	Z	BOLT SIZE	KEYWAY	KEYWAY (A)
6.00	—	.88	1.62	—	4.38	4.12	3.12	2.00	2.88	3.38	2.38	2.88	.7500	—	—	1.31	.62	3/8	3/16 x 3/32	—
6.00	—	.88	1.62	—	4.38	4.12	3.12	2.00	2.88	3.38	2.38	2.88	.7500	—	—	1.31	.62	3/8	3/16 x 3/32	—
6.00	—	.88	1.62	—	4.38	4.12	3.12	2.00	2.88	3.38	2.38	2.88	.7500	—	—	1.31	.62	3/8	3/16 x 3/32	—
7.06	—	1.12	2.00	—	5.25	5.00	4.00	2.38	3.38	3.88	2.75	3.25	.8750	—	—	1.75	.75	1/2	3/16 x 3/32	—
7.06	—	1.12	2.00	—	5.25	5.00	4.00	2.38	3.38	3.88	2.75	3.25	.8750	—	—	1.75	.75	1/2	3/16 x 3/32	—
9.00	—	1.44	2.62	—	6.94	6.38	4.88	3.00	4.56	5.44	3.81	4.69	1.2500	—	—	2.25	1.00	5/8	1/4 x 1/8	—
10.38	—	1.62	2.50	—	7.75	7.38	5.88	3.25	4.88	5.88	4.00	5.00	1.5000	—	—	2.50	1.25	3/4	3/8 x 3/16	—
10.38	—	1.62	2.50	—	7.75	7.38	5.88	3.25	4.88	5.88	4.00	5.00	1.5000	—	—	2.50	1.25	3/4	3/8 x 3/16	—
12.88	—	1.94	3.75	—	9.31	8.75	6.75	4.00	5.88	6.62	4.88	5.62	1.8750	—	—	3.25	1.50	7/8	1/2 x 1/4	—
10.38	11.75	1.62	2.50	2.38	7.75	7.38	5.88	3.25	4.88	5.88	4.00	5.00	1.5000	1.5000	8.50	2.50	1.25	3/4	3/8 x 3/16	3/8 x 3/16
12.88	14.38	1.94	3.75	3.75	9.31	8.75	6.75	4.00	5.88	6.62	4.88	5.62	1.8750	1.5000	9.75	3.25	1.50	7/8	1/2 x 1/4	3/8 x 3/16

*NOTE:

1) Input & output shafts have tapped hole for assembling couplings, pulleys, or sprockets.
   Tapped hole sizes: 2K = 5/16-18 Thd.; 4K = 3/8-16 Thd.
   6K & 7K = 1/2-13 Thd.; 8K = 5/8-11 Thd.
2) Input & output shaft keys are furnished with unit.
3) Shafts may be rotated in either direction.

DIMENSIONS SUBJECT TO CHANGE. DO NOT USE FOR CONSTRUCTION UNLESS CERTIFIED.

MOTORIZED SPEED VARIATORS

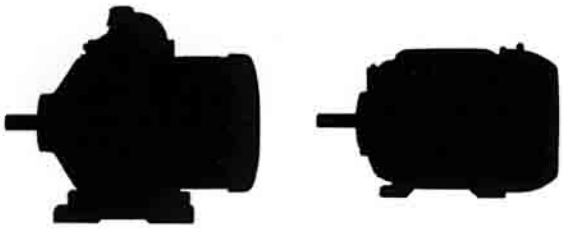


SELECTION

When selecting a motorized Speed Variator, first determine and select the proper size standard unit from the rating tables on page 9. Then, select a motor from tables at the right that will meet the desired horsepower and input speed requirements. Never select a motor that has a larger rating than the variator rating obtained from page 9.

COMPACTNESS

Cleveland Speed Variator, with its in-line shafts, affords a drive that is much more compact than most variable speed drives. Utilizing an integral "Pancake" style motor, the motorized Variator provides a variable speed packaged drive that requires only slightly more space than an equally rated conventional motor.



