CF - CFD - CFDD
FLUID COUPLING

DESCRIPTION & OPERATING CONDITIONS

1. DESCRIPTION

The LOVEJOY Fluid coupling (CF series) is a constant fill type, comprising of three main elements:

1 - driving impeller (pump) mounted on the input shaft.
2 - driven impeller (turbine) mounted on the output shaft.
3 - cover, flanged to the outer impeller, with an oil-tight seal.
The first two elements can work both as pump or turbine.

2. OPERATING CONDITIONS

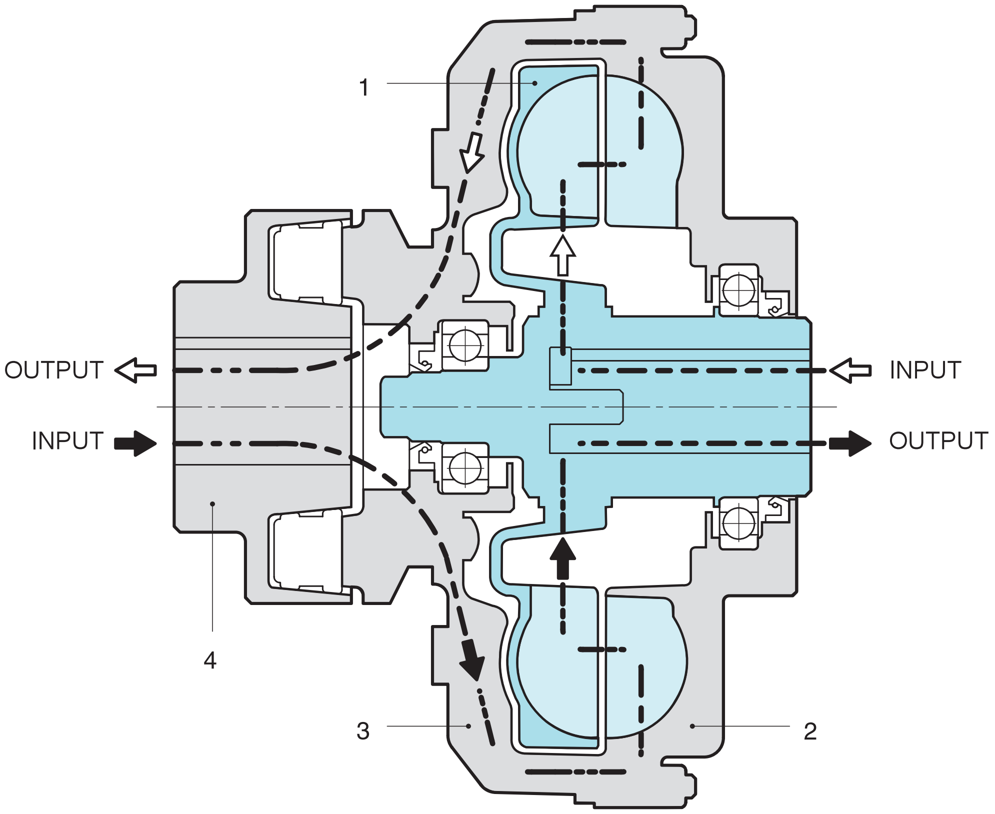
The LOVEJOY Fluid coupling is a hydrodynamic transmission. The impellers perform like a centrifugal pump and a hydraulic turbine. With an input drive to the pump (e.g. electric motor or Diesel engine) kinetic energy is transferred to the oil in the coupling. The oil is forced, by centrifugal force, across the blades of the pump towards the outside of the coupling.
The turbine absorbs kinetic energy and generates a torque always equal to input torque, thus causing rotation of the output shaft. Since there are no mechanical connections, the wear is practically zero.
The efficiency is influenced only by the speed difference (slip) between pump and turbine.

The slip is essential for the correct operation of the coupling - there could not be torque transmission without slip! The formula for slip, from which the power loss can be deduced is as follows:

$$\text{Slip \%} = \frac{\text{input speed - output speed}}{\text{input speed}} \times 100$$

In normal conditions (standard duty), slip can vary from 1,5% (large power applications) to 6% (small power applications).
LOVEJOY Fluid coupling follow the laws of all centrifugal machines:

1 - transmitted torque is proportional to the square of input speed;
2 - transmitted power is proportional to the third power of input speed;
3 - transmitted power is proportional to the fifth power of circuit outside diameter.

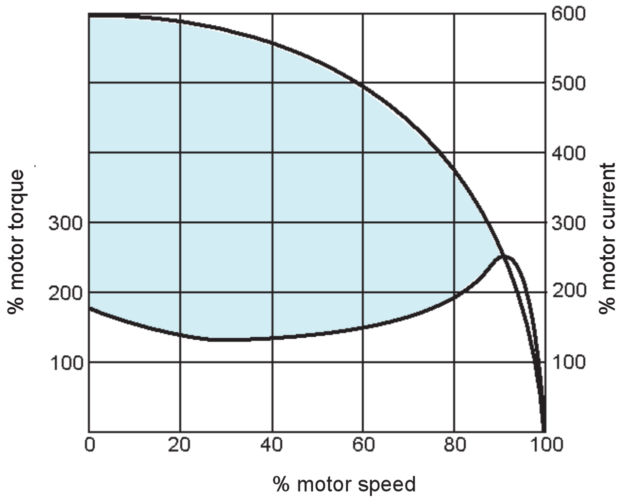


1 - INNER IMPELLER
2 - OUTER IMPELLER
3 - COVER
4 - FLEX COUPLING

2.1 Lovejoy Fluid coupling fitted on electric motors

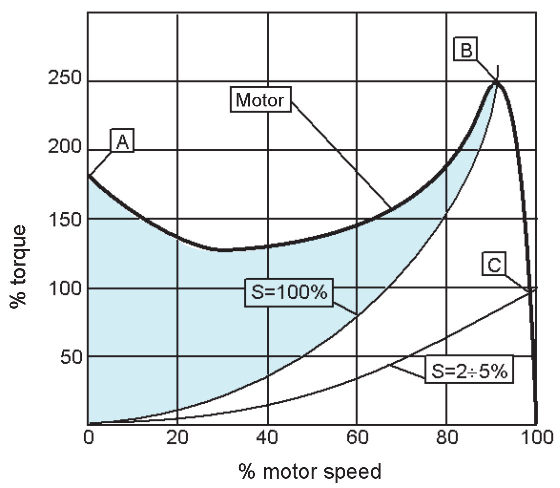
Three phase asynchronous squirrel cage motors are able to supply maximum torque only, near synchronous speed. Direct starting is the system utilized the most. Figure 1 illustrates the relationship between torque and current. It can be seen that the absorbed current is proportional to the torque only between 85% and 100% of the asynchronous speed.

Fig.**1**



Any drive system using a Lovejoy Fluid coupling has the advantage of the motor starting essentially without load. Figure 2 compares the current demands of an electric motor when the load is directly attached verses the demand when a fluid coupling is mounted between the motor and load. The coloured area shows the energy that is lost, as heat, during start-up when a fluid coupling is not used. A Lovejoy fluid coupling reduces the motor's current peak during start-up and also reduces the current losses, increasing the lifetime of electric motors. Also at start-up, a fluid coupling allows more torque to pass to the load for acceleration than in drive systems without a fluid coupling.

Fig.**3**



With a motor connected directly to the load there are the following disadvantages:

- The difference between available torque and the torque required by the load is very low until the rotor has accelerated to between 80-85% of the synchronous speed.
- The absorbed current is high (up to 6 times the nominal current) throughout the starting phase causing overheating of the windings, overloads in the electrical lines and, in cases of frequent starts, major production costs.
- Over-dimensioned motors caused by the limitations indicated above.

To limit the absorbed current of the motor during the acceleration of the load, a (λ Δ) (wye - delta) starting system is frequently used which reduces the absorbed current by about 1/3 during starting. Unfortunately, during operation of the motor under the delta configuration, the available torque is also reduced by 1/3; and for machines with high inertias to accelerate, over dimensioning of the motor is still required. Finally, this system does not eliminate current peaks originating from the insertion or the commutation of the device.

Fig.**2**

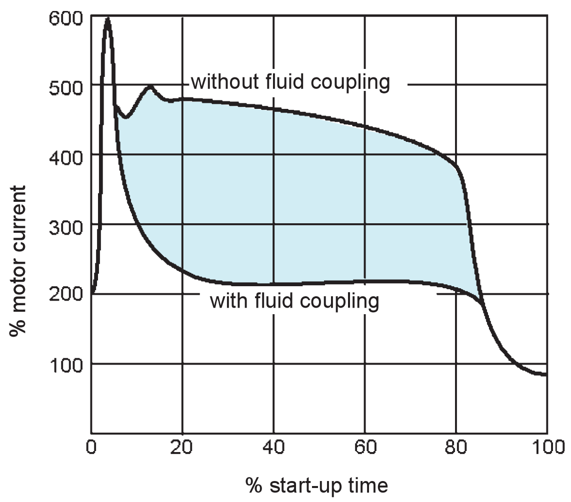
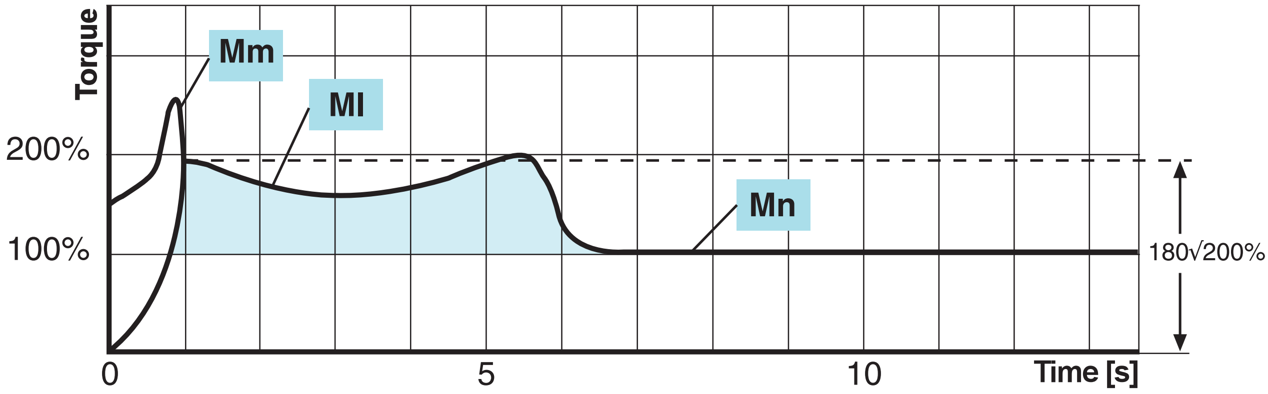


Figure 3 shows two curves for a single fluid coupling and a characteristic curve of an electric motor. It is obvious from the stall curve of the fluid coupling (s = 100%) and the available motor torque, how much torque is available to accelerate the rotor of the motor (colored area). In about 1 second, the rotor of the motor accelerates passing from point A to point B. The acceleration of the load, however, is made gradually by the fluid coupling, utilizing the motor in optimal conditions, along the part of the curve between point B, 100% and point C, 2-5%. Point C is the typical point of operation during normal running.

