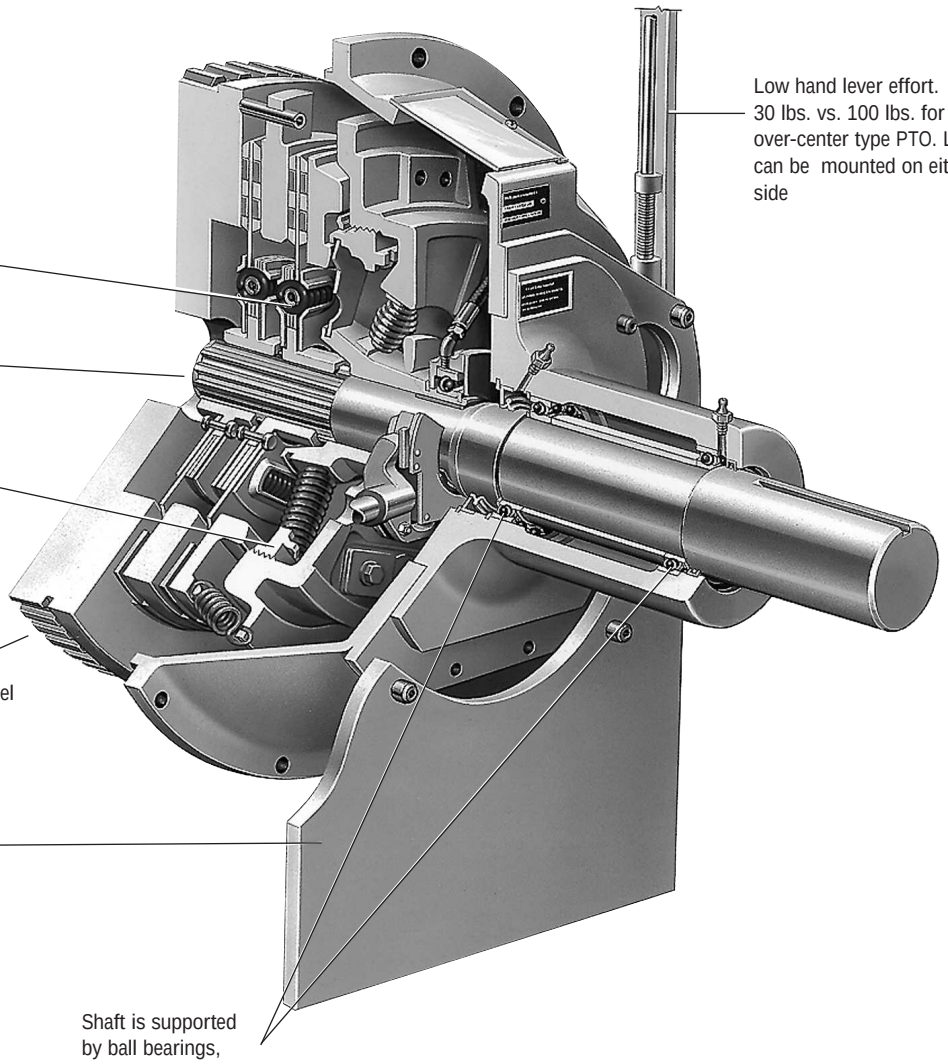
Power Take-Off Clutches

Mechanical design

In-Line

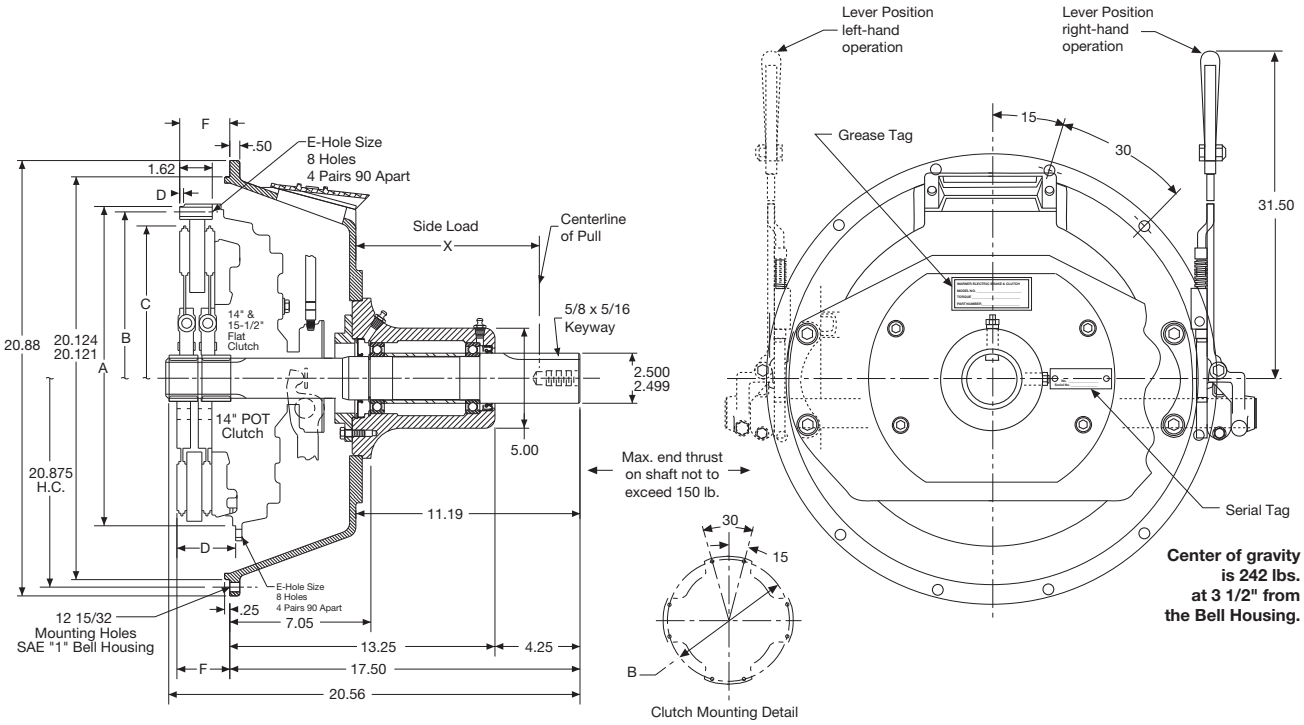


Design Features

- Side Load version incorporates a rugged cylindrical roller bearing system which eliminates trouble-prone pilot bearings. Provides 100% external support of take-off shaft. Prevents transmission of side loads that fatigue or even damage the engine crankshaft.
- Precise alignment capabilities of the bearing system ensure flywheel/clutch concentricity to minimize effects of diesel engine torsional vibration.
- Performance-proven Fuller Solo Spring clutch provides easy engagement. Axial load is provided by three pairs of springs placed at an angle to the clutch centerline, reducing required axial force as the clutch is disengaged. The discs are raced with trapezoidal ceramic buttons, and are dampened with an assembly of coaxial springs mounted in the disc hub.
- Dampened clutch discs prevent torsional vibrations from damaging engine or components.
- Available in 2 sizes, from 14" to 15 1/2" for engines up to 420 HP @ 2100 RPM.