SIMPLICITY

Variator parts are simple geometric forms that permit manufacture and assembly to a high degree of accuracy. This results in a smooth running, quiet drive that will render maximum trouble-free service.

SPEED

Cleveland Speed Variator's unique design insures precise speed setting and repeatability. It provides variable output speeds with 9:1 and 6:1 ranges. Since it employs the rolling action of a series of balls, it permits smooth adjustment of the output speed while operating under load.

PERFORMANCE

The Variator is a true torque converter, and thus provides the high torque at low speeds required for constant horsepower applications. Its torque responsive mechanisms assure traction even during periods of extreme overloading.

SPEED VARIATOR MOTOR COMBINATIONS

When using the following tables, first select the proper variator unit size from the rating tables on page 9. *THE FIRST NUMBER AND FIRST LETTER OF THE UNIT DESIGNATION, SUCH AS 2K, 6K, ETC., INDICATE THE FRAME SIZE OF THE VARIATOR.* Next, select the appropriate motor from the tables below. *WHEN DESCRIBING A MOTORIZED UNIT, THE MOTOR FRAME SIZE IS ADDED TO THE UNIT DESIGNATION FOR EXAMPLE: A 2KL4 VARIATOR EQUIPPED WITH A ½ HP-1750 RPM DRIVE MOTOR IS DESIGNATED A 2KL43M.*

SPEED VARIATOR INDUCTION MOTOR COMBINATIONS

Variator Frame Size	Motor Frame Size	Motor Speed (RPM)	Motor Horsepower	Approx. Ship Wt. (Lbs.)
2K	3M 3M 3M 3M 4M	1750	⅓ ½ ¾ 1 1½	110
2K	3M 3M 3M 4M	1150	⅓ ½ ¾ 1	
6K	3M 3M 3M 3M	1750	2 3 4 5	350
6K	3M 3M 3M	1150	2 2½ 3	
7K	4M 4M 4M 4M	1750	5 6¼ 7½ 10	490
7K	4M 4M 4M 4M	1150	3 4 5 7½	
8K	3M 3M 3M 3M 3M	1750	7½ 10 12½ 15 17½	760
8K	3M 3M 3M 3M	1150	6¼ 7½ 10 12½	

SPECIAL MOTORS

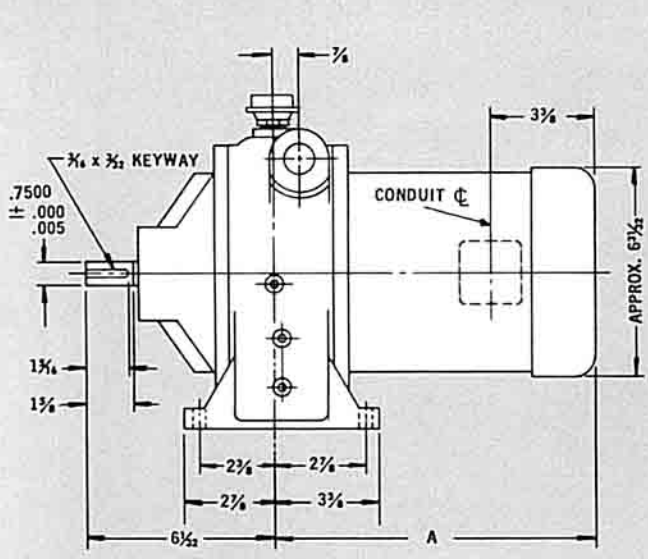
Motors are stocked with 230/460 volt, 3 phase 60 cycle voltage characteristics.