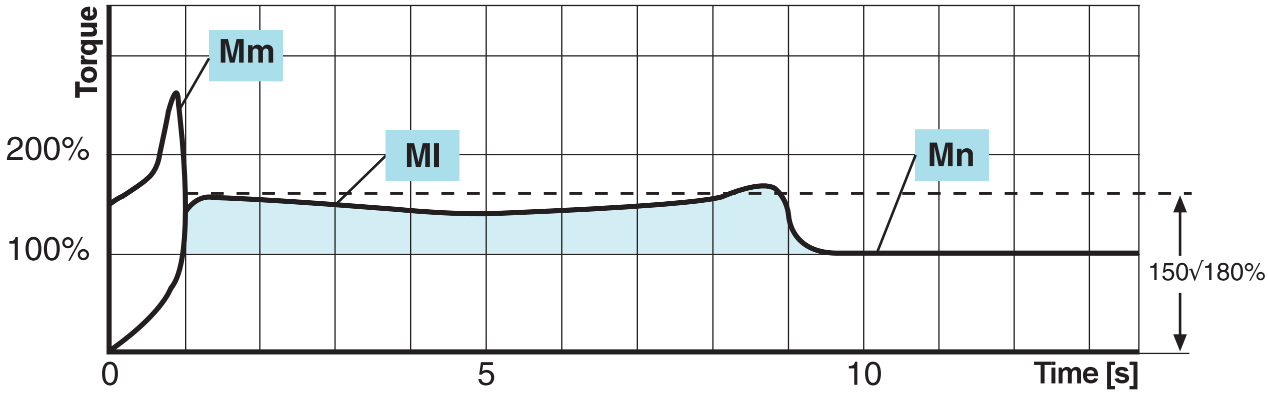
2.2 CHARACTERISTIC CURVES

Ml	: transmitted torque from fluid coupling
Mm	: starting torque of the electric motor
Mn	: nominal torque at full load
.....	: accelerating torque

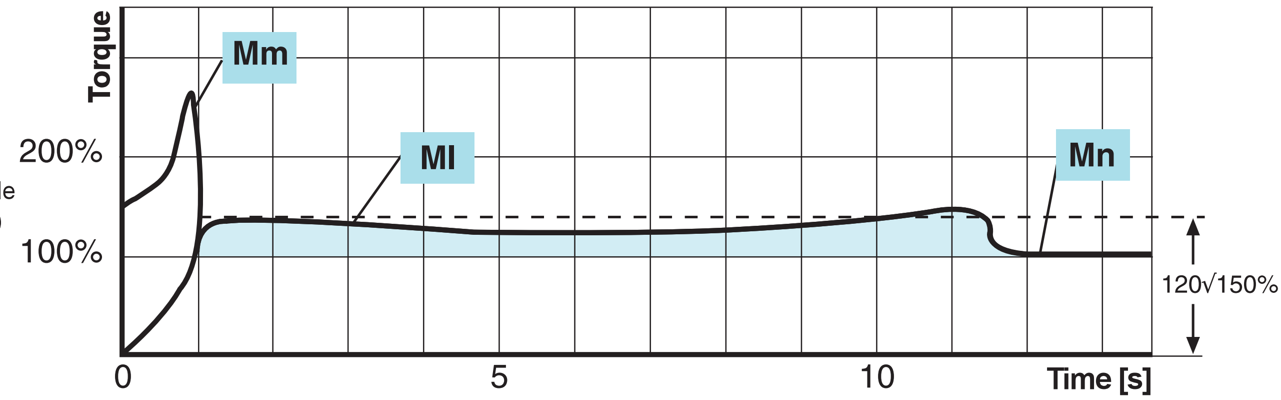
CF type
(standard circuit)



CFD type
(circuit with a delayed chamber)



CFFD type
(circuit with a double delayed chamber)



NOTE: Above starting times are indicative only

3. LOVEJOY FLUID COUPLINGS WITH A DELAYED FILL CHAMBER

A low starting torque is achieved, with the standard circuit in a maximum oil fill condition because fluid couplings limit to **less than 200%** of the nominal motor torque. It is possible to limit further the starting torque **down to 160%** of the nominal torque, by decreasing oil fill: this, contrarily creates slip and working temperature increase in the fluid coupling.

The most convenient technical solution is to use fluid couplings with a **delayed fill chamber,** connected to the main circuit by **calibrated bleed orifices. These externally adjustable** valves, available from size **CFD 400** (Fig. **4b**), can be simply adjusted to vary starting time.

In a standstill position, the **delayed fill chamber** contains part of the filling oil, thus reducing the effective quantity in the working circuit (Fig. **4a**) and a **torque reduction** is obtained, allowing the motor to quickly reach the steady running speed **as if started without load.**

During start-up, oil flows from the **delayed fill chamber** to the main circuit (Fig. **4b**) in a quantity proportional to the rotating speed.

As soon as the fluid coupling reaches the nominal speed, all oil flows into the main circuit (Fig. **4c**) and torque is transmitted with a **minimum slip.**

With a **simple delayed fill chamber,** the ratio between starting and nominal torque may reach **150 %**. This ratio may be further reduced down to **120 %** with a **double delayed fill chamber,** which contains a higher oil quantity, to be progressively transferred into the main circuit during the starting phase.

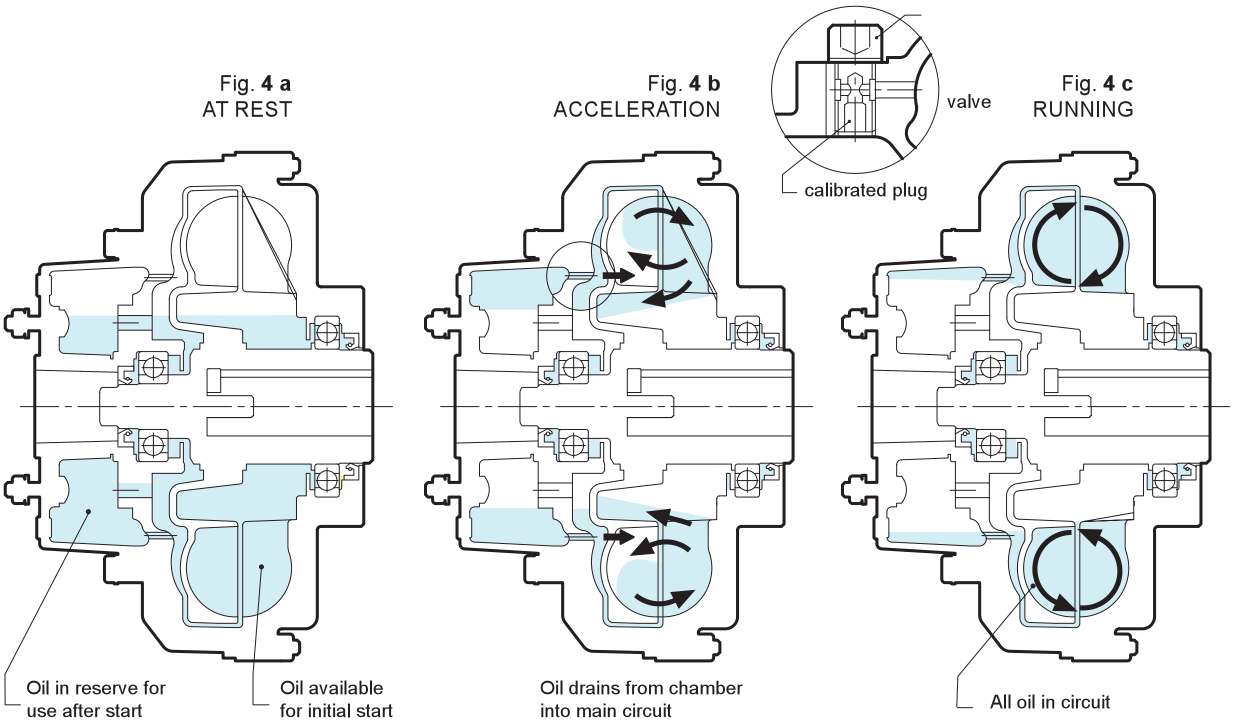
This is ideal for very smooth start-ups with low torque absorptions, as typically required for machinery with large inertia values and for belt conveyors.

The advantages of the **delayed fill chamber** become more and more evident when the power to be transmitted increases.

The **simple chamber** is available from size **CFD 320**, while the **double chamber** from size **CFDD 400**.

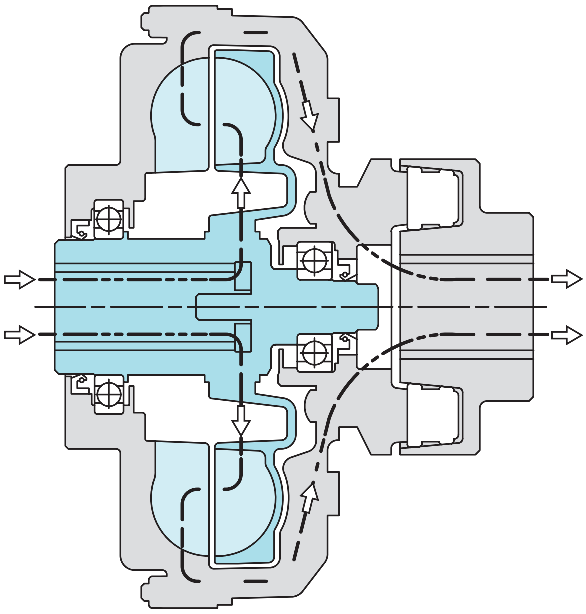
3.1 SUMMARY OF THE ADVANTAGES GIVEN BY FLUID COUPLINGS

- very smooth start-ups
- reduction of current absorptions during the starting phase: the motor starts with very low load
- protection of the motor and the driven machine from jams and overloads
- utilization of asynchronous squirrel cage motors instead of special motors with soft starter devices
- higher duration and operating convenience of the whole drive train, thanks to the protection function achieved by the fluidcoupling
- higher energy saving, thanks to current peak reduction
- limited starting torque down to 120% in the versions with a double delayed fill chamber
- same torque at input and output: the motor can supply the maximum torque even when load is jammed
- torsional vibration absorption for internal combustion engines, thanks to the presence of a fluid as a power transmission element
- possibility to achieve a high number of start-ups, also with an inversion of the rotation direction
- load balancing in case of a double motor drive: fluid couplings automatically adjust load speed to the motors speed
- high efficiency
- minimum maintenance
- Viton rotating seals
- cast iron and steel material with anticorrosion treatment



4. INSTALLATION

4.1 STANDARD MOUNTING
Driver **inner** impeller



Minimum possible inertia is added to the motor, and therefore free to accelerate more quickly.

During the starting phase, the outer impeller gradually reaches the steady running condition. **For very long starting times, heat dissipation capacity is lower.**

If a braking system is required, it is **convenient and easy to install a brake drum or disc** on the flex coupling.

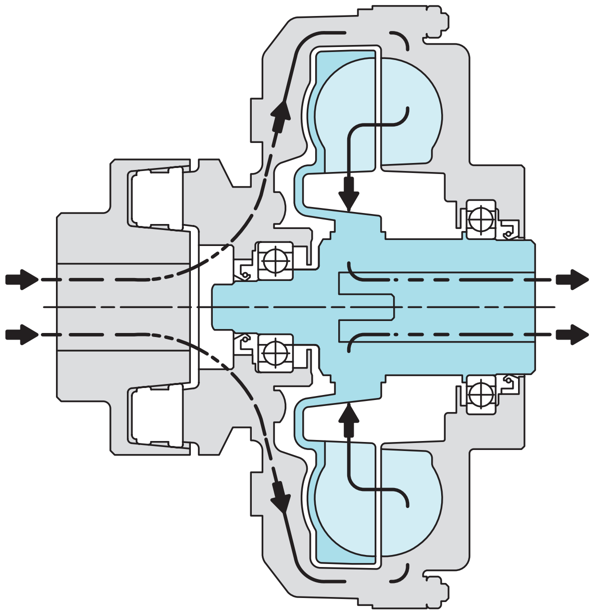
In some cases, where the driven machine cannot be rotated by hand, **maintenance procedures of oil checking and refilling,** as well as alignment, **become more difficult.**

The delayed fill chamber, when present, is fitted on the driven side. The rotating speed of the said chamber gradually increases during start-up, thus **leading to a longer starting time**, assuming the bleed orifices diameters are not changed. **If oil quantity is excessively reduced,** the transmissible torque may be lower than the starting torque of the driven machine. In such a case, part of the oil remains inside the delayed chamber. This lack of oil in the fluid coupling may cause stalling.

The **"switching pin" device might not work correctly** on machines where, owing to irregular operating conditions, the driven side may suddenly stop or jam during the starting phase.

Flex coupling is protected by the placement of the fluid coupling before it, and therefore this **configuration is fit for** applications with **frequent start-ups or inversions** of the rotating sense.