Mechanical In-line PTO (Truck Flywheel)

Size 14" Flat, 14" Pot & 15-1/2" Flat



Dimensions inches

Clutch Size	SAE Bell Housing	A Pilot (+.000/-.002) in.	B Hole Circle	C Plate Dia.	D	E Hole Size – Qty		F
14" Flat	1	16.50*	15.500	13.56	N/A	13/32	8	2.62
14" Pot	1	14.750	15.500	13.75	2.94	13/32	8	2.50
15-1/2" Flat	1	17.155	16.625	15.22	0.19	15/32	8	2.50

* Nominal diameter only, clutch is not piloted.

Center of gravity is 242 lbs. located 3.50" from bell housing mounting surface

Estimated Side Load Calculation

$$\#1 \quad L = \frac{126{,}000 \times HP}{N \times D} \times F \times SF$$

$$\#2 \quad L = \frac{1{,}945{,}000 \times kW}{N \times D} \times F \times SF$$

L = Actual Applied Load (lbs. for #1 and kgs for #2)
N = Shaft Speed (RPM)
D = Pitch Diameter (in. for #1 and mm for #2) of Sheave
F = Load Factor
- 1.0 for Chain Drive or Gear Drive
- 1.5 for Timing Belts
- 2.5 for All V-belts
- 3.5 for All Flat Belts

SF = Service Factor
- 2.1 for Reciprocating Compressors and other severe shock drives
- 1.8 for Large Inertia Drives such as Crushers, Chippers, and Planers