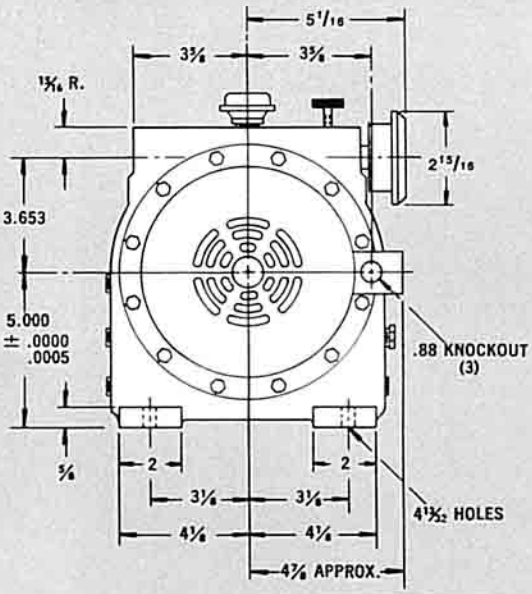
Other voltages are available on special order.

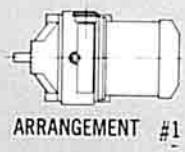
Synchronous induction motors also available on special order.

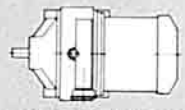
UNIT FRAME SIZE	MOTOR FRAME									
	SIZE	TYPE	A +.000 −.005	B	C	D	E	G	H	
6K	3M	TEFC	7.000	1.19	5.860	5.88	4.33	7.67	9.00	
7K	4M	TEFC	8.250	1.38	6.690	5.88	4.33	7.67	10.38	
8K	3M	TEFC	9.750	1.44	7.996	7.25	4.33	9.04	12.88	

2K





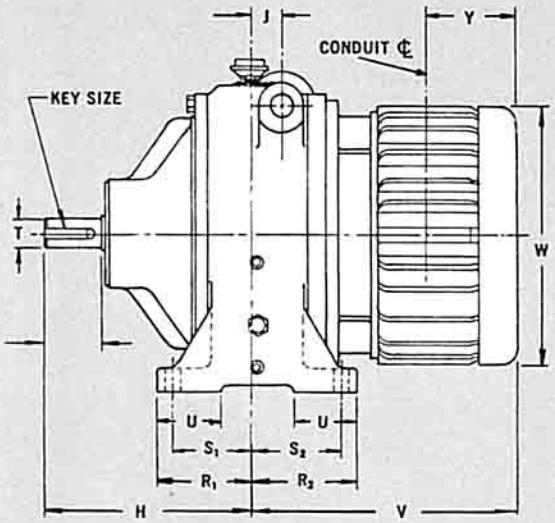

ARRANGEMENT #1

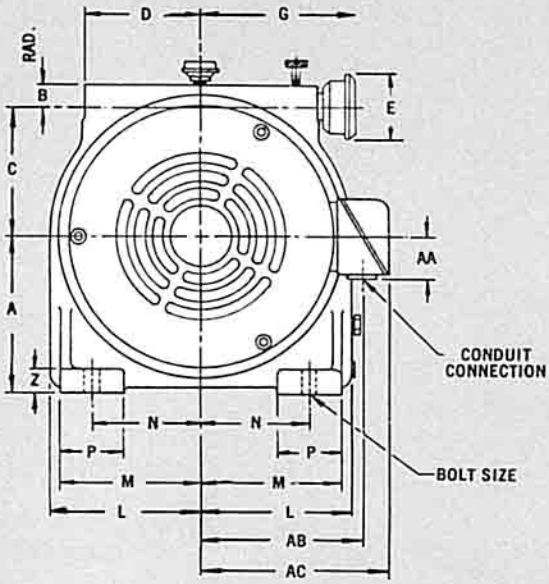

ARRANGEMENT #2

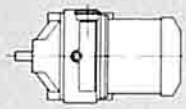
FOR 4-K MOTORIZED UNITS — CONSULT FACTORY

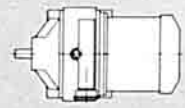
Unit Frame Size	Motor Frame		A
	Size	Type	
2K	3M	TEFC	10 5/16
	4M	TEFC	11 5/16