4.2 REVERSE MOUNITNG
Driver **outer** impeller



Higher inertia directly connected to the motor.

The outer impeller, being directly connected to the motor, reaches synchronous speed instantly. **Ventilation** is therefore maximum from the beginning.

The **assembly of a brake disc or drum** on CF fluid couplings is **more difficult, expensive** and leads to a longer axial length of the whole machine group.

The outer impeller and cover are connected to the motor, it is therefore **possible to manually rotate the coupling** to check alignment and oil level, and for refilling.

The delayed fill chamber is fitted on the driver side, and reaches the synchronous speed in a few seconds.

Oil is therefore centrifuged into the main circuit gradually and completely.

Starting time is adjustable by replacing the calibrated bleed orifices. **The starting phase**, however is **performed in a shorter time** than in the configuration with an inner driver impeller.

The **switching pin operation is always assured**, where fitted, as the outer impeller, always rotates because it is mounted on the driver shaft.

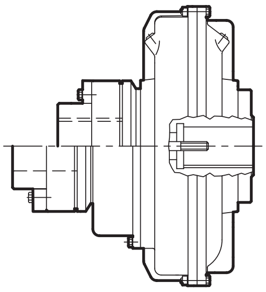
In case of frequent start-ups or inversions of the rotating direction, the **flex coupling is much more stressed.**

If not expressely required by the customer or needed for the application being performed, the fluid coupling is supplied according to our **"standard"** mounting. Do specify in your request for quotation **whether you need** a **"reverse" mounting**

NOTE: Starting from size **CF 350** and **CFD 320** included, a baffle ring is always fitted on the driver impeller, and therefore it is not recommended to mount a fluid coupling "reverse" if **"standard"** mounting, or viceversa.
In these cases contact **RATHI** for more detailed information.

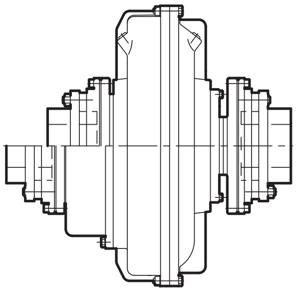
5. VERSIONS

CF RB



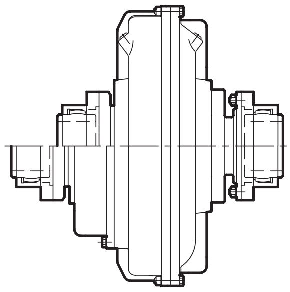
CFD RB CFDD RB

CF LM



CFD LM CFDD LM

CF GD



CFD GD CFDD GD

5.1 IN LINE

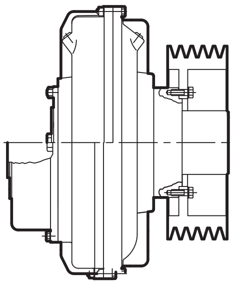
CF RB, CFD RB, CFDD RB : Fluid coupling with Pin Bush B Flex Coupling
CF GD, CFD GD, CFDD GD : Fluid coupling with gear couplings,
CF LM, CFD LM, CFDD LM : Fluid coupling with disc couplings,

N.B.: The CF GD, CF LM versions allow a radial disassembly without moving the motor or the driven machine.

5.2 PULLEY

CF P, CFD P, CFDD P : Fluid coupling with an incorporated pulley

CF P



CFD P - CFDD P

5.3 NOMECLATURE

<u>0123</u> <u>456</u> <u>78</u> <u>9</u>

0 1 2 3	**Series**
CF	Standard Fluid coupling
CFD	Fluid coupling with standard delay chamber
CFDD	Fluid coupling with extended delay chamber

456	**Size**
320 to 750	Fluid coupling size

78	**Variants**
RB	With Pin Bush Coupling
LM	With Disc Coupling
GD	With Gear Coupling
P	With 'V' Groove Pulley
S	With Stub shaft

9	**Attachment**
R	With Brake Disc
D	With Brake Drum

Examples

Specification	**Description**
CF 320	Standard FC
CFDD 320	FC with double delay chamber
CFD 320	FC with single delay chamber
CF 320 RB	FC With Pin Bush Coupling
CFD 320 LM	FC With delay chamber & Disc Coupling
CF 320 GD	FC With Gear Coupling
CF 320 P	FC With V Groove Pulley
CF 320 S	FC With Stub shaft
CF 320 RBR	FC With Pin bush Coupling & Brake Disc
CFDD 750 GDD	FC With extended delay chamber, Gear Coupling & Brake Drum

Fig. A

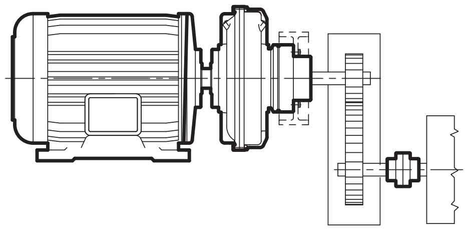


Fig. B

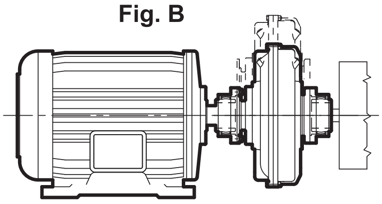
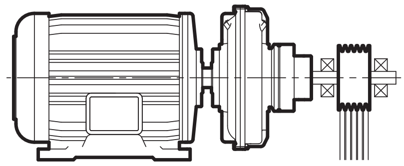


Fig. C



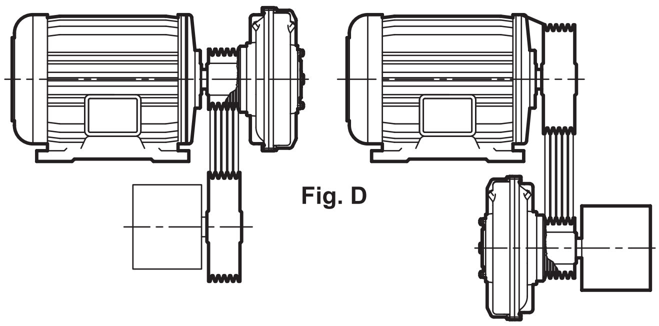
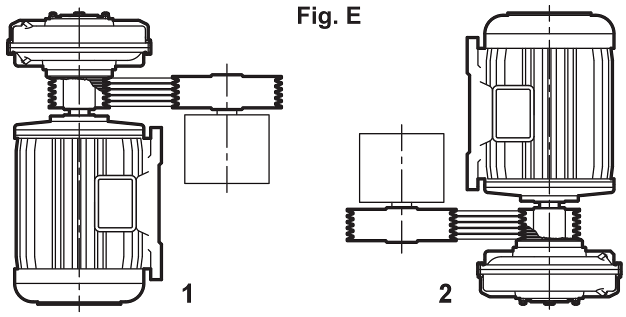


Fig. D

Fig. E



6 MOUNTING

6.1 IN LINE VERSIONS MOUNTING EXAMPLES

Fig. A Horizontal axis between the motor and the driven machine (CF SW, CFD SW, CFDD SW and similar).

Fig. B It allows a radial disassembly without moving the motor and Fig. C the driven machine (CF GD, CFD RLM and similar).

Fig. C Between the motor and a supported pulley for high powers and heavy radial loads.

6.2 PULLEY VERSIONS MOUNTING EXAMPLES

Fig. D Horizontal axis

Fig. E Vertical axis. When ordering, please specify mounting type 1 or 2.

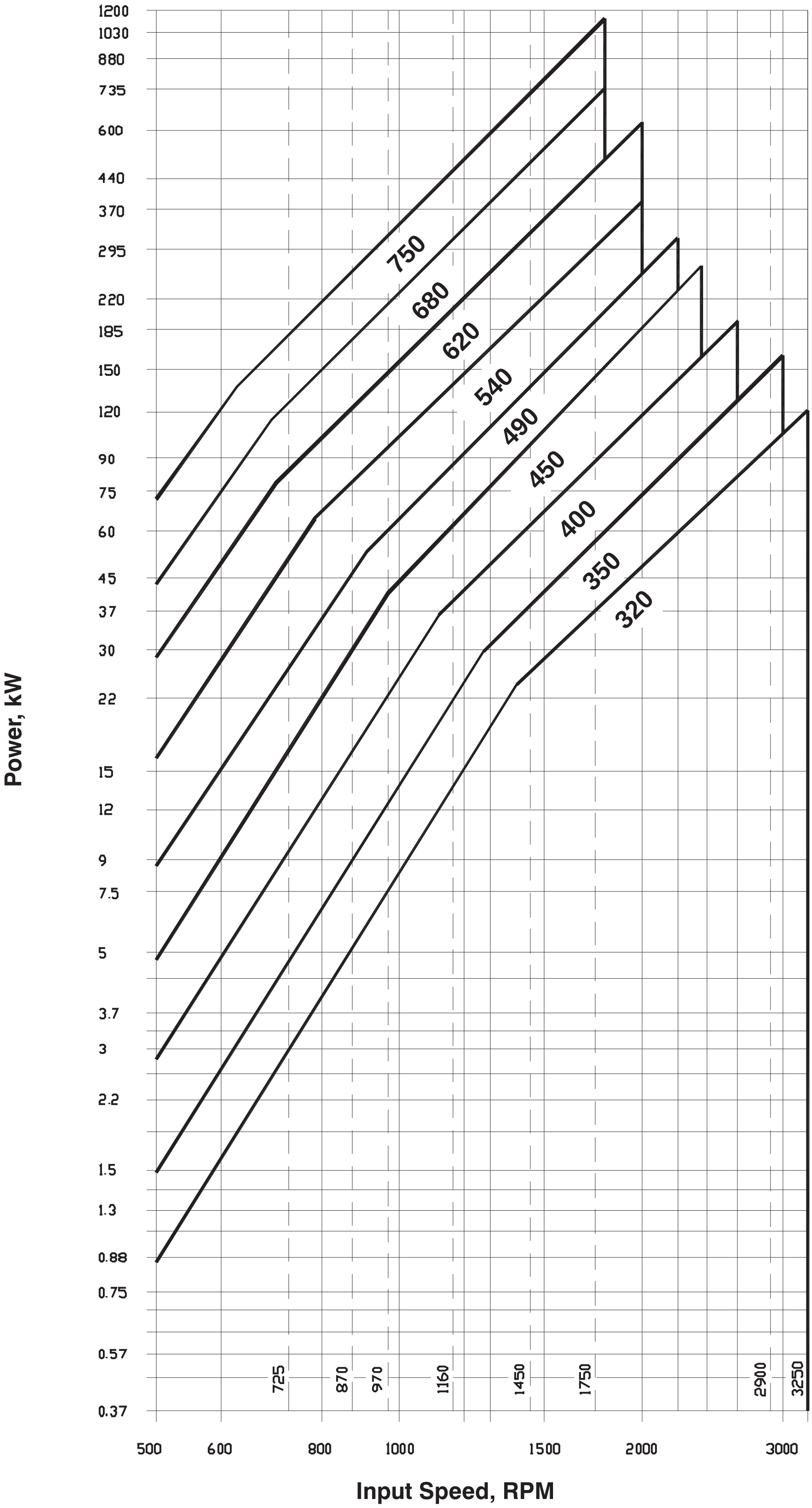
7.1 WATER FILL FLUID COUPLING

LOVEJOY Fluid Coupling has developed a version of water fill fluid coupling in order to meet the demands of environment friendly products as well as couplings suitable for working in hazardous zone and underground mines.

The water to be used is a mixture of water and glycole. The water fill couplings are available upon request on all design from size 350 upwards; they have the same overall dimensions of standard couplings series. **A suffix "W" identifies the coupling suitable for treated water operation (e.g. CFD 350 RB W)**

8.1 SELECTION CHART

The chart below may be used to select a unit size from the kW and input speed.
If the selection point falls on a size limit line dividing one size from the other, it is advisable to select the larger size with a proportionally reduced oil fill.



8.2 SELECTION TABLE

Fluid coupling for standard electric motors.

