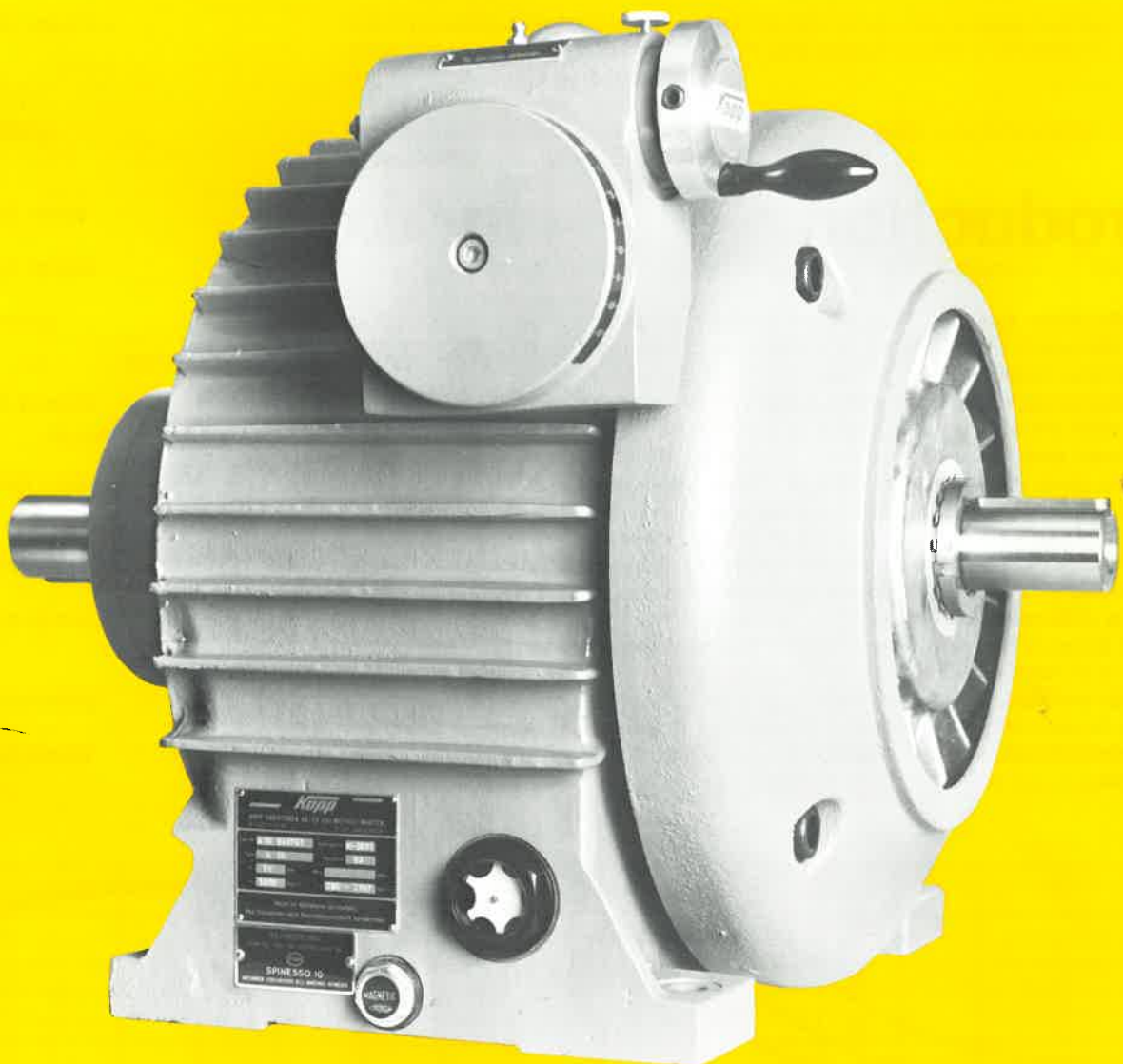


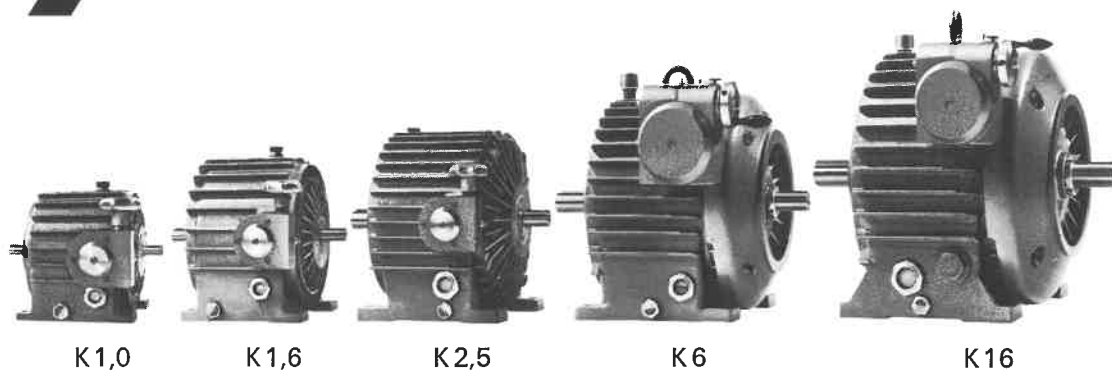
Kopp

K Type Variators





Variators World Wide



Introduction

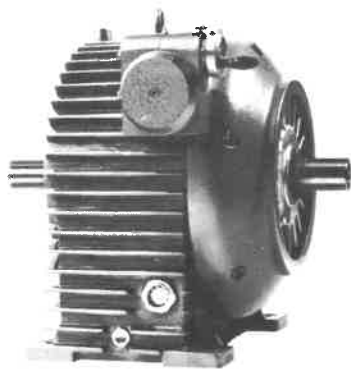
In 1946 Mr. Jean Kopp of Meyriez, Switzerland became aware of the positive advantages to be obtained from controlled variable speed drives. At this time he designed his well known ball variator. Through the extensive experience obtained with the ball variator, the requirements for lower output speed and higher horsepower capacities became evident. To meet these requirements, Mr. Kopp designed his new K series variator. The power capacity range of the new type K roller variator has been expanded and now includes 8 sizes ranging from 1 to 100 hp. With an input speed of 1800 rpm, these units have output capabilities of 250 rpm to 3000 rpm maximum.

The Kopp series K variator is ideally suited to meet the requirements of modern technology for a quick and extremely accurate variable speed drive unit.

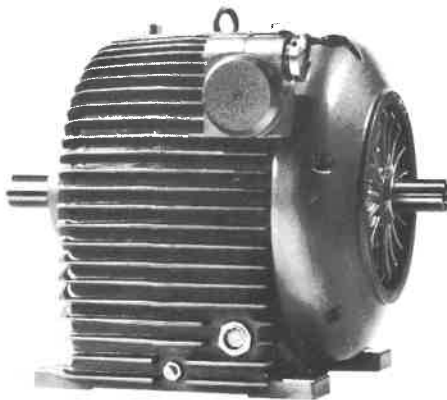
The Kopp Organization consists of a network of licensees and agents located all over the world to meet your requirements.

Index

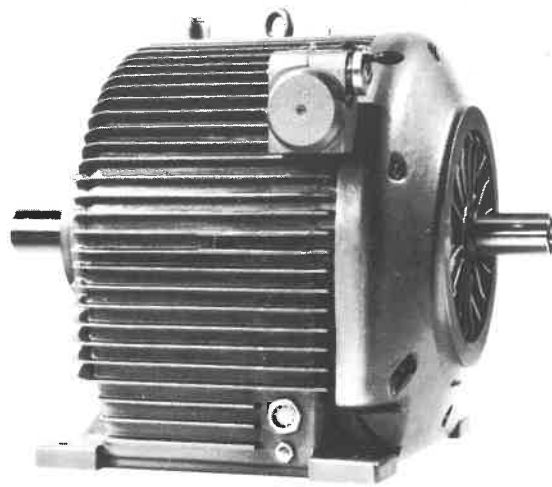
	Page
Variable Speed Drive Characteristics	3
Principles of Operation	4
External Shaft Load, Oil Content and Weight	5
Selection Data	6
Power Capacity vs Output Speed	
Torque vs Output Speed	7
Speed Increasing Variators	8
Service/Equivalent Factors/Selection Procedures	9
Styles	10, 11
Speed Control/Indicators	12, 13
Compact Drive Combinations	14
Applications	15



K 25



K 50



K 100

Characteristics

High power capacity

is achieved by distributing the power transmission over a large number of rollers arranged in a circle around the input and output power elements in a manner similar to that of a planetary gear.

High reliability, Long life

are obtained by low stress of the rotating members which transmit the power under nearly ideal rolling operation.

Wide speed range

a total ratio of 12:1, e.g. 7:1 to low speed and 1:1.7 to high speed.