6K,7K,8K






ARRANGEMENT #1


ARRANGEMENT #2

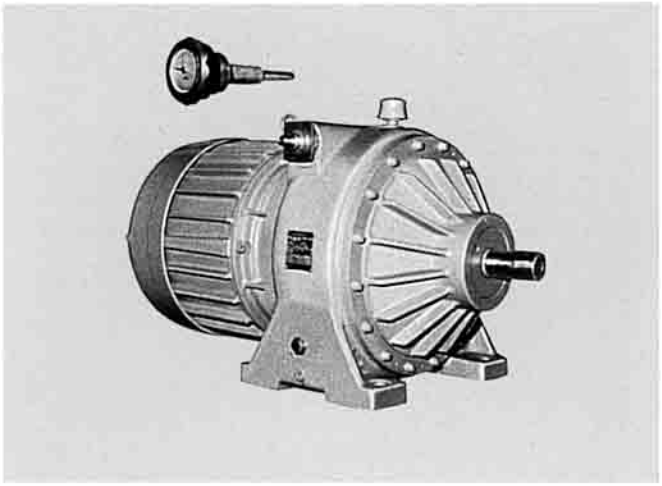
STANDARD DIMENSIONS IN INCHES

	J	K	L	M	N	P	R_1	R_2	S_1	S_2	T +.0000 −.0005	U	V	W	Y	Z	AA	AB	AC	BOLT SIZE	CONDUIT CONN.	KEY SIZE
	1.44	2.62	6.94	6.38	4.88	3.00	4.56	5.44	3.81	4.69	1.2500	3.25	13.31	11.38	6.81	1.00	1.94	6.81	8.12	5/8	3/4	1/4 sq.x2 1/8
	1.62	2.50	7.75	7.38	5.88	3.25	4.88	5.88	4.00	5.00	1.5000	3.38	17.56	14.50	6.12	1.25	2.75	8.94	10.75	3/4	1	3/8 sq.x2 1/4
	1.94	3.75	9.31	8.75	6.75	4.00	5.88	6.62	4.88	5.62	1.8750	4.00	20.50	16.50	9.12	1.50	2.75	10.50	12.31	7/8	1 1/4	1/2 sq.x3

*Dimensions subject to change. Use certified print only for construction.

SPEED VARIATOR CONTROLS

REMOTE MANUAL CONTROL

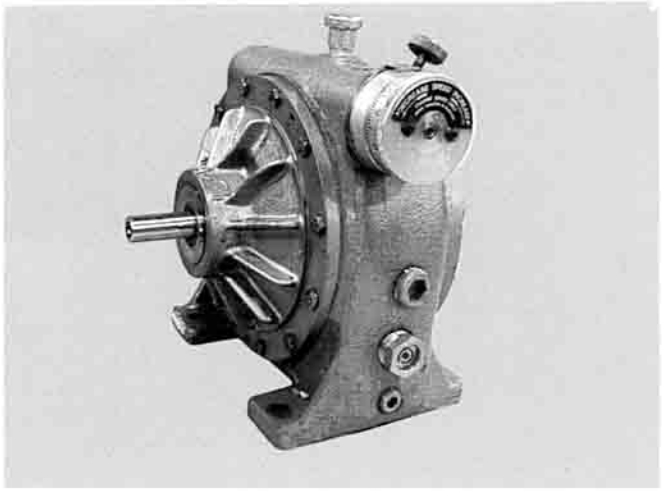


For remote manual operation, handwheel components are removed from the control worm and assembled on a stub shaft for mounting as a unit at a remote point. Chains, sprockets, gears, or shafting can be used to connect the stub shaft to the remotely mounted handwheel.

A 1:1 ratio should be maintained between the remote handwheel and the control worm to insure that the handwheel's indicator dial reads correctly. The remote handwheel is furnished with a speed control lockscrew.