2P MOTOR (3000 RPM)			
TYPE	SHAFT DIA	KW	COUPLING
80	19	0.75	CONSULT RATHI
		1.1	
90S	24	1.5	
90L	24	2.2	
100L	28	3	
		-	320
112M	28	4	
132S	38	5.5	
		7.5	
132M	38	-	
		-	
160M	42	11	
		15	
160L	42	18.5	
180M	48	22	
180L	48	-	-
200L	55	30	320
		37	
225S	60	-	-
225M	55	45	320
250M	60	55	350
280S	65	75	
280M	65	90	
315S	65	110	
315M	65	132	
		160	-
355S	80	200	-
355M	80	250	-

4P MOTOR (1500 RPM)			
TYPE	SHAFT DIA	KW	COUPLING
80M	19	0.55	CONSULT RATHI
		0.75	
90S	24	1.1	
90L	24	1.5	
100L	28	2.2	
		3	
112M	28	4	320
132S	38	5.5	
		-	
132M	38	7.5	
		-	
160M	42	11	
		-	
160L	42	15	
180M	48	18.5	
180L	48	22	
200L	55	30	350
		-	
225S	60	37	
225M	60	45	400
250M	65	55	
280S	75	75	450
280M	75	90	
315S	80	110	490
315M	80	132	
		160	540
		200	
355S	100	250	620
355M	100	315	
		510	680
		810	750

6P MOTOR (1000 RPM)			
TYPE	SHAFT DIA	KW	COUPLING
80M	19	0.37	CONSULT RATHI
		0.55	
90S	24	0.75	
90L	24	1.1	
100L	28	1.5	
		-	
112M	28	2.2	320
132S	38	3	
		-	
132M	38	4	
		5.5	
160M	42	7.5	
		-	
160L	42	11	350
180M	48	-	-
180L	48	15	400
200L	55	18.5	
		22	
225S	60	-	-
225M	60	30	450
250M	65	37	490
280S	75	45	
280M	75	55	540
315S	80	75	
315M	80	90	620
		110	
		132	
355S	100	160	680
355M	100	200	750
		250	
		370	750

NB: The fluid coupling size is tied to the motor shaft dimension.

8.3 PERFORMANCE CALCULTIONS

For frequent starts or high inertia acceleration, it is necessary to first carry out the following calculations. For this purpose it is necessary to know:

Pm	- input power	kW
nm	- input speed	rpm
P_L	- power absorbed by the load at rated speed	kW
n_L	- speed of driven machine	rpm
J	- inertia of driven machine	kgm^2
T	- ambient temperature	°C

The preliminary selection will be made from the selection graph Tab. **A** depending upon input power and speed.
Then check:

A) acceleration time
B) max allowable temperature
C) max working cycles per hour

A) **Acceleration time** t_a :

$$t_a = \frac{n_u \cdot J_r}{9.55 \cdot M_a} \quad \text{(sec) where:}$$

n_u = coupling output speed (rpm)
J_r = inertia of driven machine feddered to coupling shaft (kgm^2)
M_a = acceleration torque (Nm)

$$n_u = n_m \cdot \left(\frac{100 - S}{100}\right)$$

where S is the percent slip derived from the characteristic curves of the coupling with respect to the absorbed torque M_L.

If S is not known accurately, the following assumptions may be made for initial calculations:
4 up to size 350
3 from size 400 up to size 490
2 for all larger sizes.

$$J_r = J \cdot \left(\frac{n_L}{n_u}\right)^2$$

Note: $J = \frac{PD^2}{4}$ or $\frac{GD^2}{4}$

$$M_a = 1.65\, M_m - M_L$$

where: $M_m = \frac{9550 \cdot P_m}{N_m}$ (Nominal Torque)

$M_L = \frac{9550 \cdot P_L}{N_u}$ (Absorbed Torque)

B) **Max allowable temperature.**

For simplicity of calculation, ignore the heat dissipated during acceleration.
Coupling temperature rise during start-up is given by:

$$T_a = \frac{Q}{C} \quad (°C)$$

where: Q = heat generated during acceleration (kcal)
C = total thermal capacity (metal and oil) of coupling selected from Tab. **C** (kcal/°C).

$$Q = \frac{n_u}{10^4} \cdot \left(\frac{J_r \cdot n_u}{76.5} + \frac{M_L \cdot t_a}{8}\right) \quad \text{(kcal)}$$

The final coupling temperature reached at the end of the acceleration cycle will be:

$$T_f = T + T_a + T_L \quad (°C)$$

where: T_f = final temperature (°C)
T = ambient temperature (°C)
T_a = temperature rise during acceleration (°C)
T_L = temperature during steady running (°C)

$$T_L = 2.4 \cdot \frac{P_L \cdot S}{K} \quad (°C)$$

where: K = factor from Tab. **D**
T_f = must not exceed 150°C

C) **Max working cycles per hour H**

In addition to the heat generated in the coupling by slip during steady running, heat is also generated (as calculated above) during the acceleration period. To allow time for this heat to be dissipated, one must not exceed the max allowable number of acceleration cycles per hour.

$$H\,max = \frac{3600}{t_a + t_L}$$

where t_L = minimum working time

$$t_L = 10^3 \cdot \frac{Q}{\left(\frac{t_a}{2} + T_L\right) \cdot K} \quad \text{(sec)}$$

8.4 CALCULATION EXAMPLE

Assuming: $P_m = 20$ kW $n_m = 1450$ rpm

$P_L = 12$ kW $n_L = 700$ rpm

$J = 350$ kgm^2

$T = 25$ °C

Tab. C

THERMAL CAPACITY

size	CF kcal/°C	CFD kcal/°C	CFDD kcal/°C
320	4.2	5	
350	6	6.8	
400	9	10	10.3
450	12.8	14.6	15.8
490	15.4	17.3	19.4
540	21.8	25.4	27.5
620	29	32	33.8
680	43	50	53.9
750	56	63	66.6

Trasmission via belts.
From selection graph. on Tab. **A**, selected size is CF320.

A) **Acceleration time**

From curve T/D - 392 (supplied on request) slip S = 4%

$$n_u = 1450 \cdot \left(\frac{100 - 4}{100}\right) = 1392 \text{ rpm}$$

$$J_r = 350 \cdot \left(\frac{700}{1392}\right)^2 = 88.5 \text{ kgm}^2$$

$$M_m = \frac{9550 \cdot 20}{1450} = 131 \text{ Nm}$$

$$M_L = \frac{9550 \cdot 12}{1392} = 82 \text{ Nm}$$

$$M_L = 1,65 \cdot 131 - 82 = 134 \text{ Nm}$$

$$t_a = \frac{1392 \cdot 88.5}{9.55 \cdot 134} = 96 \text{ sec}$$

B) **Max allowable temperature**

$$Q = \frac{1392}{10^4} \cdot \left(\frac{88.5 \cdot 1392}{76.5} + \frac{82 \cdot 96}{8}\right) = 361 \text{ kcal}$$

$C = 4.2$ kcal/°C (Tab.**C**)

$$T_a = \frac{361}{4.2} = 86 \text{ °C}$$

$K = 8.9$ (Tab. **D**)

$$T_L = 2.4 \cdot \frac{12 \cdot 4}{8.9} = 13 \text{ °C}$$

$$T_f = 25 + 86 + 13 = 124 \text{ °C}$$

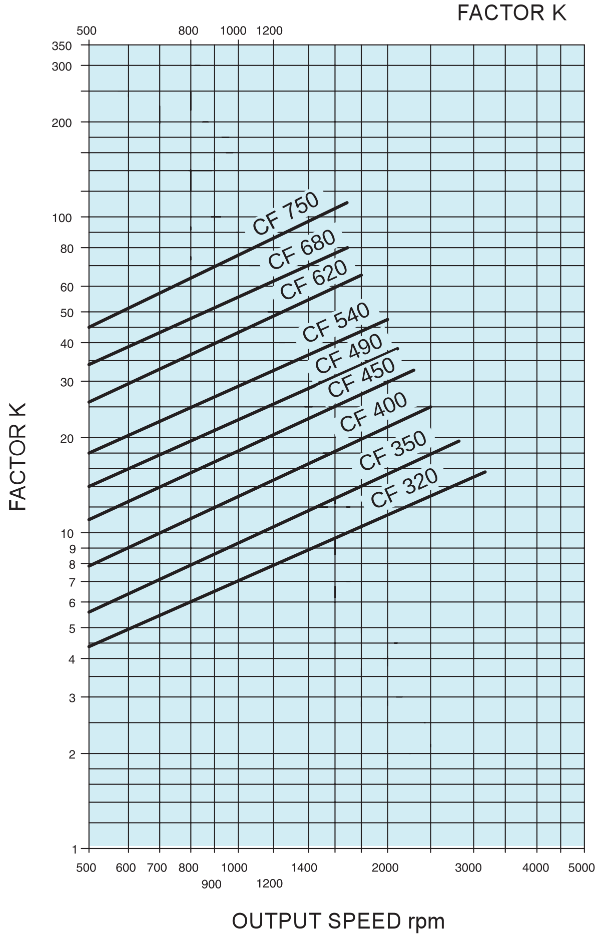
C) **Max working cycles per hour**

$$t_L = 10^3 \cdot \frac{361}{\left(\frac{86}{2} + 13\right) \cdot 8.9} = 724 \text{ sec}$$

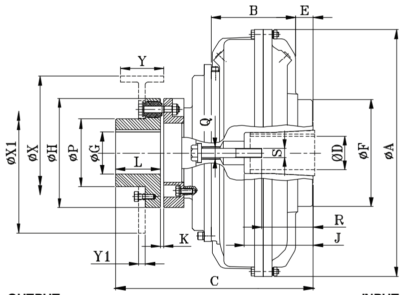
$$H = \frac{3600}{96 + 724} = 4 \text{ starts per hour}$$