High output torque

through transmission of the output power on the large diameter of the ring.

High efficiency

by the optimized rolling geometry of the rollers, disc and ring, low loading of the rollers and bearings and correct lubrication.

Low output speeds

as low as $\frac{1}{12}$ of the input speed. In many cases a reduction gear will not be necessary.

Vibrationless operation

All power transmitting parts are perfect rotary bodies. The operating sound level is approximately equal to that of an electric motor of the same power.

High speed holding

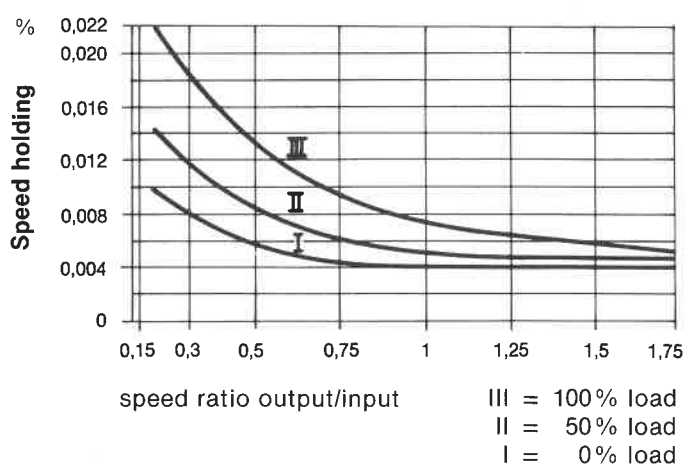
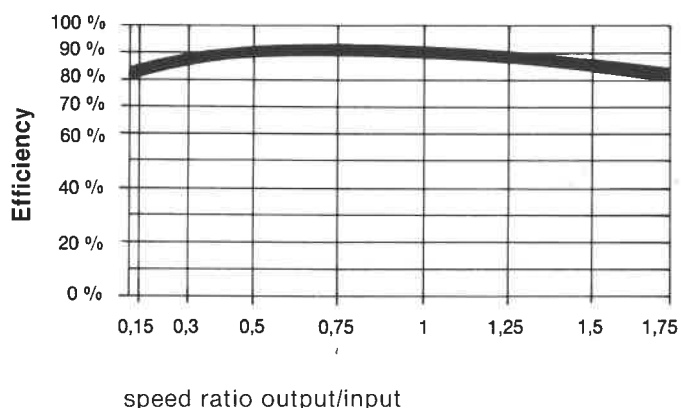
Speed variation is less than 0,03% and is unsurpassed by any other means of mechanical power transmission. This is achieved by a compact design with no flexibility of the power transmitting parts, high production and quality standards and speed variation controls having no clearance.

Universal mounting

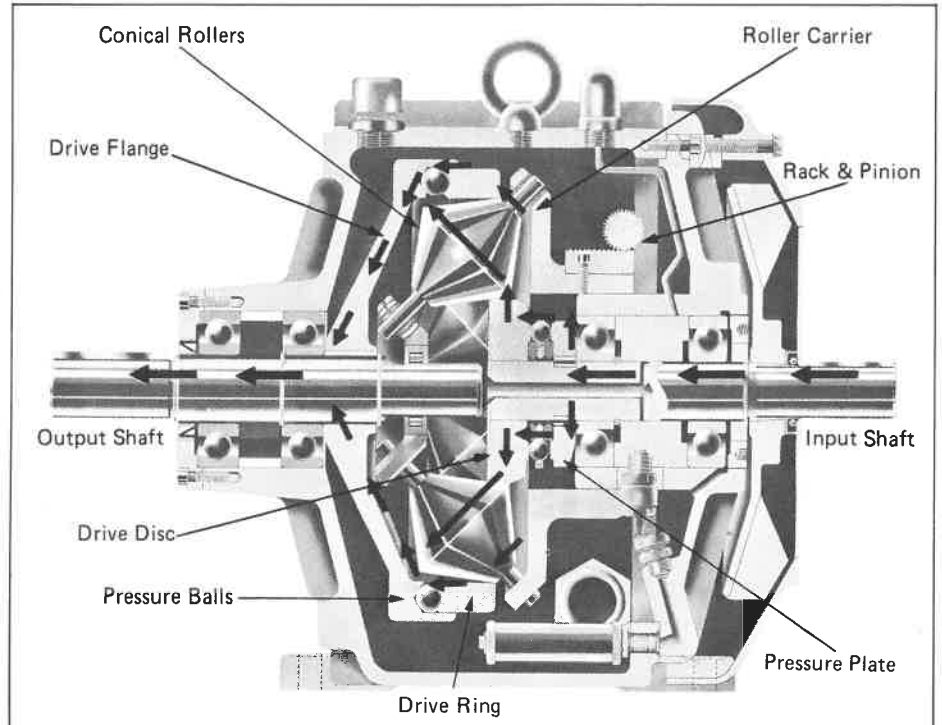
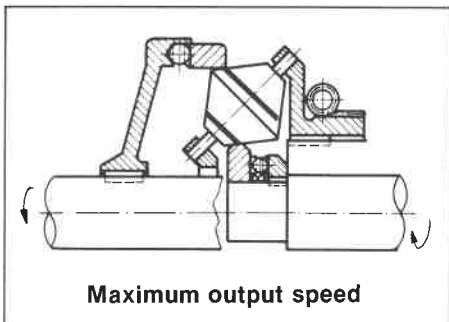
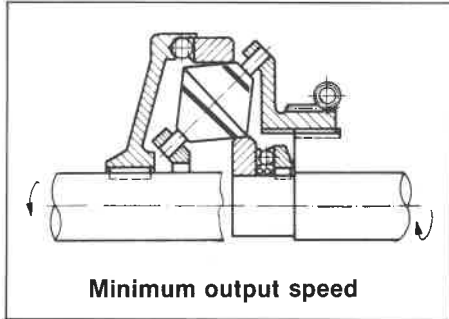
in all possible ways: horizontal, vertical, inclined input side above or below.

High output speed

where high output speeds are required, the variator can be driven from the flange side, thereby multiplying the output speed up to 5 times the input speed.

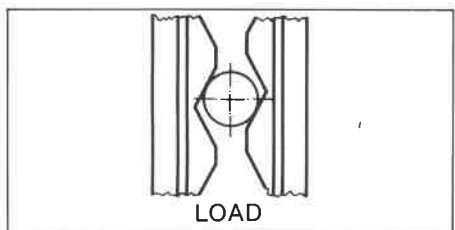
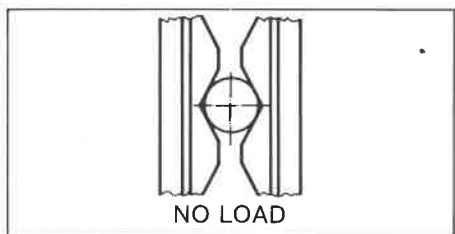


Principle of Operation



In the operation of the Kopp Variable Speed Drive, the flow of power is from the input shaft, through the pressure plate and drive disc, to the double conical rollers which rotate freely in fixed needle bearings. From the rollers it is transmitted through the drive ring, pressure balls and drive flange to the output shaft. The carrier in which the rollers are fitted can be moved axially by the rack and pinion.

The drive ring is partially immersed in an oil sump and lubricates all rotating parts. An oil pump is built-in in larger units between the bearings of the input side and assures the oil circulation. An extremely thin elasto-hydrodynamic film of lubricant is formed between the contact surfaces of the drive disc, ring and rollers, transmitting the power and preventing metal-to-metal contact. The maximum ratio between low and high speed is 12:1. The output shaft rotates in the opposite direction to the input shaft. The movement of the carrier increases or decreases the diameters of the drive rollers which are in contact with the drive disc and the drive ring as shown in fig. 2. This causes the changes of the output speed.



Torque Responsive Mechanisms

Torque Responsive Mechanisms incorporated on the input and output sides provide traction proportional to the torque transmitted through the drive. The pressure plate is keyed to the input shaft. The drive disc is free to revolve on the shaft. Both plate and disc have V-shaped ramps with steel balls held in a retainer. When torque is transmitted to the shaft, the steel balls tend to roll up the ramps and exert an axial pressure on the drive disc, thus producing the contact pressure between the rollers and the inclined face of the drive disc. This pressure is greater than the necessary pressure for transmitting power, thereby assuring security against slip.

A similar torque responsive mechanism is arranged between the outer ring and the flange.

These mechanisms insure traction at all time, regardless of load, speed or direction of rotation. The variator can never slip. This automatic regulation of the friction pressure results in high efficiency and long life.