Dimensions for the Remote Manual control will be found below.

VERNIER CONTROL



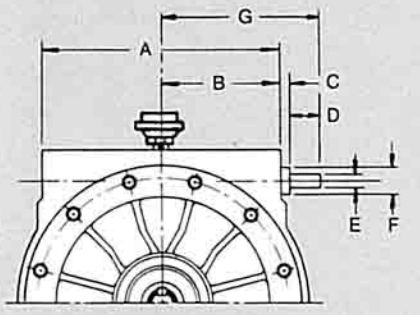
The vernier handwheel speed control is available for all the various sizes of the Cleveland Speed Variators and can be mounted on either side of the unit.

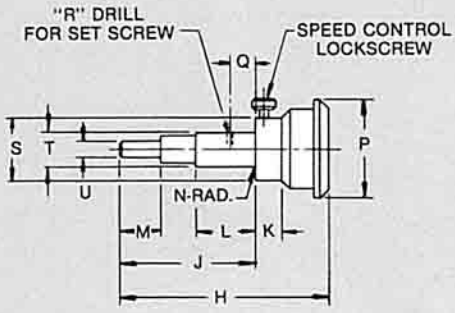
This handwheel is furnished with a vernier indicator dial for those applications that require speed accuracies to 0.1% repeatability.

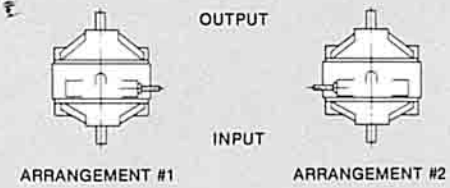
The vernier scale on this handwheel is calibrated into 100 divisions.

A thumbscrew lock to secure the control worm is also furnished with the Vernier handwheel.

REMOTE MANUAL CONTROL DIMENSIONS*







For Standard Unit Dimensions, see pages 10 & 11.
For Motorized Unit Dimensions, see page 13.

DIMENSION IN INCHES*

UNIT FRAME SIZE	A	B	C	D	E [1]	F	G	H	J	K	L	M	RAD. N	P	Q	R	S	T [2]	U [3]
2K	7.25	3.62	.25	.88	.3747	.88	4.75	6.22	4.06	.81	1.75	1.25	.03	2.95	.75	.16	1.88	1.000	.500
4K	7.50	3.75	.25	1.62	.4997	.88	5.62	6.22	4.06	.81	1.75	1.25	.03	2.95	.75	.16	1.88	1.000	.500
6K	11.75	5.88	.16	1.47	.7495	1.25	7.50	9.46	6.75	1.12	3.00	2.44	.03	4.33	1.00	.25	2.75	1.375	.750
7K	11.75	5.88	.16	2.22	.7495	1.25	8.25	9.46	6.75	1.12	3.00	2.44	.03	4.33	1.00	.25	2.75	1.375	.750
8K	14.50	7.25	.16	2.34	.7495	1.25	9.75	9.46	6.75	1.12	3.00	2.44	.03	4.33	1.00	.25	2.75	1.375	.750

* Dimensions subject to change. Use certified print only for construction.
[1] This dimension will be held to limits of +.0000" – .0005".
[2] This dimension will be held to limits of +.000" – .002".
[3] This dimension will be held to limits of +.000" – .001".

OPERATIONAL NOTES

OVERHUNG LOADS

Overhung loads are radial loads imposed on the output shaft by power transmission devices such as sprockets, sheaves and gears. Overhung loads do not greatly affect the Speed Variator's life, assuming that the sprocket, sheave or gear's pitch diameter is not less than good practice dictates and that the applied load's center is no farther out than the mid-point of the shaft keyway. Special bearing mounting designs are available for abnormal overhung loads.

SHOCK LOADS

The Speed Variator is intended for applications involving smooth loading. It is not directly applicable for shock loads as encountered in crushers or in equipment with jaw or dog clutches. Applications that involve shock or cyclic loading, plug reversals, or rapid starts and stops should be referred to the factory for engineering assistance.