Tab. **D**

FACTOR K

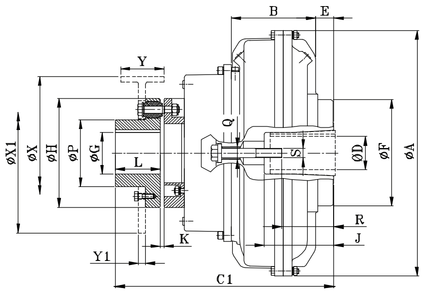


FLUID COUPLING WITH PIN BUSH COUPLING



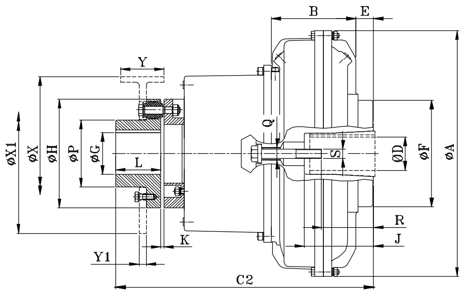
OUTPUT INPUT

CF RB



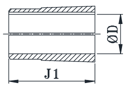
OUTPUT INPUT

CFD RB



OUTPUT INPUT

CFDD RB



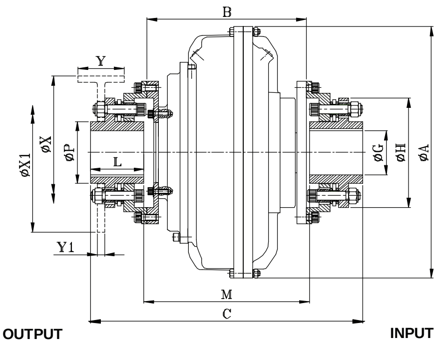
TAPER BUSH

Sizes	ØD		J		J1		ØA	B	C	C1	C2	E	ØF	Q	R		S		RB Size	ØG Max	ØH	ØP	L	K	Brake Drum ØX-Y	Brake Disc ØX1-Y1	Weight kg (without oil)			Oil max (litre)		
																											CF	CFD	CFDD	CF	CFD	CFDD
320	28	38	111		60	80	372	122	273	307	-	24	145	M20	42	56	M10	M12	144	50	144	82	55	6	160-60 200-75	on request	21.8	23	-	4.1	4.8	-
	42***	48***			80	110									83		M16															
350	42	48	143		110		398	137	329	349	-	28	179	M27	84		M16		178	70	178	105	70	6	200-75 250-95	400-30 450-30	36.2	36.7	-	5.2	5.8	-
	55***	60***			110	58.5									74	104	M20															
400	48	55	145		110		460	151	387	415	465	35	206		80	70	M16	M20	228	90	228	133	90	7	250-95 315-118	400-30 450-30	60.5	61.3	69	7.65	8.6	9.3
	60	65***			140										100		M20															
450	48	55	145		110		520	170	415	455	535	37	225		80		M16	M20	252	105	252	156	100	7	315-118 400-150	445-30 450-30	81.1	82.6	91.6	11.7	13.6	14.9
	60	65***			140										103		M20															
	75*	80*	140	170	-										103	133																
490	48	55	145		110		565	190				17			80		M16	M20									88.1	89.6	98.6	14.2	16.5	18.5
	60	65***			140										103		M20															
	75*	80*	140	170	-										103	133																
540	80*	90	170		-		620	205	483	526	615	45	250	M36	130		M20	M24	285	115	285	170	110	7	400-150 500-190	560-30 630-30 710-30 795-30	128.5	128.7	136.7	19	23	31
	100**		210		-				518	561	650	80			165		M24															
620	80*	90	170		-		714	229	483	526	615	21			130		M20	M24									146.5	146.7	154.7	28.4	31.2	39
	100**		210		-				518	561	650	56			165		M24															
680	120 max		210 max		-		780	278	566	623	723	6	315	M45	167 (For max bore)		M24 (For max bore)		360	135	360	212	140	8	500-190	710-30 795-30	243.1	233.4	262.4	42	50	61
750	135 max		240 max		-		860	295	595	652	752	18	350														296.1	296.4	306.4	55	63	73

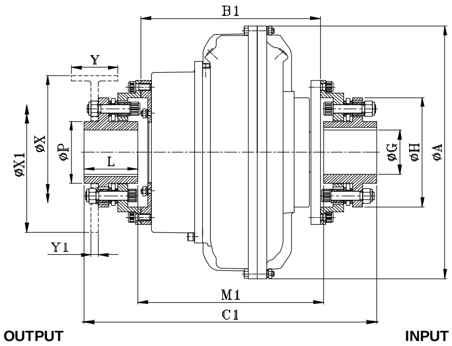
NOTES-

1) For Sizes 320-490; `D' Bores relative to taper bushes with a keyway according to ISO 773 - DIN 6885/1.
2) For Sizes 540-750; `D' Bores with a keyway according to ISO 773 - DIN 6885/1.
3) * - Cylindrical bore without taper bush with a keyway according to ISO 773-DIN 6885/1.
4) ** - Cylindrical bore without taper bush with a reduced keyway according to DIN 6885/2.
5) *** - Taper bush without keyway.
6) Special Brake Drum & Brake Disc available on request.
7) Weights are at maximum bores.

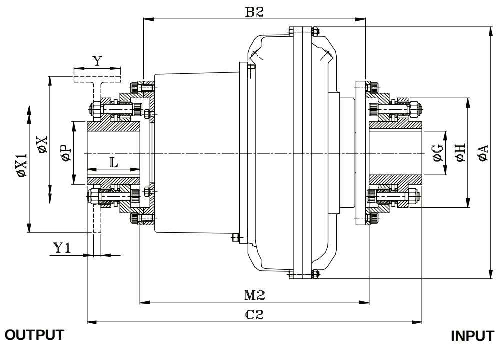
FLUID COUPLING WITH DISC COUPLING



CF LM



CFD LM

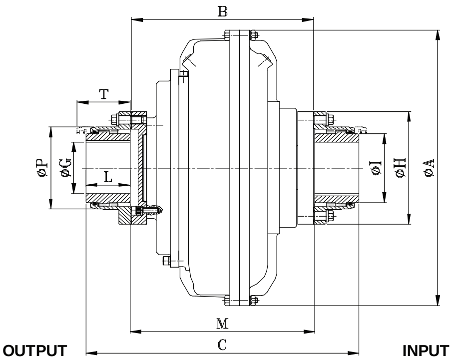


CFDD LM

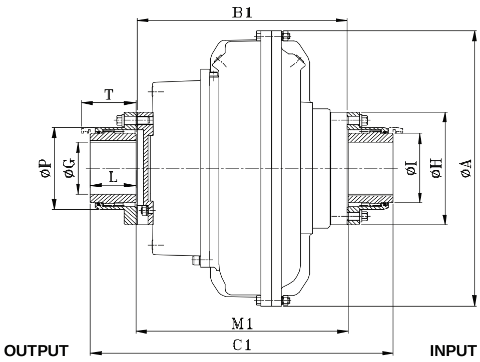
Sizes	ØA	B	B1	B2	C	C1	C2	LM Size	ØG Max	ØH	ØP	L	M	M1	M2	Brake Drum ØX-Y	Brake Disc ØX1-Y1	Weight kg (without oil)			Oil max (litre)		
																		CF	CFD	CFDD	CF	CFD	CFDD
320	372	216	250	-	359	393	-	220	52	146	77	68.5	222	256	-	160-60 200-75	on request	35.4	36.5	-	4.1	4.8	-
350	398	252	272	-	415	435	-	400	65	176	94	78	259	279	-	200-75 250-95	400-30 450-30	54.1	54.6	-	5.2	5.8	-
400	460	280	308	358	467	495	545	520	80	197	113	88	291	319	369	250-95 315-118	400-30 450-30	79.5	80.3	88	7.65	8.6	9.3
450	520	303	343	423	518	558	638	1000	90	225	128	102	314	354	434	315-118 400-150	445-30 450-30	117.7	119.1	128.1	11.7	13.6	14.9
490	565																	124.7	126.1	135.1	14.2	16.5	18.5
540	620	375	418	507	658	701	790	2500	115	300	158	140	378	420	510	400-150 500-190	560-30 630-30 710-30 795-30	221.3	221.5	229.5	19	23	31
620	714																	239.3	239.5	247.5	28.4	31.2	39
680	780	422	479	579	705	762	862		115	300	158	140	425	482	582	500-190	710-30 795-30	301	291.3	320.3	42	50	61
750	860	451	508	608	734	791	891						454	511	611			354	354.3	364.3	55	63	73

NOTES-

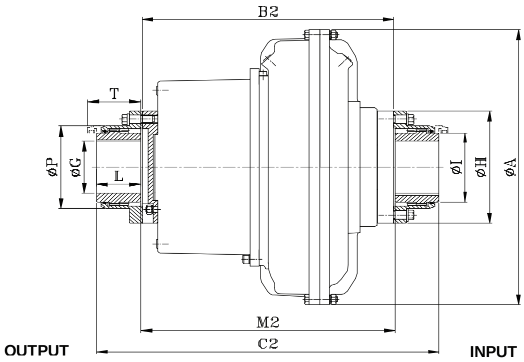
1) Special Brake Drum & Brake Disc available on request.
2) Weights are at maximum bores.



CF GD



CFD GD

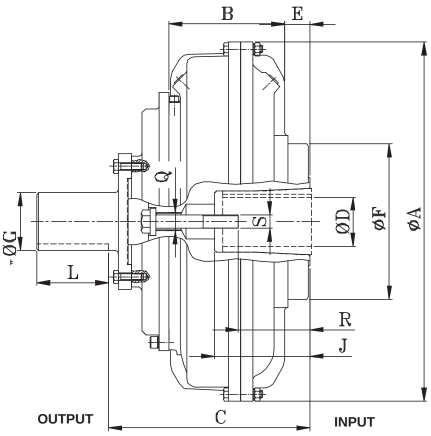


CFDD GD

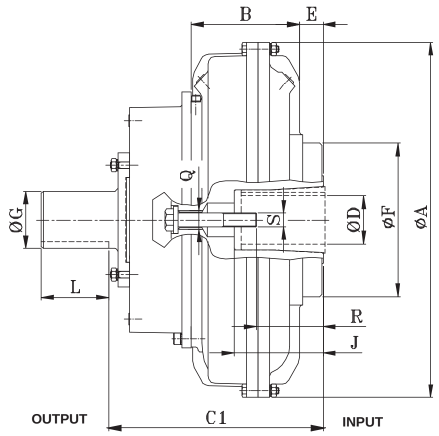
Sizes	ØA	B	B1	B2	C	C1	C2	RGD Size	ØG Max	ØH	ØP	ØI	L	T	M	M1	M2	Weight kg (without oil)			Oil max (litre)		
																		CF	CFD	CFDD	CF	CFD	CFDD
320	372	229.6	263.6	-	332.6	366.6	-	15	65	152	107	86	50	61	232.6	266.6	-	30.3	31.4	-	4.1	4.8	-
350	398	262.1	282.1	-	365.1	385.1	-								265.1	285.1	-	40.0	40.5	-	5.2	5.8	-
400	460	293	321	371	452	480	530	25	98	213	156	131	77	92	298	326	376	72.8	73.6	81.3	7.65	8.6	9.3
450	520	317	357	437	476	516	596								322	362	442	89.3	90.8	99.8	11.7	13.6	14.9
490	565																	96.3	97.8	106.8	14.2	16.5	18.5
540	620	376	419	508	563	606	695	30	115	240	182	152	91	106	381	423	513	135.7	135.9	143.9	19	23	31
620	714																	153.7	153.9	161.9	28.4	31.2	39
680	780	472	529	629	692	749	849	35	135	279	212	178	107	130	478	535	635	253.2	243.5	272.5	42	50	61
750	860	501	558	658	721	778	878								507	564	664	306.2	306.5	316.5	55	63	73

NOTES-
1) Weights are at maximum bores.