Input Power

Max. allowable input power and torque
in relation to output speed

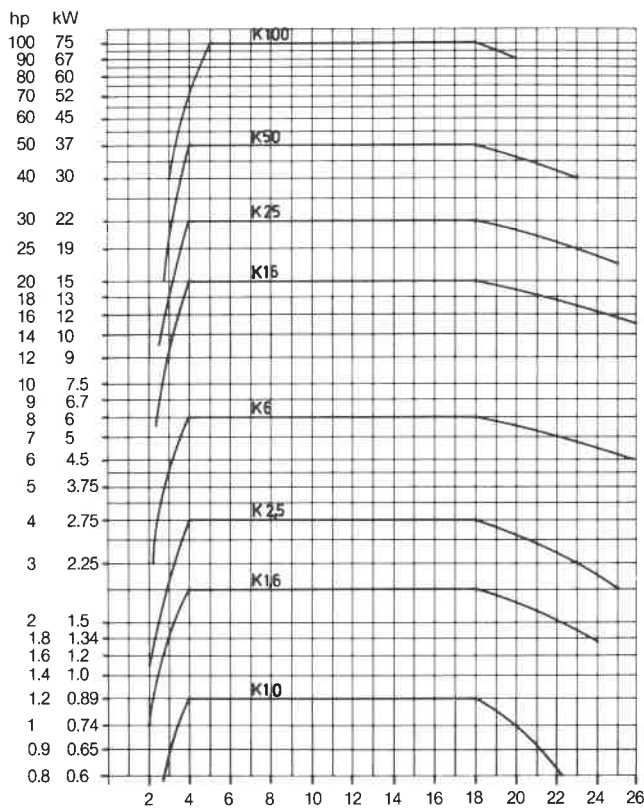
Type	Input speed n_1 $m_1 = 1500 \text{ min}^{-1}$				Input speed $n_1 = 1800 \text{ min}^{-1}$			
			Output speed n_2				Output speed n_2	
	Input power kW	HP	With constant power	With constant torque	Input power kW	HP	With constant power	With constant torque
K 1.0	0.37	0.5	185-2220	185-2220	0.75	1	370-2250	222-2550
	0.55	0.75	250-2220	185-2220	0.9	1.25	450-2270	222-2270
	0.75	1.0	350-2000	185-2000				
	0.88	1.5	400-1800	185-1800				
K 1.6	0.75	1.0	200-2400	200-2400	1.1	1.5	300-2880	240-2880
	1.1	1.5	270-2400	200-2400	1.5	2.0	370-2880	240-2880
	1.5	2.0	330-2200	200-2200	1.85	2.5	430-2420	240-2420
	1.85	2.5	400-1800	200-1800				
K 2.5	1.5	2.0	250-2500	210-2500	1.85	2.5	350-3000	252-3000
	2.2	3.0	330-2300	210-2300	2.2	3.0	380-2800	252-2800
	3.0	4.0	400-1800	210-1800	3.0	4.0	450-2400	252-2400
K 6	3.0	4.0	250-2580	220-2580	3.0	4.0	280-2900	265-2900
	4.0	5.5	300-2580	220-2580	4.3	6	360-2900	265-2900
	5.5	7.5	380-2000	220-2000	5.5	7.5	420-2700	265-2700
	6.0	8.0	400-1800	220-1800	6.7	9	480-2160	265-2160
K 16	5.5	7.5	230-2600	230-2600	6.7	9	300-2800	288-2800
	7.5	10	270-2600	230-2600	8.8	12	340-2800	288-2800
	11	12	330-2600	230-2600	14.7	20	450-2450	288-2450
	15	20	400-1800	230-1800	16.8	22.5	480-2150	288-2150
K 25	15	20	320-2500	250-2500	14.7	20	350-2600	300-2600
	18.5	25	360-2300	250-2300	18.4	25	400-2600	300-2600
	22	30	400-1800	250-1800	25.5	34	480-2160	300-2160
K 50	22	30	320-2300	270-2300	22	30	370-2300	340-2300
	30	40	360-2300	270-2300	29.5	40	420-2300	340-2300
	37	50	400-1800	270-1800	37	50	480-2150	340-2150
					40	55	500-2000	340-2000
K 100	37	50	330-2000	300-2000	45	60	410-2100	350-2100
	45	60	370-2000	300-2000	55	75	460-2100	350-2100
	55	75	420-2000	300-2000	75	100	560-2100	350-2100
	75	100	500-1800	300-1800	82.5	110	600-1900	350-1900

Remark

To reach lower speeds as indicated in above list, it is generally cheaper to apply reduction gears instead of 8 or more pole motors and accordingly larger variators.

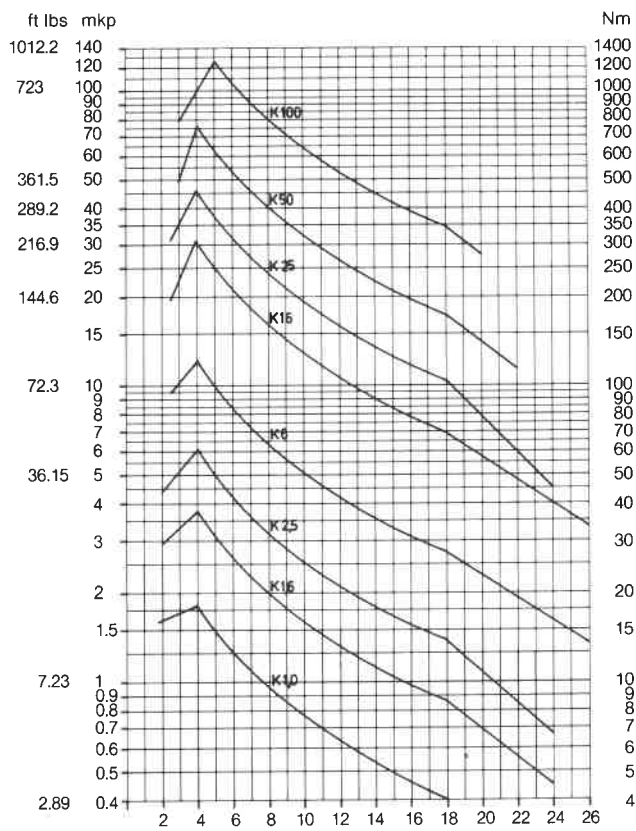
HP Diagrams

Input 1500 r.p.m.

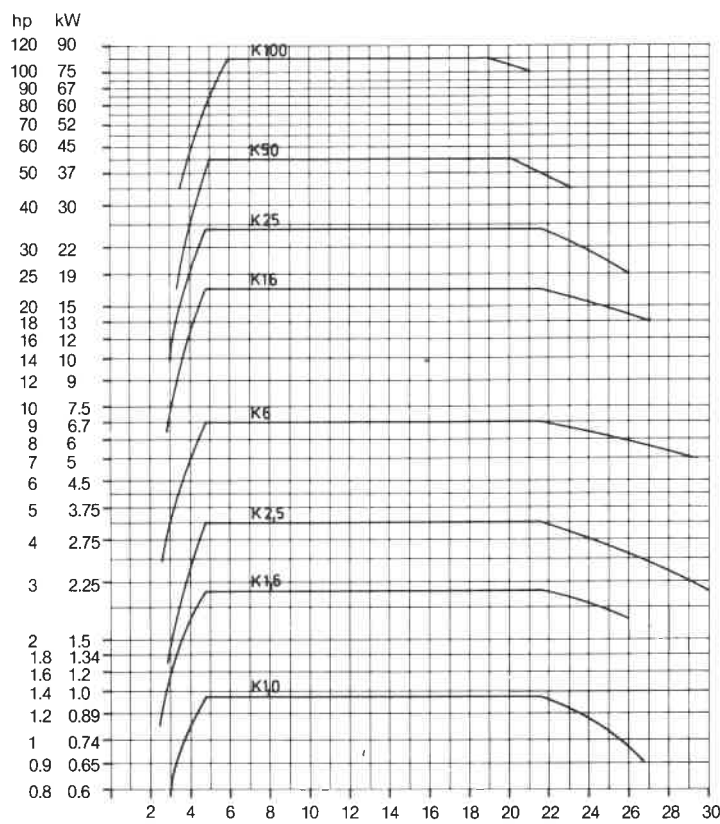


Torque Output

Input 1500 r.p.m.