INERTIA LOADS

The "moment of inertia" or "WR^2" of the load applied to the Speed Variator may warrant consideration when determining unit size for the application. If a very large mass or one having a large radius of gyration has to be accelerated within a certain time limit, factors are present which could cause severe overloading of the Variator. Consult Factory for these applications.

SPEED VARIATOR INERTIA

The input shaft inertia present in the Speed Variator is tabulated below for various ratio settings. Output shaft inertia can be obtained by using the reciprocal of the ratio. Example: The input shaft WR^2 of the 2K4 unit at the 3.0 ratio setting would be .465 lbs. ft^2. The output shaft WR^2 would be .052 lbs. ft^2. Because of the symmetry of the Speed Variator, inertia at the 1.0 ratio setting is identical for both input and output shafts.

SPEED VARIATOR INERTIA VALUES IN LB. FT^2

RATIO (RATIO x INPUT SPEED = OUTPUT SPEED)				
Unit Size	**.333**	**1.0**	**2.0**	**3.0**
2K3	.050	.101	.251	.442
2K4	.052	.106	.263	.465
2K6	.059	.109	.297	.534
4K4	.130	.257	.652	1.188
4K6	.159	.311	.784	1.454
6K4	.424	.833	2.003	3.801
7K4	.993	1.927	4.563	8.870
7K6	1.168	2.267	5.368	10.435
8K6	3.095	6.132	14.647	27.973

COUPLINGS

Flexible couplings should be used when the Speed Variator is directly connected to a motor or shaft — rigid couplings should not be used. Proper coupling alignment is necessary to assure long service life of shaft bearings and other internal Speed Variator components. Do not drive or pound couplings, sheaves, etc. onto Variator drive shafts, as damage to internal Variator parts may result. The end of each shaft is drilled and tapped and a bolt and washer should be used to pull the component onto the shaft.

OPERATING TEMPERATURES

Speed Variators are designed to operate in ambient air temperatures of 90°F. It is not uncommon for a fully loaded Variator housing to reach temperatures uncomfortable to the touch. Housing temperatures will normally vary between 120°F. to 180°F. depending upon load, speed setting and unit size. 7K and 8K units operated at input speeds of 750 RPM or higher have integral fan cooling. See Dimensions, page 11.

LUBRICATION

A NAPTHENIC BASE OIL HAVING A VISCOSITY OF 55 TO 65 S.S.U. AT 100°F. SUCH AS "CLEVELAND SPEED VARIATOR TRACTION FLUID TYPE I", MUST BE USED IN THE SPEED VARIATOR IF OPERATING EFFICIENCY AND LONG SERVICE LIFE ARE TO BE REALIZED. Use of an improper lubricant may cause serious damage to the drive.

A supply of traction fluid, adequate for the initial filling of the Speed Variator, is shipped with each unit.

Under normal operating conditions oil should be changed after every 1000 hours of operation. Unusual operating conditions may dictate that a more frequent or less frequent oil change schedule be followed — if so, consult factory.

OIL LEVEL AND CAPACITY

In operation all internal parts of the Speed Variator are splash lubricated.

At input speeds below 600 RPM, a higher than standard oil level is required to insure adequate shaft bearing lubrication. For these applications, the factory should be notified at time of order, so that the sight glass, installed in the Speed Variator housing, can be properly located.