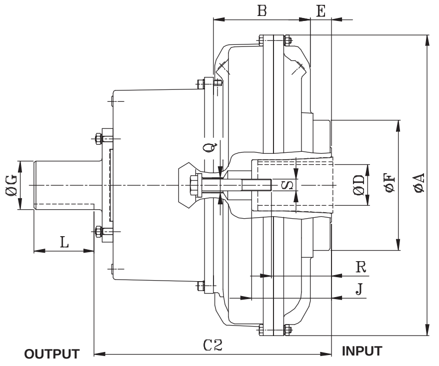
FLUID COUPLING WITH SHAFT



CF S



CFD S

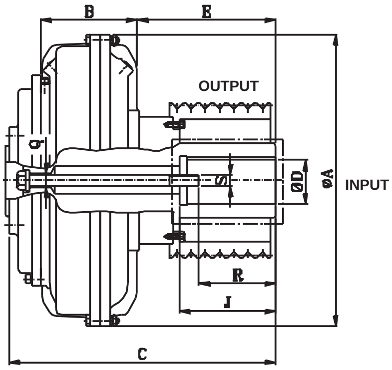


CFDD S

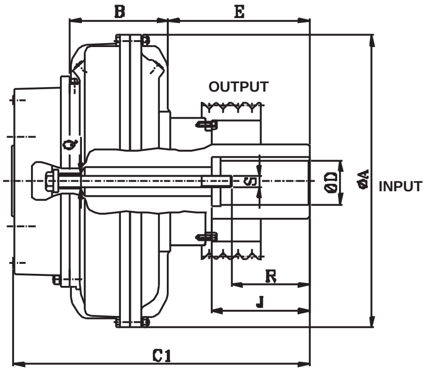
<table>
<tr><th rowspan="2">Sizes</th><th rowspan="2" colspan="2">ØD</th><th rowspan="2" colspan="2">J</th><th rowspan="2" colspan="2">J1</th><th rowspan="2">ØA</th><th rowspan="2">B</th><th rowspan="2">C</th><th rowspan="2">C1</th><th rowspan="2">C2</th><th rowspan="2">E</th><th rowspan="2">ØF</th><th rowspan="2">Q</th><th rowspan="2" colspan="2">R</th><th rowspan="2" colspan="2">S</th><th rowspan="2">ØG</th><th rowspan="2">L</th><th colspan="3">Weight kg (without oil)</th><th colspan="3">Oil max (litre)</th></tr>
<tr><th>CF</th><th>CFD</th><th>CFDD</th><th>CF</th><th>CFD</th><th>CFDD</th></tr>
<tr><td rowspan="2">320</td><td>28</td><td>38</td><td rowspan="2" colspan="2">111</td><td>60</td><td>80</td><td rowspan="2">372</td><td rowspan="2">122</td><td rowspan="2">268</td><td rowspan="2">301</td><td rowspan="2">-</td><td rowspan="2">24</td><td rowspan="2">145</td><td rowspan="2">M20</td><td>42</td><td>56</td><td>M10</td><td>M12</td><td rowspan="2">42</td><td rowspan="2">50</td><td rowspan="2">18.5</td><td rowspan="2">19.7</td><td rowspan="2">-</td><td rowspan="2">4.1</td><td rowspan="2">4.8</td><td rowspan="2">-</td></tr>
<tr><td>42***</td><td>48***</td><td>80</td><td>110</td><td colspan="2">83</td><td colspan="2">M16</td></tr>
<tr><td rowspan="2">350</td><td>42</td><td>48</td><td rowspan="2" colspan="2">143</td><td colspan="2">110</td><td rowspan="2">398</td><td rowspan="2">137</td><td rowspan="2">320</td><td rowspan="2">340</td><td rowspan="2">-</td><td rowspan="2">28</td><td rowspan="2">179</td><td rowspan="10">M27</td><td colspan="2">84</td><td colspan="2">M16</td><td rowspan="2">48</td><td rowspan="2">60</td><td rowspan="2">28.8</td><td rowspan="2">29.3</td><td rowspan="2">-</td><td rowspan="2">5.2</td><td rowspan="2">5.8</td><td rowspan="2">-</td></tr>
<tr><td>55***</td><td>60***</td><td>110</td><td>58.5</td><td>74</td><td>104</td><td colspan="2">M20</td></tr>
<tr><td rowspan="2">400</td><td>48</td><td>55</td><td rowspan="2" colspan="2">145</td><td colspan="2">110</td><td rowspan="2">460</td><td rowspan="2">151</td><td rowspan="2">365</td><td rowspan="2">393</td><td rowspan="2">443</td><td rowspan="2">35</td><td rowspan="2">206</td><td>80</td><td>70</td><td>M16</td><td>M20</td><td rowspan="2">60</td><td rowspan="2">80</td><td rowspan="2">43.6</td><td rowspan="2">44.4</td><td rowspan="2">52.1</td><td rowspan="2">7.65</td><td rowspan="2">8.6</td><td rowspan="2">9.3</td></tr>
<tr><td>60</td><td>65***</td><td colspan="2">140</td><td colspan="2">100</td><td colspan="2">M20</td></tr>
<tr><td rowspan="3">450</td><td>48</td><td>55</td><td rowspan="2" colspan="2">145</td><td colspan="2">110</td><td rowspan="3">520</td><td rowspan="3">170</td><td rowspan="6">404</td><td rowspan="6">444</td><td rowspan="6">524</td><td rowspan="3">37</td><td rowspan="6">225</td><td colspan="2">80</td><td>M16</td><td>M20</td><td rowspan="6">75</td><td rowspan="6">100</td><td rowspan="3">62.7</td><td rowspan="3">64.1</td><td rowspan="3">73.1</td><td rowspan="3">11.7</td><td rowspan="3">13.6</td><td rowspan="3">14.9</td></tr>
<tr><td>60</td><td>65***</td><td colspan="2">140</td><td colspan="2">103</td><td rowspan="2" colspan="2">M20</td></tr>
<tr><td>75*</td><td>80*</td><td>140</td><td>170</td><td colspan="2">-</td><td>103</td><td>133</td></tr>
<tr><td rowspan="3">490</td><td>48</td><td>55</td><td rowspan="2" colspan="2">145</td><td colspan="2">110</td><td rowspan="3">565</td><td rowspan="3">190</td><td rowspan="3">17</td><td colspan="2">80</td><td>M16</td><td>M20</td><td rowspan="3">69.7</td><td rowspan="3">71.1</td><td rowspan="3">80.1</td><td rowspan="3">14.2</td><td rowspan="3">16.5</td><td rowspan="3">18.5</td></tr>
<tr><td>60</td><td>65***</td><td colspan="2">140</td><td colspan="2">103</td><td rowspan="2" colspan="2">M20</td></tr>
<tr><td>75*</td><td>80*</td><td>140</td><td>170</td><td colspan="2">-</td><td>103</td><td>133</td></tr>
<tr><td rowspan="2">540</td><td>80*</td><td>90</td><td colspan="2">170</td><td colspan="2">-</td><td rowspan="2">620</td><td rowspan="2">205</td><td>492</td><td>535</td><td>624</td><td>45</td><td rowspan="4">250</td><td rowspan="4">M36</td><td colspan="2">130</td><td>M20</td><td>M24</td><td rowspan="4">90</td><td rowspan="4">120</td><td rowspan="2">109.3</td><td rowspan="2">109.5</td><td rowspan="2">117.5</td><td rowspan="2">19</td><td rowspan="2">23</td><td rowspan="2">31</td></tr>
<tr><td colspan="2">100**</td><td colspan="2">210</td><td colspan="2">-</td><td>527</td><td>570</td><td>659</td><td>80</td><td colspan="2">165</td><td colspan="2">M24</td></tr>
<tr><td rowspan="2">620</td><td>80*</td><td>90</td><td colspan="2">170</td><td colspan="2">-</td><td rowspan="2">714</td><td rowspan="2">229</td><td>492</td><td>535</td><td>624</td><td>21</td><td colspan="2">130</td><td>M20</td><td>M24</td><td rowspan="2">127.3</td><td rowspan="2">127.5</td><td rowspan="2">135.5</td><td rowspan="2">28.4</td><td rowspan="2">31.2</td><td rowspan="2">39</td></tr>
<tr><td colspan="2">100**</td><td colspan="2">210</td><td colspan="2">-</td><td>527</td><td>570</td><td>659</td><td>56</td><td colspan="2">165</td><td colspan="2">M24</td></tr>
<tr><td>680</td><td colspan="2">120 max</td><td colspan="2">210 max</td><td colspan="2">-</td><td>780</td><td>278</td><td>561</td><td>618</td><td>718</td><td>6</td><td>315</td><td rowspan="2">M45</td><td rowspan="2" colspan="2">167 (For max bore)</td><td rowspan="2" colspan="2">M24 (For max bore)</td><td rowspan="2">100</td><td rowspan="2">140</td><td>195.7</td><td>186</td><td>215</td><td>42</td><td>50</td><td>61</td></tr>
<tr><td>750</td><td colspan="2">135 max</td><td colspan="2">240 max</td><td colspan="2">-</td><td>860</td><td>295</td><td>590</td><td>647</td><td>747</td><td>18</td><td>350</td><td>248.7</td><td>249</td><td>259</td><td>55</td><td>63</td><td>73</td></tr>
</table>

NOTES-
1) For Sizes 320-490; `D' Bores relative to taper bushes with a keyway according to ISO 773 - DIN 6885/1.
2) For Sizes 540-750; `D' Bores with a keyway according to ISO 773 - DIN 6885/1.
3) * - Cylindrical bore without taper bush with a keyway according to ISO 773-DIN 6885/1.
4) ** - Cylindrical bore without taper bush with a reduced keyway according to DIN 6885/2.
5) *** - Taper bush without keyway.
6) Weights are at maximum bores.

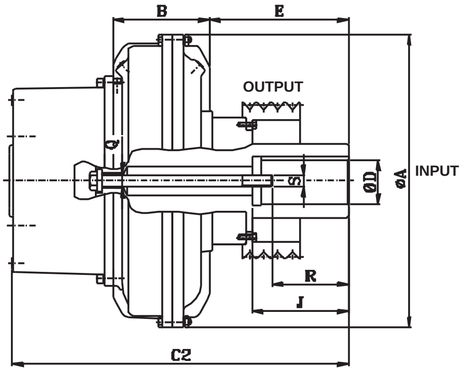
FLUID COUPLING WITH PULLEY



CF P



CFD P



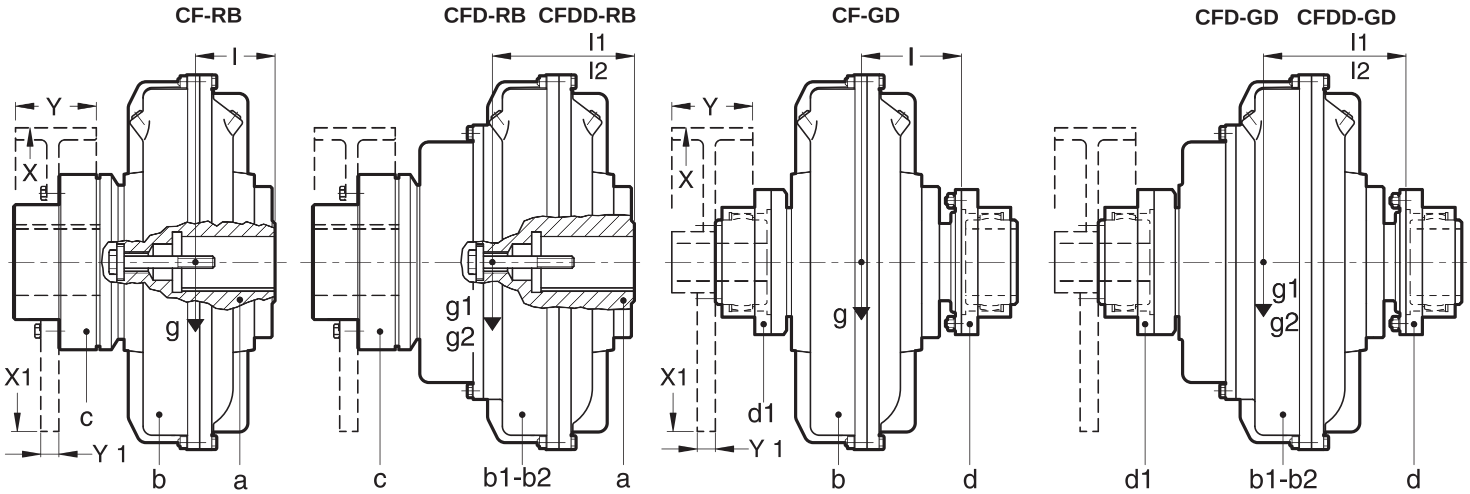
CFDD P

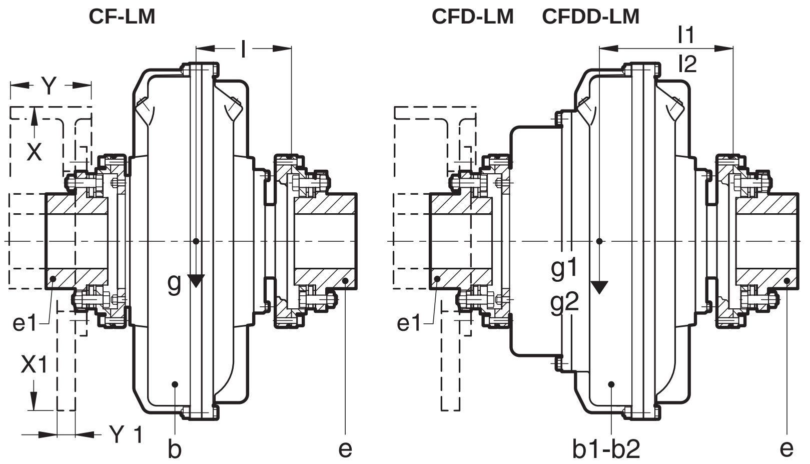
Sizes	ØD		J		J1		ØA	B	C	C1	C2	E	Q	R		S		Weight kg (without oil)			Oil max (litre)		
																		CF	CFD	CFDD	CF	CFD	CFDD
320	38	42	113		80	110	372	122	288	327	-	125	M20	54	83	M12	M16	20.8	22	-	4.1	4.8	-
	48***				110									83		M16							
350	42	48	144		110		398	137	382	407	-	190	M27	76		M16		33.5	34	-	5.2	5.8	-
	55***	60***			110	58.5								76	106	M20							
400	48	55	145		110		460	151	405	438	488	195		80	70	M16	M20	49.2	50	57.5	7.65	8.6	9.3
	60	65***			140									100		M20							
450	48	55	145		110		520	170	471	516	596	245		69		M20		78.6	80	89	11.7	13.6	14.9
	60	65***			140									99									
	75*	80*	140	170	-									99	139								
490	48	55	145		110		565	190				225		69				86.6	88	97	14.2	16.5	18.5
	60	65***			140									99									
	75*	80*	140	170	-									99	139								
540	80*		170		-		620	205	532	580	670	260	M36	135		M20		119.8	120	128	19	23	31
	100**		210		-				572	620	710	300		165		M24							
620	80*		170		-		714	229	532	580	670	236		135		M20		136.8	137	145	28.4	31.2	39
	100**		210		-				572	620	710	276		165		M24							
680	120 max		210		-		780	278	Consult Rathi														

NOTES-

1) For Sizes 320-490; `D' Bores relative to taper bushes with a keyway according to ISO 773 - DIN 6885/1.
2) For Sizes 540-680; `D' Bores with a keyway according to ISO 773 - DIN 6885/1.
3) * - Cylindrical bore without taper bush with a keyway according to ISO 773-DIN 6885/1.
4) *** - Taper bush without keyway.
5) Weights are at maximum bores.