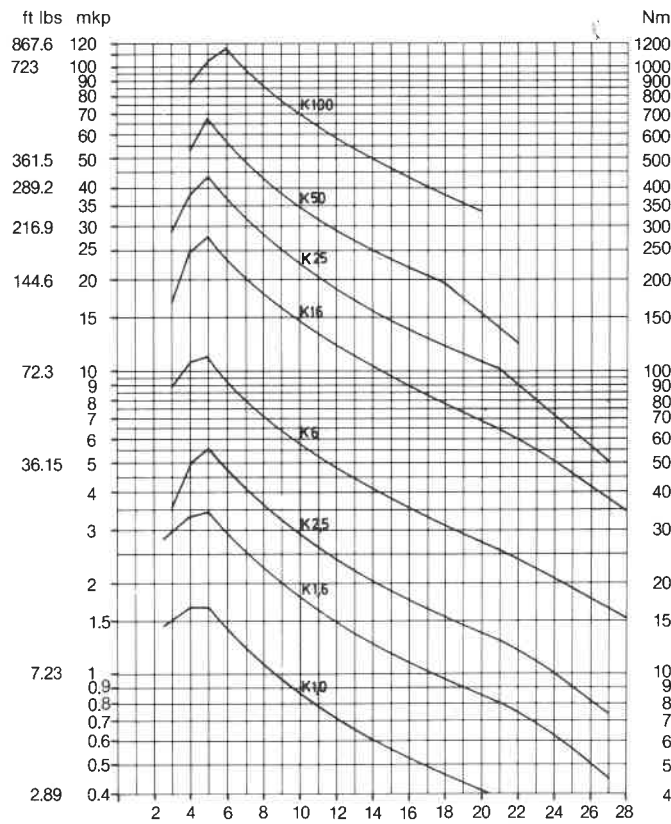


Input 1800 r.p.m.



Output speed r.p.m. × 100

Input 1800 r.p.m.



Output speed r.p.m. × 100

High output speed type KHS

The input side of the variator can be reversed and the variator driven from the flange side, allowing very high output speeds. The horse power capacity is also increased as shown on the graph below. The input speed must not be higher than 1800 r.p.m. and the output speed must not exceed the limits indicated in the graph.

The size of the HS-variator must be determined **by the power** to be applied and not by the torque. The power drop from 2000 to 1000 r.p.m. output should be noted. The HS type should only be used for constant torque transmission.

Power limitations due to cooling

As the variators in this HS-execution can transmit up to double the power, more heat must be dissipated with the same housing. In continuous operation under maximum power the temperature is too high, thus we must apply an outside lubrication with additional cooling.

Model A

Model A variators has an outside lubrication pump with a motor and a separate oil tank. This oil tank must contain the appropriate quantity of oil to reach the required cooling. It might be necessary to apply an oil cooler (water or air) for the large variators.

Model B

These HS-Variators are used **only for intermittent operation** (not over 30 min. duration). To properly cool the model B variator, it is necessary to respect standstill intervals.

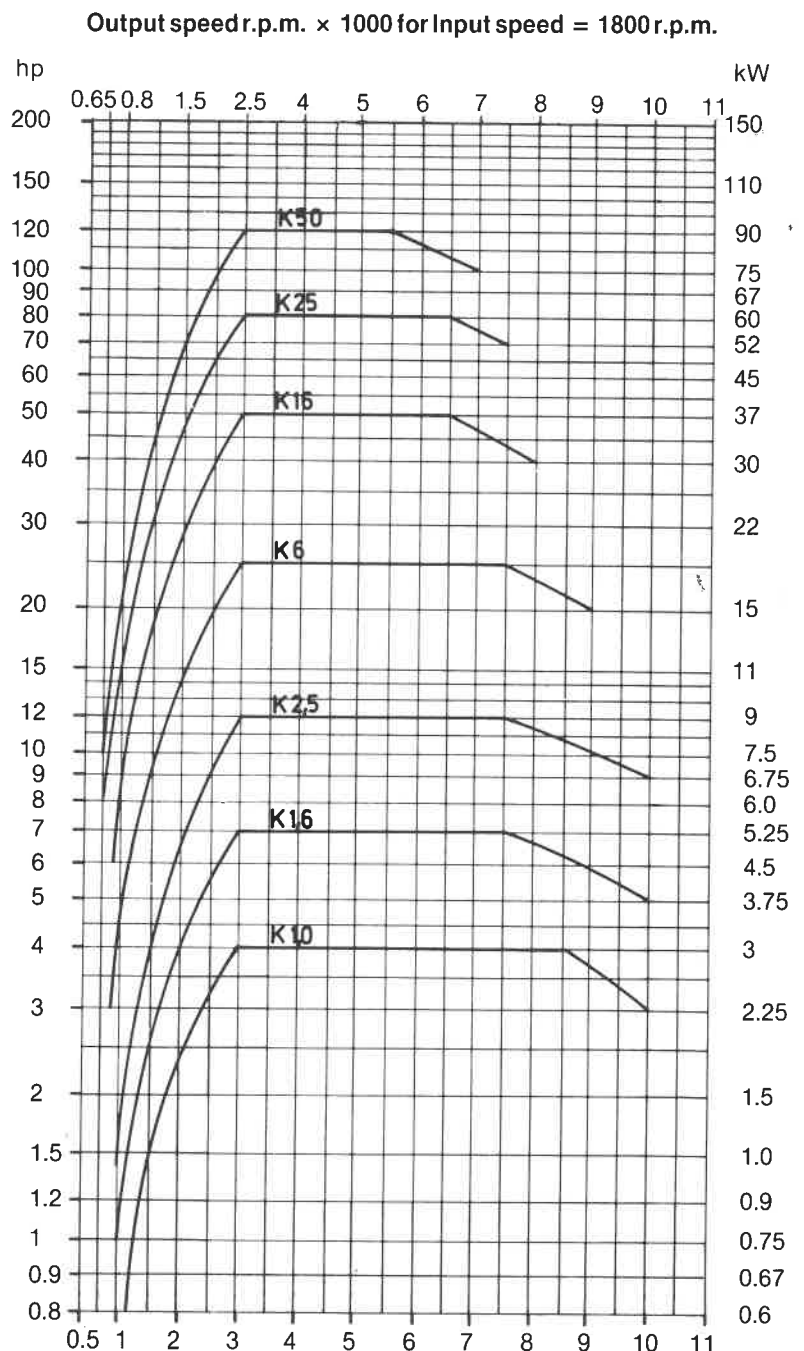
For the size K 1.0 to K 16 the normal inside lubrication can be used. The fan is put on the opposite side as a normal variator to assist in cooling.

The mounting of motor to the variator is effected with a frame. The direct flanging is not recommended.

The vertical execution is possible but requires special arrangements for the lubrication. Contact the manufacturer.

Overload clutch

With high output speeds we have high acceleration forces transmitted when starting the variator. Therefore a safety UK clutch must be arranged.



Service Factors

When running a variator under irregular conditions apply the following safety factors to the Power and Torque.

Variator load	Direct coupling	Overload clutch
Regular load, medium masses to accelerate	1.0	1.0
Regular load, heavy masses to accelerate	1.1	1.0
Irregular load, slight shocks, medium masses to accelerate	1.2	1.1
Shock loads with medium load and masses to accelerate	1.3	1.2
Shock load, reversing of speed, heavy masses to accelerate	1.5	1.3
Combustion engines } Diesel motors }	the variator must in any case be driven with the KOPP UK clutch	
	2.5	1.7

AMBIENT TEMPERATURE

below 30°C	below 90°F	values given above
30-40°C	90-105°F	multiply above factors by 1.2
40-50°C*	105-120°F*	multiply above factors by 1.4

* Sizes K 25-100 must have an oil cooler for these temperatures

The maximum oil temperature with continuous operation must not be over 90°C.
Operation in explosive or acid air requires a special aeration on the variator.

EQUIVALENT FACTORS for Power and Torque (speeds from 10 to 3000 r.p.m.)

When the input speed of the variator is not 1400-1500 r.p.m., the listed factors must be applied to obtain the correct power, torque and output speed for that variator.

INPUT SPEED	10	50	100	200	500	750	900	1200	1500	1800	2000	2500	3000
INPUT POWER	0.01	0.05	0.1	0.2	0.44	0.59	0.68	0.85	1.0	1.13	1.22	1.40	1.59
OUTPUT TORQUE	1.5	1.5	1.5	1.5	1.32	1.18	1.13	1.06	1.0	0.94	0.92	0.84	0.80
OUTPUT SPEED	0.0066	0.033	0.066	0.133	0.33	0.5	0.6	0.8	1.0	1.2	1.33	1.66	2.0

SELECTION EXAMPLES

The variator K 16 can transmit 20 hp with 1500 r.p.m. input speed over a speed range of 400-1800 r.p.m.

Question

Which constant power is transmitted by this variator over the same speed range with input speed reduced to 500 r.p.m.? What are the maximum torque and output speeds?

Solution

- applicable power with 500 r.p.m. input:
 $P = 20 \times 0.44 = 8.8$ hp
- output speed for constant power of 8.8 hp with 500 r.p.m. input:
 $n_2 = 0.33 \times (400-1800 \text{ r.p.m.}) = 132-594 \text{ r.p.m.}$

— applicable output torque:

- with $n_1 = 1500$ r.p.m.
 $n_2 = 400$ r.p.m. = 217 ft.lbs
 $n_2 = 1800$ r.p.m. = 50 ft.lbs
- with $n_1 = 500$ r.p.m.
 $n_2 = 132$ r.p.m. / $M_2 = 1.32 \times 217 = 286$ ft.lbs
 $n_2 = 594$ r.p.m. / $M_2 = 1.32 \times 50 = 66$ ft.lbs

Question

Which variator will transmit the full power of 15 kW with 500 r.p.m. input and a minimum output speed range of 1:4.5?