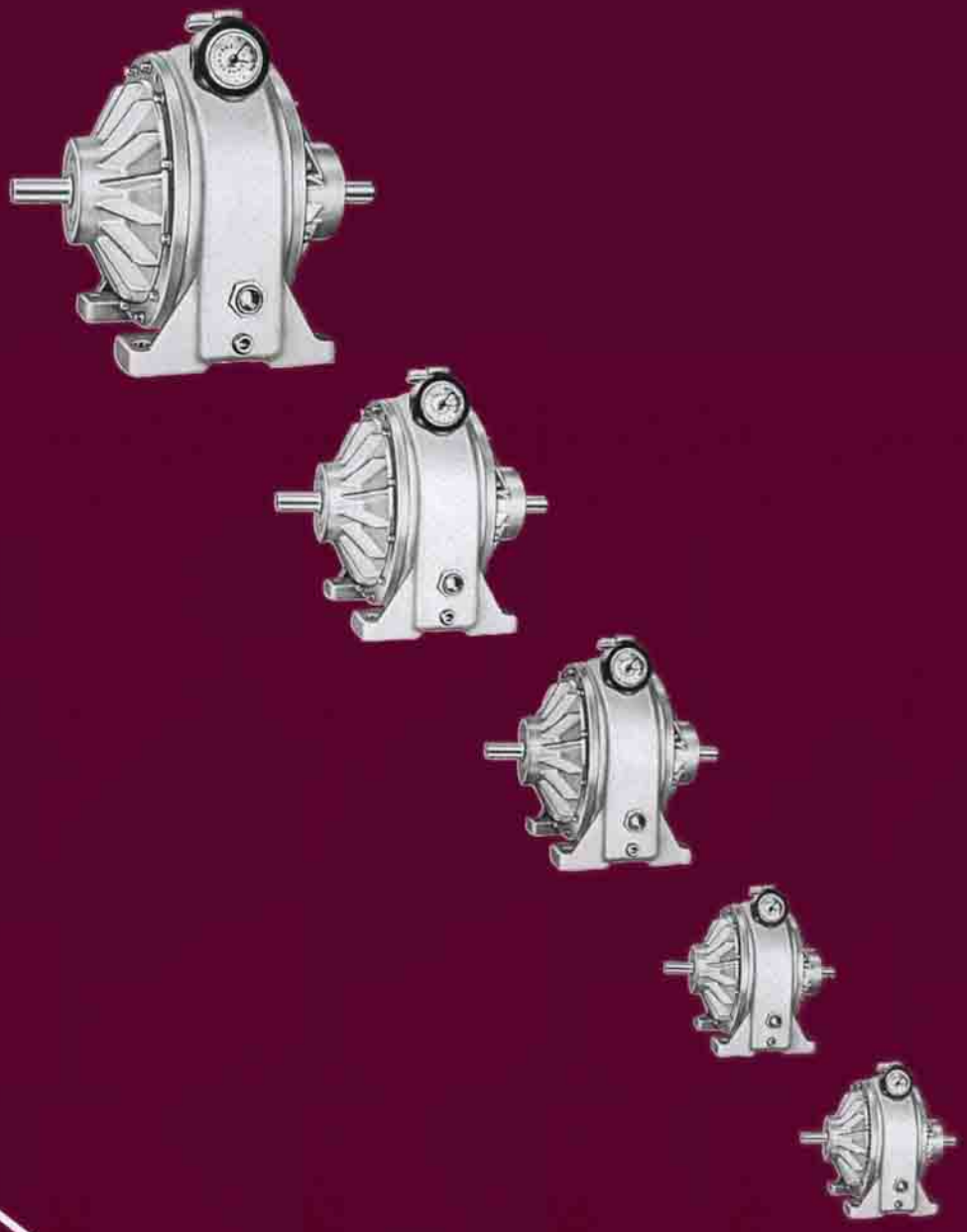
Units should be filled, with the specified traction fluid, to the centerline of the sight glass. Oil level must be read while unit is standing still. DO NOT OVERFILL.

OIL CAPACITY

Unit Size		**2K**	**4K**	**6K**	**7K**	**8K**
Approximate Oil Capacity (Pints)	**Std. Level**	1¼	1½	3¼	4¼	7
	High Level	2¼	3	7	12	17

Cleveland Gear

SPEED VARIATORS



CLEVELAND GEAR

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