Allowable Side Load (lbs.) at 1,800 RPM

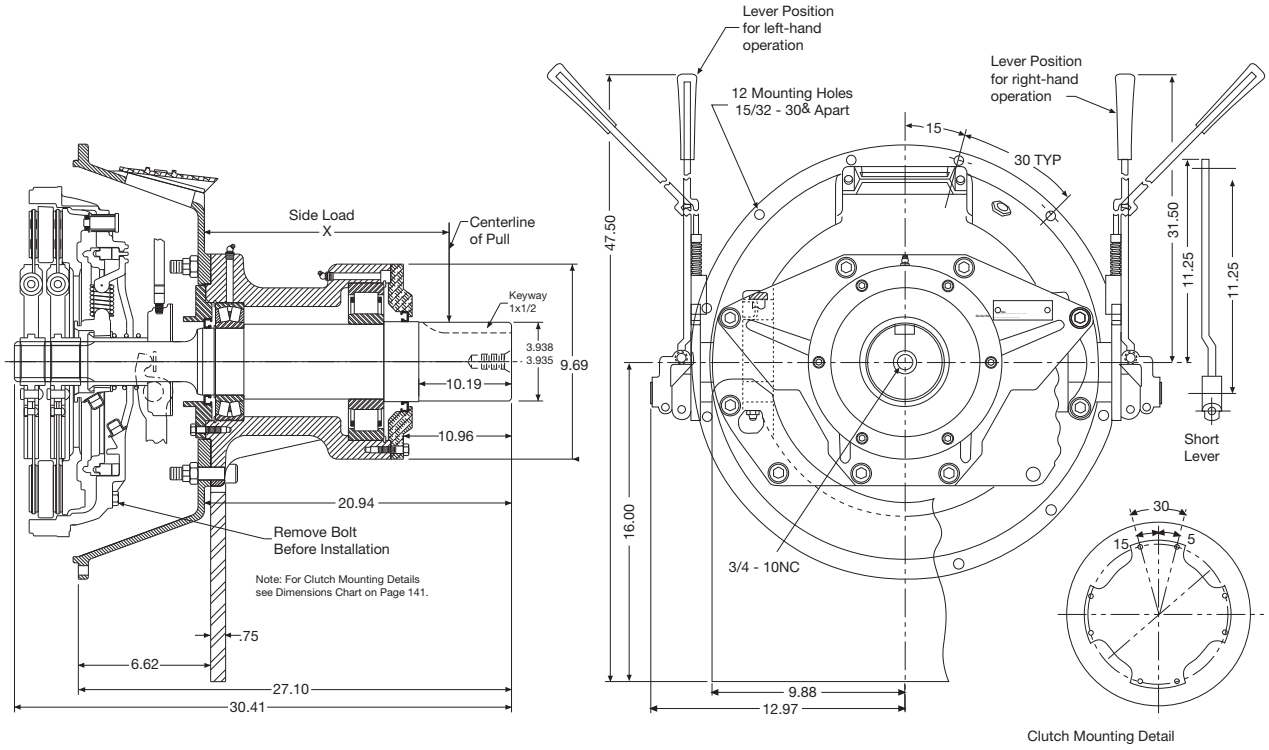
X Distance from Bell Housing	Side Load (lbs.) B_{10} Bearing LIfe
3.62	1,600
4.62	1,100
5.62	850
6.62	680
7.62	565
8.62	450
9.62	400
10.26	370
11.25	340

At 2,100 RPM, derate side load by 20%.

Note: It is recommended that the optional support plate be used in side load applications.

Mechanical Side Load PTO (Truck Flywheel)

Size 15-1/2" Flat



Clutch Size	Engine Manufacturers Common Truck Flywheels*		
	Caterpiller	Cummins	Detroit
14" Pot		FW1101	5129650 5101878
15-1/2" Flat	9N3136 4W6800	FW1134	5138863

* Check with engine manufacturer for flywheel compatibility.

Allowable Side Load (lbs.)

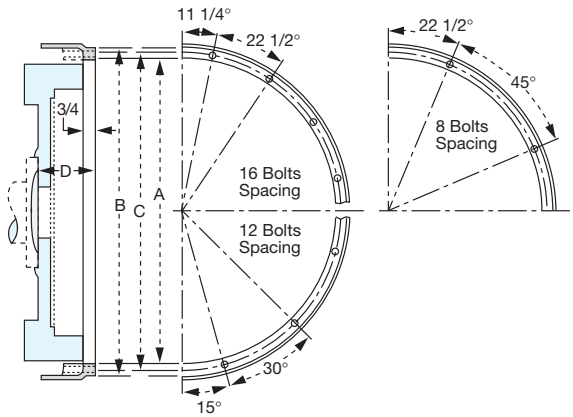
X Dimension	RPM 1000	1200	1800	2200	2400
11 in.	11,100	10,700	9,500	8,900	8,200
12 in.	10,000	9,500	8,500	8,000	7,400
13 in.	9,000	8,600	7,600	7,200	6,600
14 in.	8,200	7,800	7,000	6,500	6,100
15 in.	7,500	7,000	6,300	6,000	5,600
16 in.	7,000	6,600	5,800	5,500	5,300
17 in.	6,400	6,100	5,400	5,100	4,800
18 in.	6,000	5,700	5,000	4,700	4,400
19 in.	5,600	5,300	4,700	4,400	4,200
20 in.	5,400	5,200	4,500	4,200	4,000