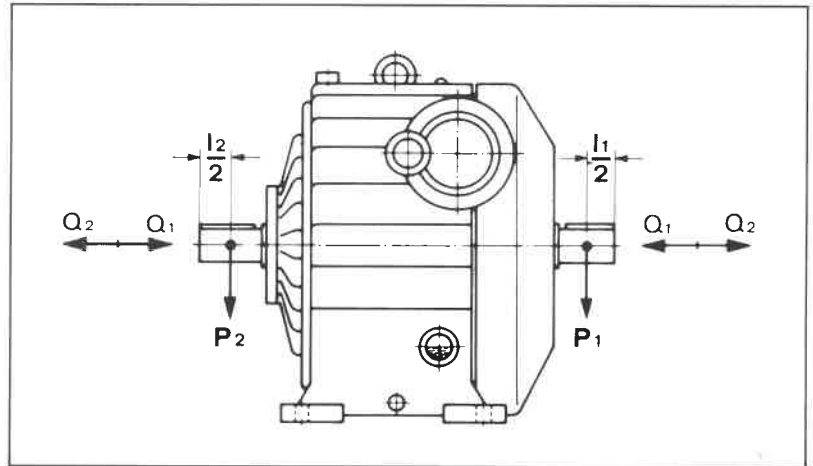
Solution

- The variator K 50 transmits
with n_1 1500 r.p.m. 37 kW
with n_1 500 r.p.m. = $0.44 \times 37 \text{ kW} = 16.3 \text{ kW}$

NOTE: For irregular loads apply the appropriate safety factor to the required HP and Torque before using the equivalent HP and Torque conversions from 1500 r.p.m.

- External shaft loads
- Oil content
- Weight

The figure “P” and “Q” shown are the permissible loads, in kilogrammes, for both the Input and Output shafts of the Series “K” Variable Speed Drive, when the load is applied at the midpoint of the shaft.



EXTERNAL LOADS in kg (1 kg = 2.2 lbs)									
		K 1.0	K 1.6	K 2.5	K 6	K 16	K 25	K 50	K 100
P 1 max.	kg	40	60	75	100	200	225	350	500
P 2 max.	kg	80	120	150	200	400	450	1300	2000
Q 1 max.	kg	40	60	80	100	130	150	300	600
Q 1 max.	kg	20	30	40	50	65	75	150	300

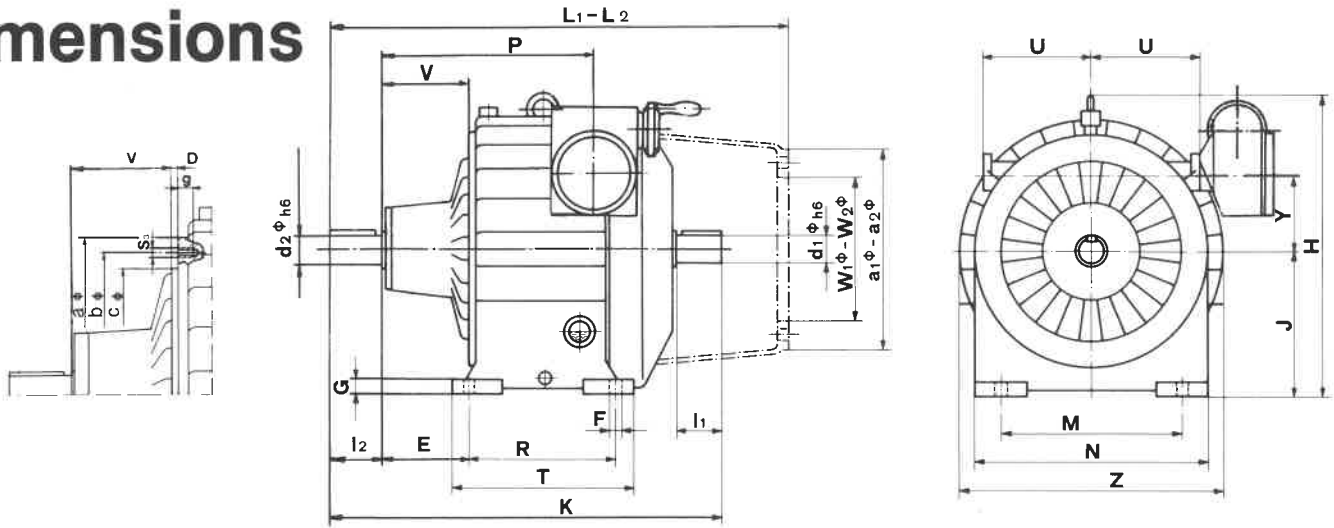
OIL CONTENT in liters (1 US Gallon = 3.8 liters) (1 imper. Gallon = 4.55 liters)									
Style		K 1.0	K 1.6	K 2.5	K 6	K 16	K 25	K 50	K 100
B3/B314	Liter	0.4	0.9	1.5	1.8	3.2	5.0	7.0	24.0
B5	Liter	0.4	0.8	1.8	2.6	3.0	6.6	—	—
V6, V614	Liter	0.5	1.2	2.0	2.8	5.0	6.0	9.1	16.0
V3	Liter	0.5	1.0	1.8	2.8	5.2	6.8	9.1	—
V1	Liter	0.4	0.8	1.7	2.5	5.0	6.2	14.0	—

Recommended oils

Mineral Oil on Naphta base or Synthetic Oil. Viscosity of 2.5—20 c St.
at 50° C ISO VG 10—22. Solidifying point at least —20° C.

WEIGHT OF VARIATORS in kg (1 kg = 2.2 lbs)									
		K 1.0	K 1.6	K 2.5	K 6	K 16	K 25	K 50	K 100
All units	kg	20	33	58	98	147	213	345	605

Dimensions



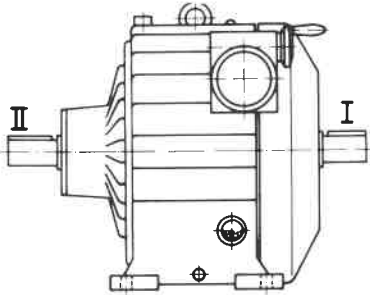
General dimensions - all units													Foot mounted units									
Size	d ₁	l ₁	d ₂	l ₂	K	H	Z	P	U	V	J	Y	R	T	E	F	G	M	N	a	b	
K 1.0	14	30	15	30	257	230	200	150	101	25	100	—	155	180	57	8	14	155	180	160	130	
K 1.6	18	40	20	40	310	280	244	173	123	32	125	—	175	200	77,5	9	16	180	220	200	165	
K 2.5	25	45	30	50	365	330	278	201	140	51	150	—	205	235	98	13	20	200	252	252	230	
K 6	30	54	35	65	488	400	350	266	148	86	180	95	230	265	148,5	13	24	270	305	305	280	
K 16	40	70	45	80	574	470	413	302	170	107	212	120	245	285	184	16	26	300	372	372	340	
K 25	50	80	50	90	648	550	464	332	192	114	280	132	260	320	207	18	25	360	450	410	370	
K 50	50	85	55	100	754	610	530	418	220	83	300	155	380	460	190	18	30	380	475	450	400	
K 100	65	120	75	130	960	780	664	523	270	100	400	192	500	570	225	20	35	560	648	550	500	

* All shafts can be supplied in standard inch dimensions. Designation is Ka (ex. Ka 1.0).