CENTER OF GRAVITY
MOMENT OF INERTIA





Dimensions

Size	MOMENT OF INERTIA With brake drum X - Y	kgm²	Weight kg	With brake disc X_1 - Y_1	kgm²	Weight kg
350-400	250 -95	0.143	11.9	400	0.587	27
	315 -118	0.379	20.1	450	0.944	34.9
450-490	315 -118	0.378	19.8	450	0.941	34.2
				500	1.438	43
	400 -150	1.156	37.5	560	2.266	54.7
540-620	400 - 150	1.201	39.9	560	2.255	52.7
				630	3.623	68.1
	500 - 190	3.033	64.1	710	5.856	88
				795	9.217	111.6
680-750	500 - 190	3.022	62.8	710	5.840	86
				795	9.200	109.6
				800	9.434	111.1

Dimensions

Size	CENTER OF GRAVITY CF-RB g Kg	CF-RB l mm	CFD-RB g_1 Kg	CFD-RB l_1 mm	CFDD-RB g_2 Kg	CFDD-RB l_2 mm	CF-GD g Kg	CF-GD l mm	CFD-GD g_1 Kg	CFD-GD l_1 mm	CFDD-GD g_2 Kg	CFDD-GD l_2 mm	CF-LM g Kg	CF-LM l mm	CFD-LM g_1 Kg	CFD-LM l_1 mm	CFDD-LM g_2 Kg	CFDD-LM l_2 mm
320	25.1	142	28.7	154			32.1	98	35.6	113			29.6	92	33.2	104		
350	38.5	157	42	176			42.2	104	45.7	115			45.8	101	49.3	109		
400	57	174	61.8	195	70.2	216	77.3	124	82.1	135	90.4	147	71.7	121.5	76.6	130	85.7	145
450	87.2	205	94.8	225	106.5	238	85.3	138	103.1	152	126.6	185	99.2	135	106.9	145	118.3	163
490	96.4	201	104.4	221	116	227	104.6		112.6		136	182	106.4		116.4		127.4	161
540	145.6	233	159	265	169.3	288	151.2	157	164.5	174	200.2	211	175.6	156	189	168	201	182
620	172	227	184	255	195.3	280	177.2		190.2	170	225.2	201	202		214.3	166	226	178
680	265	262	290	298	313	312	276.2	185	304.2	210	361.2	248	326	164	351	174	378	195
750	329	277	354	305	368	321	344.2	198	359.2	218	415.2	251	383	176	411	188	432	200

MOMENT OF INERTIA J kgm² ..CF.. a	b	b_1	b_2	CF-RB c	CF-GD d	CF-GD d_1	CF-LM e	CF-LM e_1
0.072	0.189	0.217		0.011	0.017	0.016	0.014	0.014
0.122	0.307	0.359		0.032			0.032	0.036
0.236	0.591	0.601	0.887	0.082	0.091	0.102	0.063	0.064
0.465	1.025	1.281	1.372	0.192	0.091	0.102	0.121	0.125
0.770	1.533	1.788	1.879					
1.244	2.407	2.997	3.181	0.370	0.145	0.375	0.210	0.373
2.546	4.646	5.236	5.420					
3.278	7.353	9.410	10.37	1.350	0.500	0.436	0.934	0.887
4.750	11.070	13.126	13.754					

g g1 g2 = TOTAL WEIGHT, INCLUDING OIL (MAX FILL)
* For **CF-I** (without pulley) = a + b
* For **CFD-I** (without pulley) = a + b1
* For **CFDD-I** (without pulley) = a + b2

a = INTERNAL ELEMENT b = EXTERNAL ELEMENT + COVER
b1 = b + DELAY CHAMBER b2 = b + DOUBLE DELAY CHAMBER
c FLEXIBLE COUPLING
d e = HALF FLEXIBLE COUPLING (INTERNAL ELEMENT)
d1 e1 = HALF FLEXIBLE COUPLING (EXTERNAL ELEMENT)
EXAMPLE: J..CFDD-GD = a+d (INT. ELEM.) b2+d1 (EXT. ELEM.)

DIMENSIONS ARE SUBJECT TO ALTERATION WITHOUT NOTICE

10. FILLING

LOVEJOY hydraulic couplings are supplied without oil. Standard filling: X for CF series, 2 for CFD series, and 3 for CFDD series.

The quantities are indicated on page 13 to 16 of this catalog. Follow the procedure indicated on Installation and Maintenance manuals delivered with each coupling.

Suggested oil: **ISO32 HM** for normal operating temperatures. For temperatures down zero, **ISO FD 10 (SAE 5W)** and for temperatures lower than -20°C contact RATHI.

11. SAFETY DEVICES

FUSIBLE PLUG

In case of overloads, or when slip reaches very high values, oil temperature increases excessively, damaging oil seals and conseguently allowing leakage.

To avoid damage when used in severe applications, it is advisable to fit a fusible plug. Fluid couplings are supplied with a fusible plug at 140°C (109°C, 120°C or 198°C upon request).

SWITCHING PIN

Oil venting from fusible plug may be avoided with the installation of a switching pin. When the temperature reaches the melting point of the fusible ring element, a pin releases that intercepts a relay cam that can be used for an alarm or stopping the main motor. As for the fusible plug, 2 different fusible rings are available.

11.1 SWITCHING PIN DEVICE

This device includes a percussion fusible plug installed on the taper plug. The percussion fusible plug is made of a threaded plug and a pin hold by a fusible ring coming out due to the centrifugal force when the foreseen melting temperature is reached. Such increase of temperature can be due to overload, machinery blockage or insufficient oil filling. The pin, moving by approx. 16 mm, intercepts the cam of the switch to operate an alarm or motor trip signal.

After a possible intervention and removal of the producing reason, this device can be easily restored with the replacement of the percussion plug or even the fusible ring following the specific instructions included in the instruction manual.

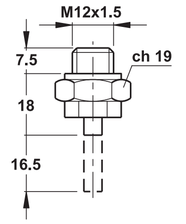
With external wheel as driver, as indicated in Fig. 5, the percussion plug operates in any condition, while in case of driven external wheel it can operate correctly only in case of increase of the slip due to overload or excessive absorption.

It is possible to install this system on all fluid couplings starting from size CF350 even in case it has not been included as initial supply, asking for a kit including percussion fusible plug, gasket, modified taper plug, counterweight for balancing, glue, lever switch assembly installation instructions.

In order to increase the safety of the fluid coupling a standard fusible plug is always installed, set at a temperature greater than that of the percussion fusible plug.

For a correct operation, please refer to the instructions relevant to the standard or reverse installation described at page 6.

- Lever switch standard supply 240 Vac
- Upon request: Atex version
- Switching pin available: see below tab



ELECTRONIC OVERLOAD CONTROLLER

This device consists of a proximity sensors measuring the speed variation between the input and output of the fluid coupling and giving an alarm signal or stopping the motor in case the set threshold is overcome.

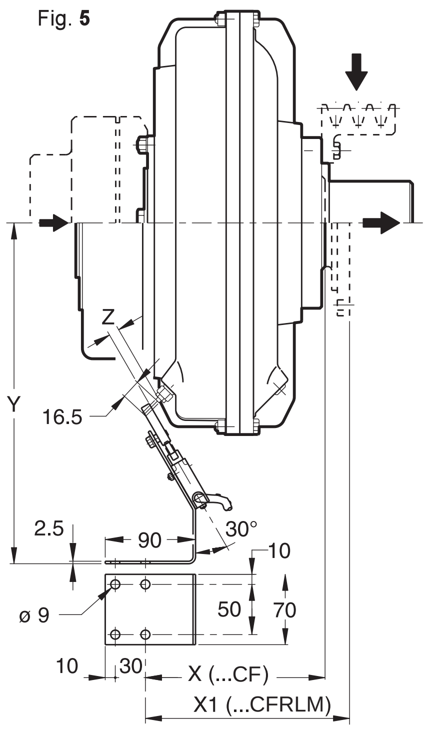
With such a device, as well as with the infrared temperature controller, no further maintenance or repair intervention is necessary after the overload occupance, because the machinery can operate normally, once the cause of the inconvenience has been removed (see page 19).

INFRARED TEMPERATURE CONTROLLER

To measure the operating temperature, a device fitted with an infrared sensor is available. After conveniently positioning it by the fluid coupling, it allows a very precise non-contact temperature measurement.

Temperature values are reported on a display that also allows the setting of 2 alarm thresholds, that can be used by the customer (see page 20).

Fig. **5**



DIM.	X	X_1	Y	Z
320	157	173	323	15
350	174	187	335	16
400	197	214	358	16
450	217	235	382	12
490	209	227	400.5	9
540	•257	277	423	8
620	•257	277	460	4
680	271.5	295	491	9
750	296.5	322	524	8

• For Dia. 100 + 35 mm
•• For Dia. 100 + 40 mm
••• Only for CF.. (CFD.. upon request)
REFERENCE DIMENSIONS

11.2 OVERLOAD CONTROLLER (Fig. 6)

When load torque increases, slip also increases and output speed consequently decreases.
The said speed variation can be measured by means of a sensor sending a pulse train to the speed controller. If the rotating speed goes lower than the set threshold (see diagram) on the controller, a signal is given through the intervention of the inner relay.
The device has a "TC" timer with a blind time before starting (1 - 120 s) avoiding the alarm intervention during the starting phase, and another "T" timer (1 – 30 s) preventing from undesired relay intervention during sudden changes of torque.
The device also provides a speed proportional analogic output signal (0 – 10 V), that can be forwarded to a display or a signal transducer (4 – 20 mA).
Standard supply is 240 V ac, other supplies are available upon request: 115 V ac, 24 V ac or 24 V dc, to be specified with the order.
Atex version is available too.