BASIC STYLES

STYLE B3

Standard horizontal foot mounting



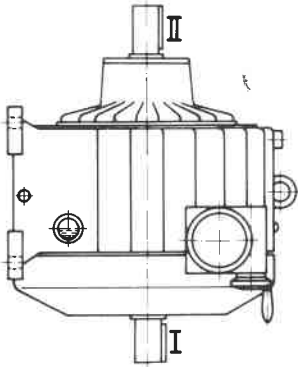
STYLE B3

STYLE B314

Horizontal foot mounting with output side of housing machined and drilled for integral reducer

STYLE V6

Same as Style B3, except wall mounting with output shaft up



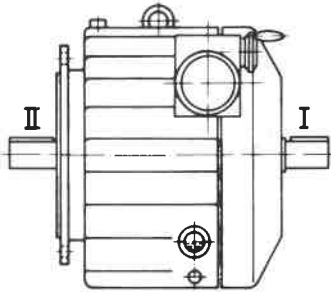
STYLE V6

STYLE V614

Same as Style B314, except wall mounted with output shaft up

STYLE B5

Horizontal flange mounted



STYLE B5

STYLE V1

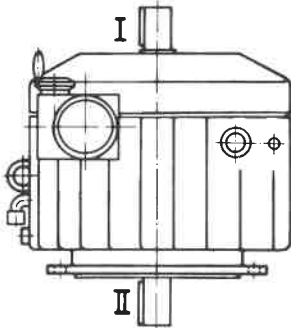
Same as Style B5, except with output shaft down

NOTE:

Basic Style are available with Output and Input Shafts on the same side

STYLE V3

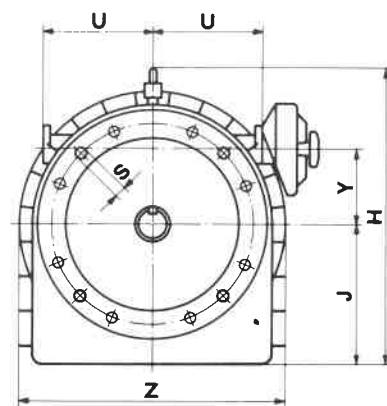
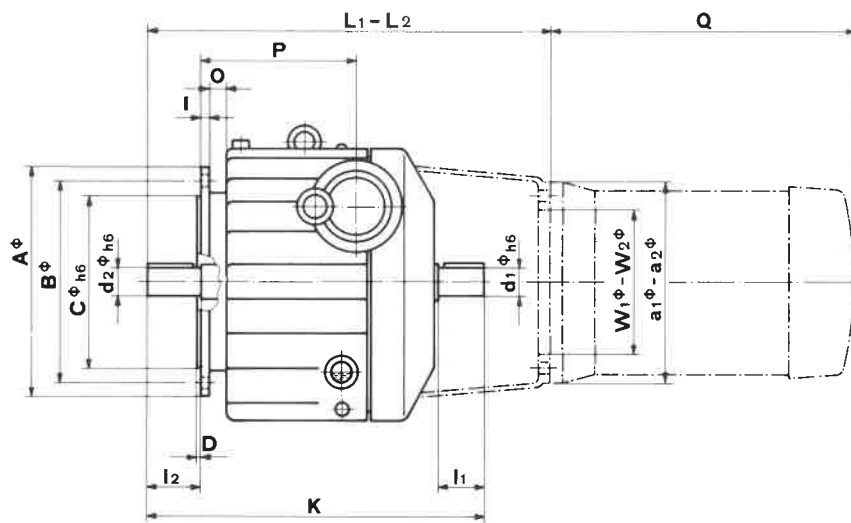
Vertical Flange Mounted with output shaft up (Not shown)



STYLE V1

NOTE:

Shaft "I" is input for Normal Operation, providing 7:1 Reduction and 1:1.7 Increase Ratios. Shaft "II" is considered the Input only for Speed Increaser Drives



		Flange mounted units							Motor mounting**							
c	S3/g	A	B	C	D	I	O	S	L ₁	W ₁	a ₁	L ₂	W ₂	a ₂	Q min.	Q max.
110	4 × M8/12	160	130	110	3	9	18	4 × 9	298	110	160	302	130	200	226	232
130	4 × M10/14	200	165	130	3	10	20	4 × 11.5	362	130	200	—	—	—	226	274
200	8 × M10/14	250	215	180	4	12	22	4 × 14	418	130	200	428	180	250	265	323
260	8 × M10/15	300	265	230	4	14	27	4 × 14	556	180	250	576	230	300	323	422
300	8 × M12/16	350	300	250	5	15	30	4 × 18	657	230	300	687	250	350	422	473
340	12 × M12/18	400	350	300	5	15	34	4 × 18	762	250	350	762	300	400	517	687
350	8 × M16/22	450	400	350	5	15	30	8 × 18	770	250	350	770/800	300/350	400/450	517	687
450	8 × M16/22	—	—	—	—	—	—	—	978	350	450	978	450	550	—	—

** The dimensions for motor mounting on adaptor are only for estimation convenience.

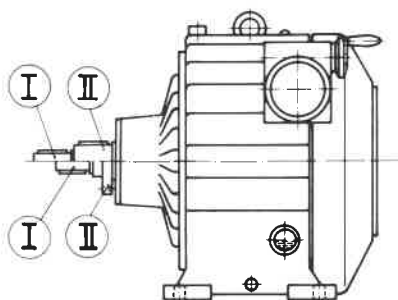
SPECIAL STYLES

STYLE B3/8

Styles with in-and output on the same side

(Body style B3 or B314)

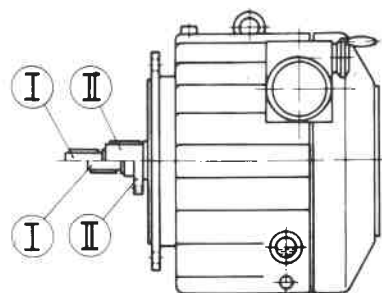
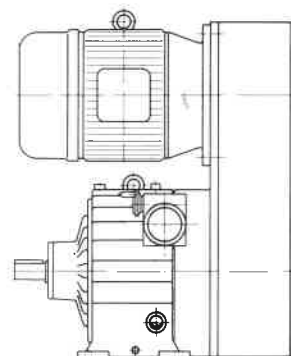
I = input shaft
II = output shaft



STYLE B3/9

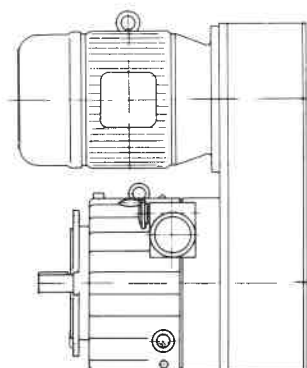
Compact drive

(Body style B3 or B314)



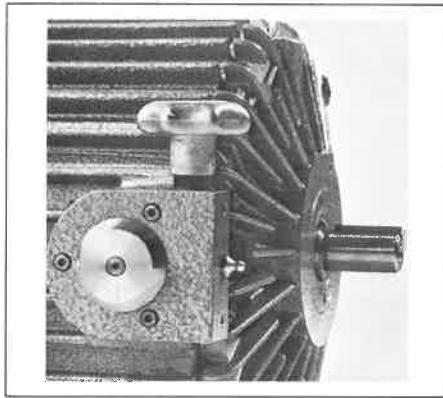
(Body style V1)

The styles B3/8 and B3/9 can also be used in the vertical position



(Body style V1)

Speed Control



MANUAL CONTROL C2 for variators K 1.0 to K 2.5

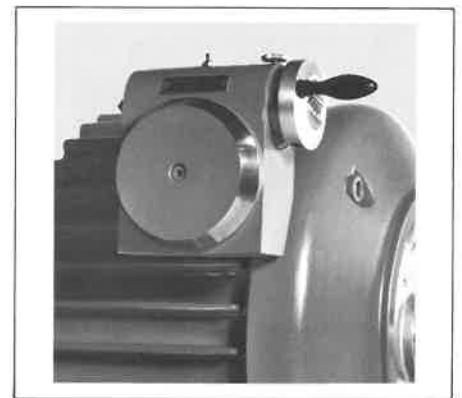
12 turns for complete range.



MANUAL CONTROL C1 for variators K 6 and K 16

For a faster speed change.

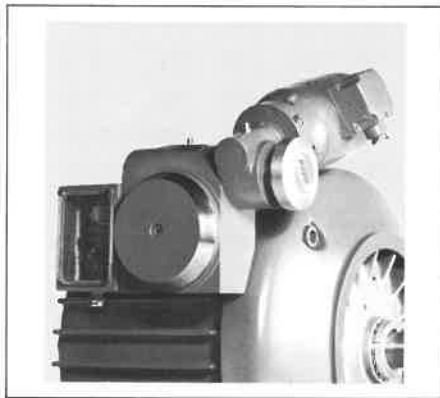
6.25 turns for complete range.



MANUAL CONTROL C2 for variators K 6 to K 100

Is standard for all vertical variators and horizontal units.

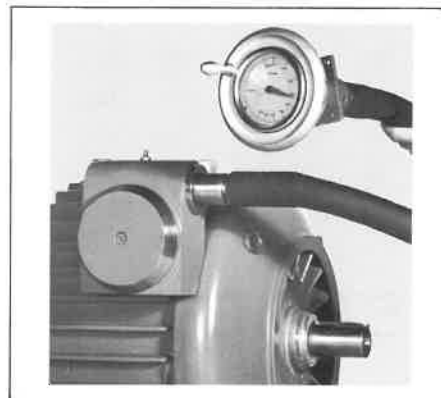
32 turns for complete range.



ELECTRICAL REMOTE CONTROL C3 for variators K 6 to K 100

This control incorporates a servo motor driving the control shaft of the variator through worm gears. The time taken to traverse from maximum to minimum output speed is 20 to 40 seconds. For other traverse time requirements, alternative servo motors are available.

A disengageable clutch in the handwheel also allows hand control of the variator.