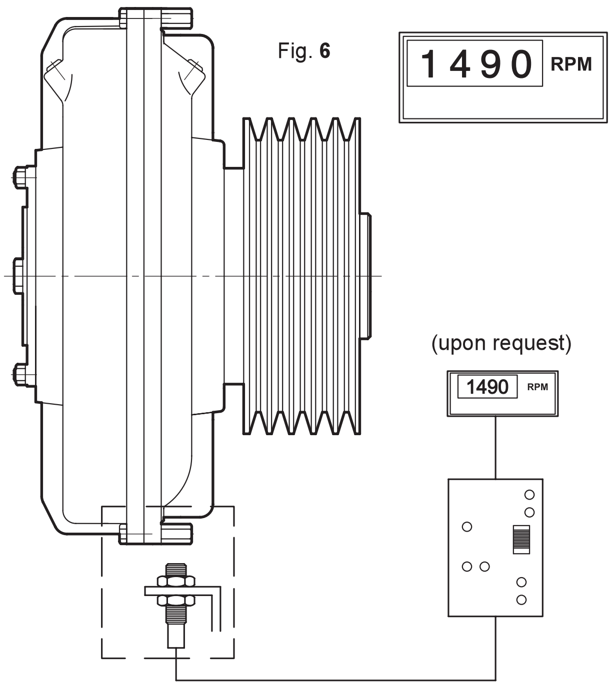


Fig. 6

CONTROLLER PANEL (Fig. 7)

TC Blind time for starting

Set screw regulation up to 120 s

DS Speed range regulation

Programmable DIP-SWITCH (5 positions), selecting relay status, roximity type, reset system, acceleration or deceleration.
Programming speed Dip-Switch with 8 positions allows to choose the most suitable speed range, according to the application being performed.

SV Speed level (set point)

Set screw regulation with digits from 0 to 10. The value 10 corresponds to full range set with Dip-Switch.

R Reset

Local manual reset is possible through R button, or remote reset by connecting a N.O. contact at pins 2-13.

SS Threshold overtaking

(RED LED) It lights up every time that the set threshold (set point) is overtaken.

A Alarm led

(RED LED) It lights up when alarm is ON and the inner relay is closed.

E Enable

(YELLOW LED) It lights up when the device is enabled.

T Delay time

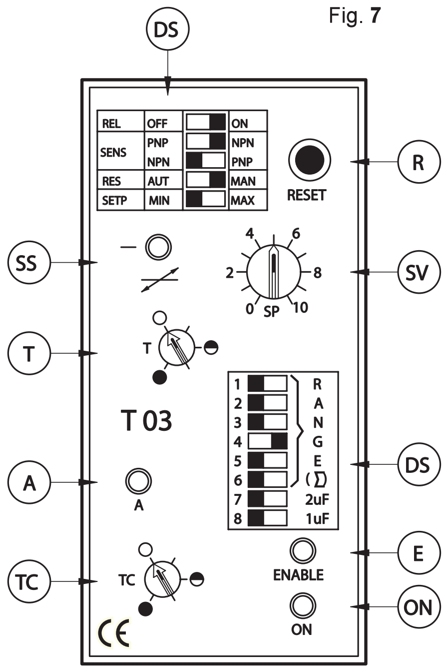
Set screw regulation up to 30 s.

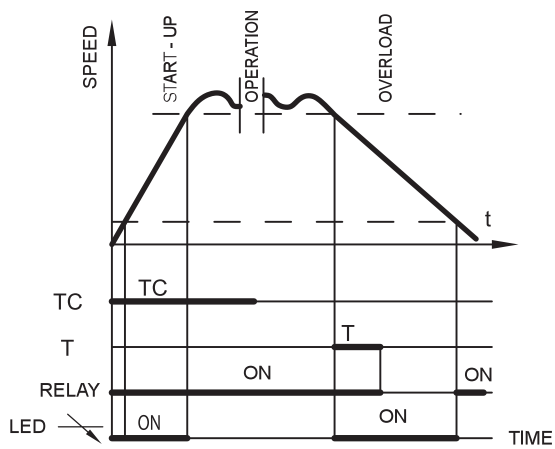
ON Supply

(GREEN LED) It shows that the device is electrically supplied.

FOR FURTHER DETAILS, ASK FOR TF 5800-A.

Fig. 7





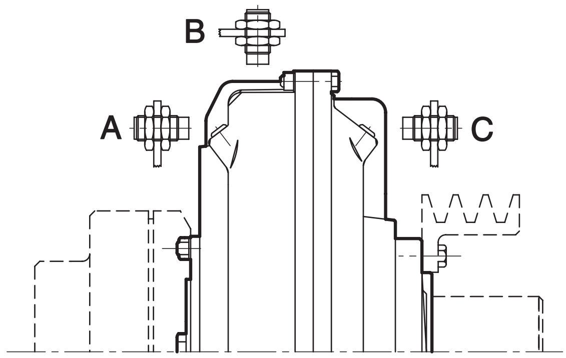
Diagram

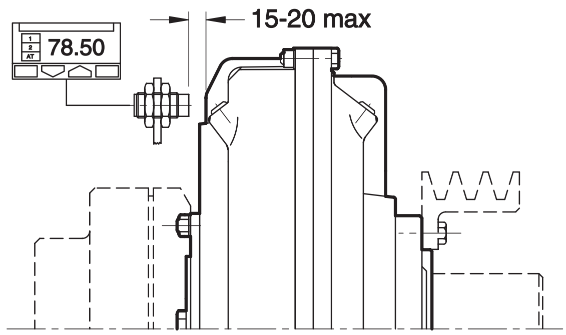
11.3 INFRARED TEMPERATURE CONTROLLER

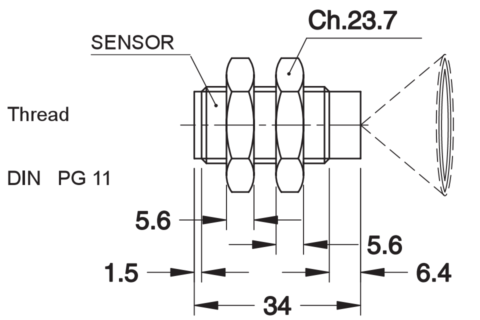
This is a non contact system used to check fluid coupling temperature. It is reliable and easily mounted.
It has 2 adjustable thresholds with one logical alarm and one relay alarm.

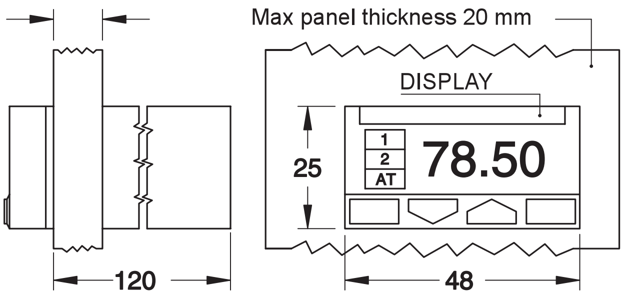
The proximity sensor must be positioned near the fluid coupling outer impeller or cover, according to one of the layouts shown in Fig. **8**.
It is advised to place it in the **A** or **C** positions, as the air flow generated by the fluid coupling, during rotation, helps removal dirt particles that may lay on the sensor lens.
The distance between the sensor and the fluid coupling must be about 15-20 mm (cooling fins do not disturb the correct operation of the sensor).
To avoid that the bright surface of the fluid coupling reflects light, and thus compromises a correct temperature reading, it is necessary to paint the surface, directly facing the sensor with a flat black colour (a stripe of 6-7 cm is sufficient).
The sensor cable has a standard length of 90 cm. If required, a longer one may be used only if plaited and shielded as per type “K” thermocouples.

Fig. **8**







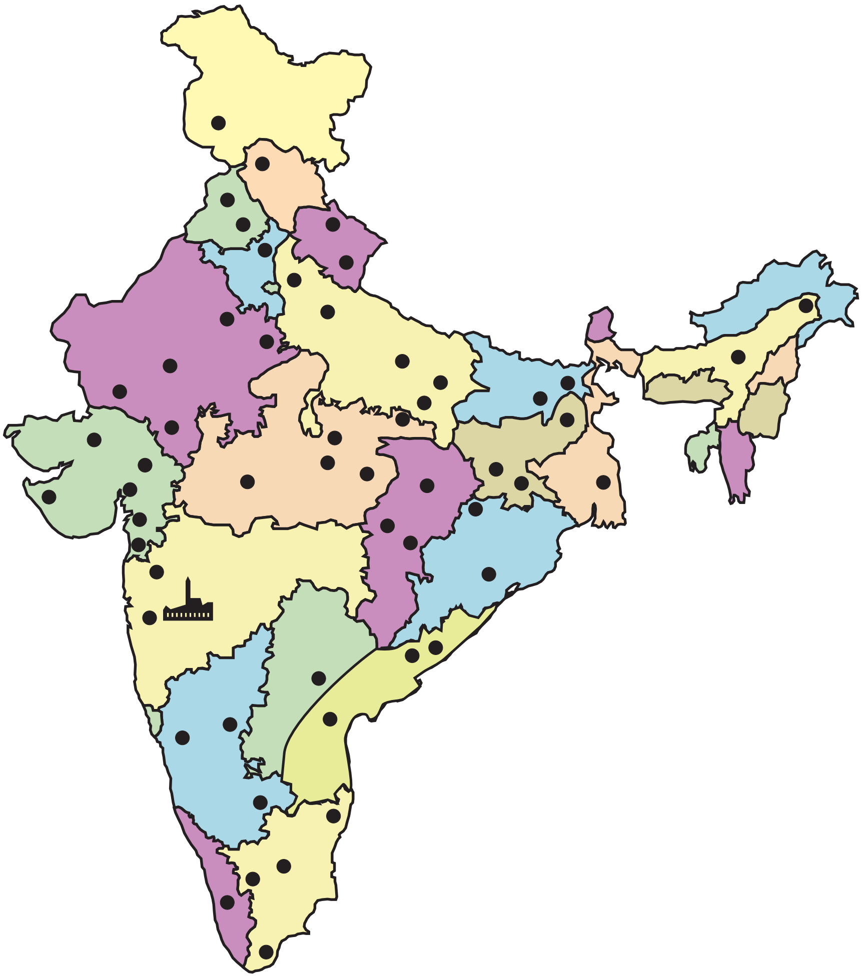


SENSOR	
Temperature range	0 ÷ 200 °C
Ambient temperature	- 18 ÷ 70 °C
Accuracy	0.0001 °C
Dimensions	32.5 x 20 mm
Standard wire lenght •	0.9 m
Body	ABS
Protection	IP 65
CONTROLLER	
Power supply	85...264 Vac / 48...63 Hz
Relay output OP1	No (2A - 250 V)
Logical output OP2	Not insulated
(5Vdc, ±10%, 30 mA max)	
AL1 alarm (display)	Logic (OP2)
AL2 alarm (display)	Relay (OP1) (NO, 2A / 250Vac)
Pins protection	IP 20
Body protection	IP 30
Display protection	IP 65
Dimensions	1/32 DIN – 48x24x120 mm
Weight	100 gr

• TO BE MADE LONGER WITH TWISTED AND SHIELDED WIRES FOR TYPE K THERMOCOUPLES (NOT SUPPLIED)

RATHI

Lovejoy INDIA



ZONE EAST	ZONE NORTH	ZONE SOUTH	ZONE WEST	ZONE CENTRAL
Kolkata (W.B)	Kanpur (U.P)	Banglore (Karnataka)	Ahmedabad (Gujarat)	Raipur (CH)
Guwahati (Assam)	Lucknow (U.P)	Chennai (TN)	Baroda (Gujarat)	Bhilai (CH)
Sibsagar (Assam)	Varanasi (U.P)	Coimbatore (TN)	Vapi (Gujarat)	Korba (CH)
Jamshedpur (Jhd)	Allahbad (U.P)	Cochin (Kerala)	Surat (Gujarat)	Indore (M.P)
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Patna (Bihar)	Haridwar (Uttarakhand)	Tuticorin (TN)	Mumbai (Maharashtra)	Waidhan (M.P)
Ranchi (Jharkhand)	Panipat (Haryana)	Hubli (Karnataka)	Udaipur (Rajasthan)	Singrauli (M.P)
Dibrugarh (Assam)	Gurgaon (Haryana)	Hospet (Karnataka)	Jaipur (Rajasthan)	**ZONE MAHARASHTRA**
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Bokaro (Jharkhand)	Delhi	Karimnagar (TL)	Bhiwadi (Rajasthan)	
	Ludhiyana (Punjab)	Vijaywada (A.P)		
	Rudrapur (Uttarakhand)	Gajuwaka (A.P)		

In technical collaboration with TRANSFLUID S.p.A, Italy

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