MECHANICAL REMOTE CONTROL C4 for variators K 1.0 to K 100

Where the variator is to be mounted in an inaccessible position or must be operated by manual remote control, the C2-control can be supplied with a flexible shaft. The maximum distance for the handwheel is 2,5 meters.

Pneumatic remote control for variators K 1.0 to K 100

Instead of the electrical servomotor we apply an air motor.

Control position

The control of the Kopp Variable Speed Drive Series can be supplied in position A or position B (refer to Fig. 5) for all horizontal mountings. For vertical shaft units the choice of positions is A, B, C or D per Fig. 6. Unless specified otherwise, control will be supplied in position "A".

I = input shaft

II = output shaft

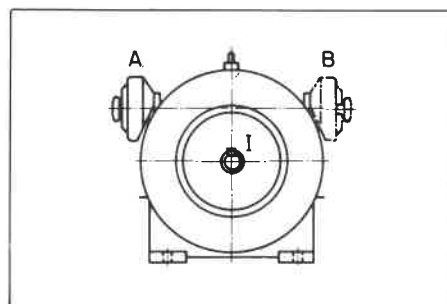


Figure 5.

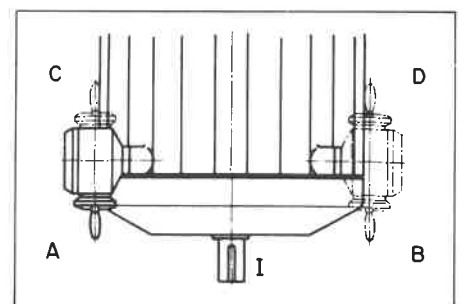


Figure 6.

Speed Indicators

D0 scale engraved

The indicating drum of control C1/C2 can be scaled with speed or any other data.

D1 Handwheel speed indicator

can be delivered instead of the normal handwheel.

D2 Handwheel with position indicator

is used specially with the C4 control. The Handwheel has a normal scale. Special scales can be delivered on request.

D3 Electric remote speed indicator

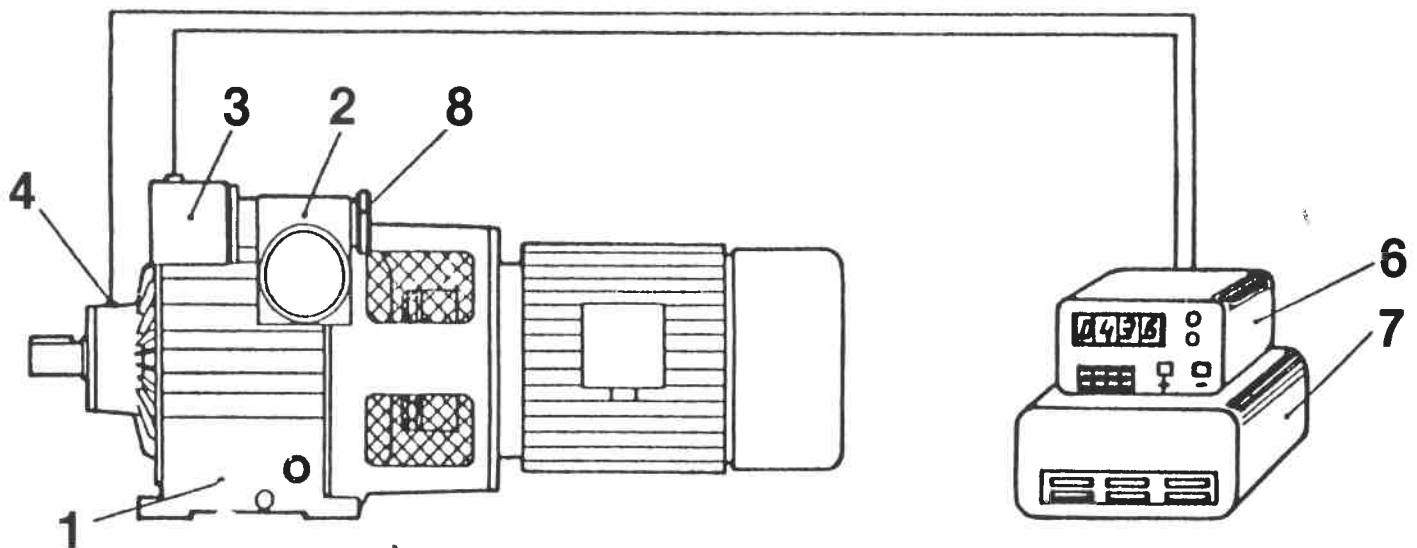
Tachogenerator with indicating instrument for K 1.0 to K 100 of style B3 and V3.

D4 Electronic speed measurement

Contactless speed measurement instrument. Sensor is screwed into the body. Magnetic pickup speed indicating system analog or digital signal. Delivered also with Zener barrier.

Electronic speed regulation

The required power for the speed regulation is only 1% of the power transmitted



This system serves for regulating the speed of the machine automatically. All controls which can be effected by electric signals like for instance revolutions, speed, quantities and others can be processed with this system. These values are shown digitally. They can be registered by various systems or by tabulators. Also different values can be processed which are activated from outside. The regulator compares the registered values. According to the difference a signal is given to the control motor adjusting immediately the variator to the regulated speed. With a manual switch, the automatic regulation can be shut-off and the control of the variator shaft can be effected by hand to any speed. The automatic control can then be switched back and the variator is immediately regulated to the original speed setting.

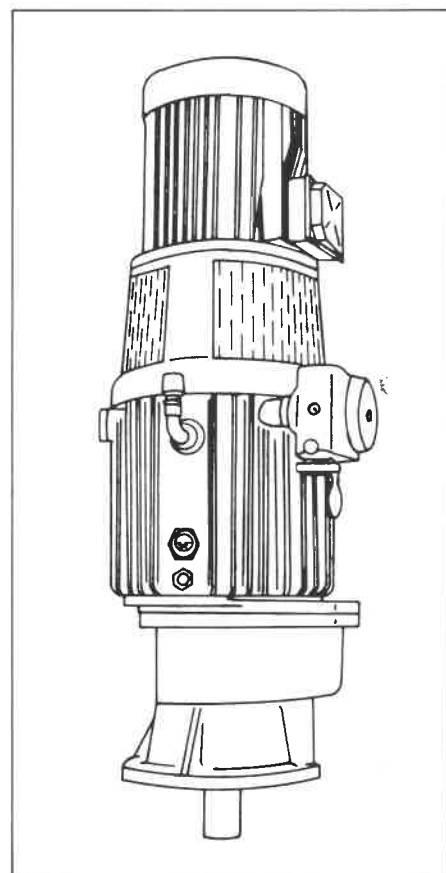
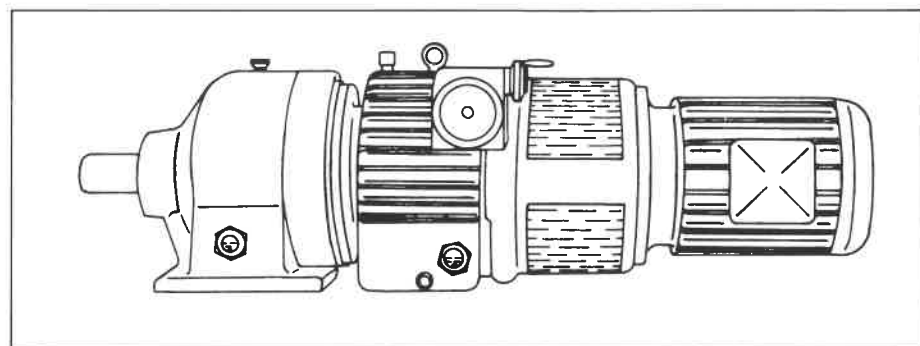
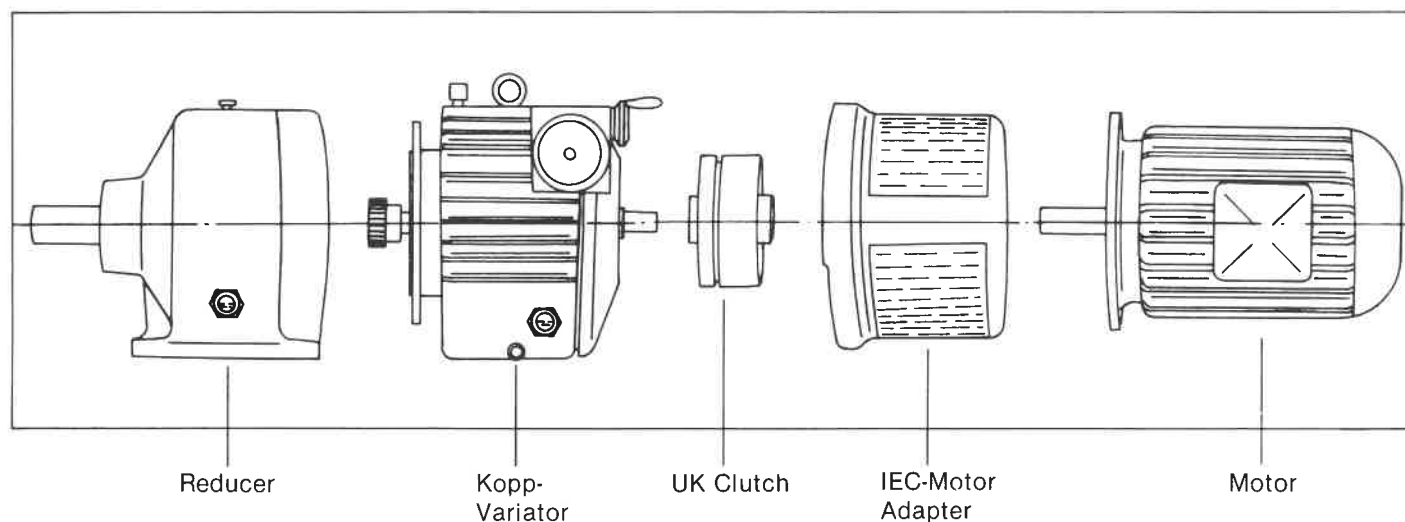
The regulation force is only 10-60 Watt depending on the variator size.

A control-motor (3) is flanged on the control body (2) fixed to the variator (1). A pick-up element (4) transmits the speed of the output shaft digitally to the box (6) and the processing unit (7).

The transmission of the variator power from the input to the output shaft is fully independent of the speed control system and has no influence to the speed control. In case of trouble in the control system, the power transmission is not interrupted. With the handwheel (8) on the control body (3) the speed can be adjusted by hand.

The variator can be driven by any motor or machine shaft. It is not necessary that the variator is driven by an electric motor.

Compact Drive Combination



The Kopp Series K variable speed drive is readily adaptable to a wide variety of combination mounting arrangements with a motor and/or speed reducer.

The arrangements shown are the vertical/horizontal motor-variator-reducer combination. A similar style uses the motor and variator of this arrangement, but has a right angle wormgear reducer.

Another type of combination is the Style 9 composite drive shown on page 11. In this arrangement the motor, which is found above the variator, is connected by a belt system. This combination can also come with or without an integral reducer on the output side.

Consult the Kopp engineering team with your specific application.

Applications



Applicable for either constant HP or constant torque requirements, the series "K" drives represent the latest improvements in the mechanical variable speed drive field. They offer an increase in h.p. capacity and greater ratio range than has previously been available in this market.

A few of the many uses:

Machine tools:

main drives and/or feed drives, lathes, grinders, milling machines, boring mills, stamping presses, saws, drills, etc.

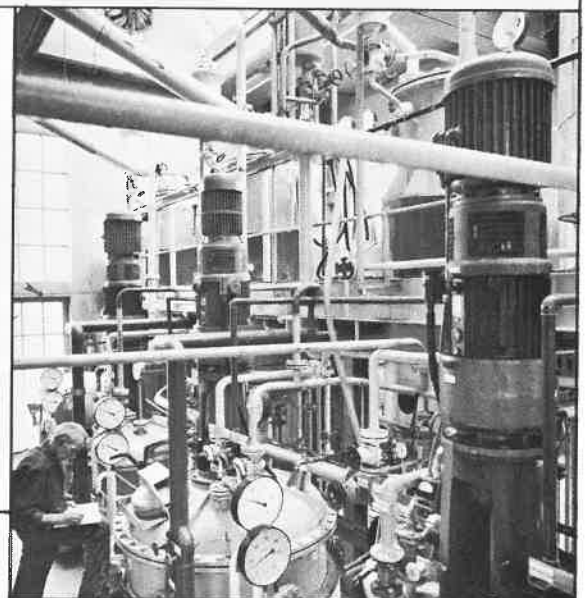
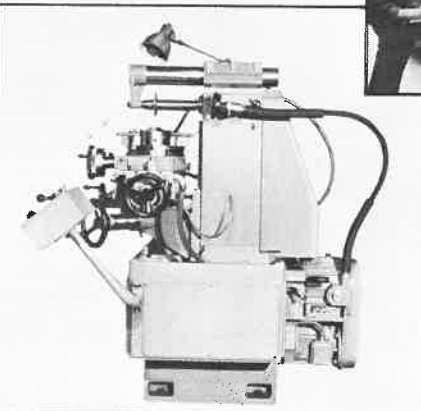
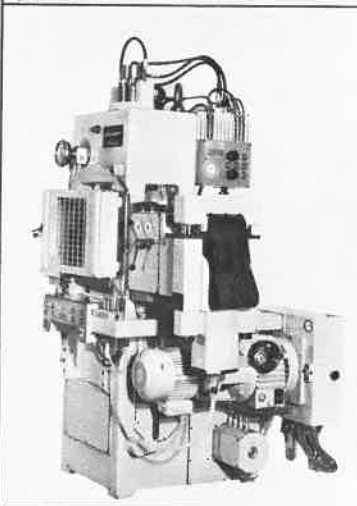
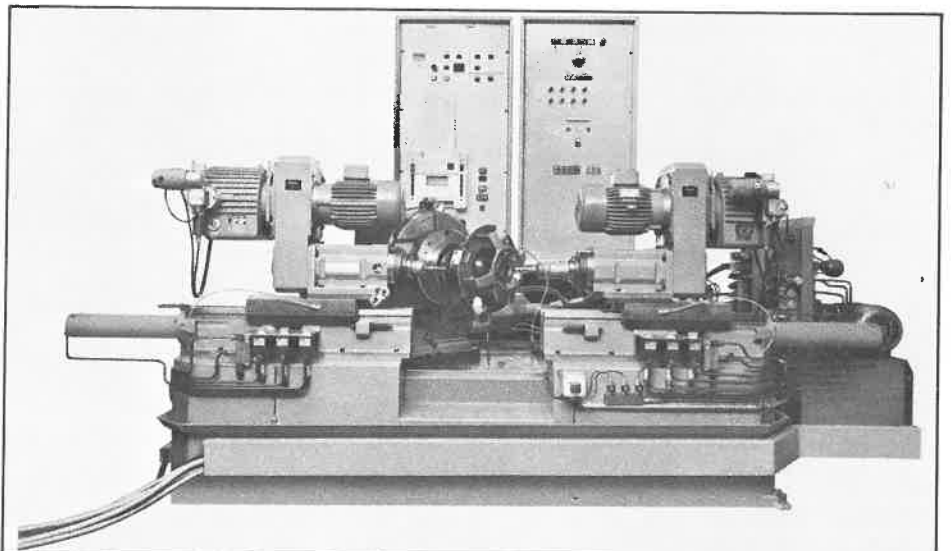
Plastics and rubber:

extruders, unwinds, re-winds, laminators, etc.

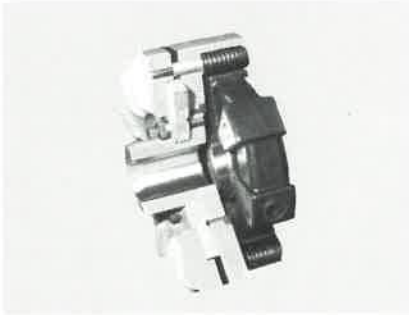
Chemicals and drugs:

mixers, centrifuges, pumps, packaging machinery, printing presses, paper machinery, conveyors, etc.

Or wherever a compact, high efficient, high torque and silent running drive with minimal maintenance is required.



**Apart from the K Type Variators the following products
are manufactured by the KOPP Organization**



Safety Clutch type UK

This clutch increases the lifetime of machines and drives in that it prevents overloading of machines through the start impact of drives. Being a flexible coupling it compensates for shaft misalignment.



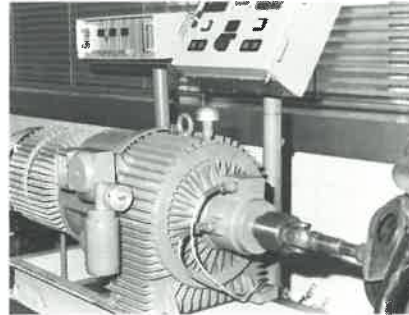
Ball Variator type M

This is a further developed type B variator of simple construction, low output speed and extended regulation range. HP capacity 0.12 to 1.5 kW.



Lubrication Pump PK in ball bearing size

Easily mounted on a shaft. The pump operates in each rotating direction and can deliver lubricant in 4 directions. Simple design, without springs or valves, delivers lubricant also into a rotating shaft without special oil feed arrangement.



Dynamometer type DK

Performance 1 to 75 kW. Can be applied as brake dynamometer for engines and motors of all kinds. As drive dynamometer to determine the HP required by pumps, fans, generators, machine-tools, etc. Or as complete test stand with brake and drive dynamometers to determine efficiency, slip, speed holding, etc.

Kopp



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