Engine Flywheel Housing SAE Standards

SAE Size No.	A in.	B in.	Bolt Circle C in.	D in.	Tapped Holes No.	Tapped Holes Size
00	31.000/31.010	34-3/4	33-1/2	3-15/16	16	1/2-13
0	25.500/25.510	28	26-3/4	3-15/16	16	1/2-13
1/2	23.000/23.008	25-1/2	24-3/8	3-15/16	12	1/2-13
1	20.125/20.130	21-3/4	20-7/8	3-15/16	12	7/16-14
2	17.625/17.630	19-1/4	18-3/8	3-15/16	12	3/8-16
3	16.125/16.130	17-3/4	16-7/8	3-15/16	12	3/8-16
4	14.250/14.255	15-7/8	15	3-15/16	12	3/8-16
5	12.375/12.380	14	13-1/8	2-13/16	8	3/8-16
6	10.500/10.505	12-1/8	11-1/4	2-13/16	8	3/8-16

For flywheel standards consult the SAE standards manual.

Note: For mounting, use socket head capscrews conforming to the ASTM-574-97a. Support plate must be perpendicular to side load pull.



Specifications

Clutch Size	Torque* lb.in. (Nm)	Flywheel Bore Opening in.(cm)	Spline Dia. and Number of Splines in. - qty	Duty A to B[1] Light and Normal HP/100 RPM	Duty C to D[1] Heavy and Extra Heavy HP/100 RPM	Max. Speed RPM	Max. Slip Sec.
14" Flat (109504-10) Solo	10,800 (1,220)	7 (17.8)	2" - 10	17	13	2100	3
14" Pot[3] (108050-59) EP	16,800 (1,898)	7 (17.8)	2" - 10	27	20	2100	3
15-1/2" Flat (109701-74) Solo	19,800 (2,237)	8.5 (21.6)	2" - 10	32	20	2100	3
15-1/2" Flat HC** (109701-15) Solo	24,600 (2,779)	10 (25.4)	2" - 10	39	20	2100	3
15-1/2" Flat SHC*** (109706-32Y) Solo	27,000 (3,051)	10 (25.4)	2" - 14	43	22	2100	3

* On C & D duty applications, Clutch Torque must exceed Engine's Peak torque

** 15-1/2" Flat, high capacity clutch model – available upon request.

*** 15-1/2" Flat, super high capacity clutch model – available upon request and with a minimum quantity of 4.

Power Take Off Chart

PTO Clutch	Flywheel Type	Type	SAE Bell Housing	Parts List Number	Drawing Number
14" Flat	Truck†	Inline	1	Available	Consult Factory
14" Flat	Truck†	Inline	2	6-714-299-210-0	6-714-202-915-9
14" Flat	Truck†	Side Load	1	6-714-299-211-0	6-714-202-916-9
14" Flat	Truck†	Side Load	2	6-714-299-209-0	6-714-202-914-9
14" Pot	Truck†	Inline	1	6-714-299-104-0	6-714-200-911-9
14" Pot	Truck†	Inline	2	6-714-299-105-0	6-714-200-910-9
15-1/2" Flat	Truck†	Inline	1	6-715-299-206-0	6-715-202-909-9
15-1/2" Flat	Truck†	Inline	2	6-715-299-207-0	6-715-202-910-9
15-1/2" Flat HC	Truck†	Inline	1	6-715-299-229-0	6-715-202-909-9
15-1/2" Flat	Truck†	Side Load	1	6-715-299-208-0	6-715-202-912-9
15-1/2" Flat	14" Industrial	Inline	1	6-715-299-209-0	6-715-202-913-9
15-1/2" Flat	14" Industrial	Side Load	1	6-715-299-221-0	6-715-202-918-9
15-1/2" Flat	18" Industrial	Side Load	0	See[2]	Consult Factory

† Alternately referred to as a "Vehicular" flywheel.

Conversion Kits	Flywheels	SAE Bell Housing
8-560-320-017-0	15-1/2" Truck to 14" Industrial	1 to 1
8-560-320-073-1	15-1/2" Truck to 18" Industrial	1 to 0

Mechanical Side Load PTO

HP Rating based on side load using 12-1/2 P.D., 8-8V groove sheave at max. SF.

Speed	Bearing Carrier	Clutch Only
1,800	200 HP	360 HP
2,100	225 HP	420 HP

[1] See chart "A", on page 117.

[2] 15-1/2" Flat, Side Load PTO uses conversion kit 8-560-320-073-1.

[3] Old style flywheel, often not available on new engines.

See Engine manufacturer for flywheel availability.

Estimated Side Load Calculation

$$\#1 \quad L = \frac{126{,}000 \times HP}{N \times D} \times F \times SF$$

$$\#2 \quad L = \frac{1{,}945{,}000 \times kW}{N \times D} \times F \times SF$$

L = Actual Applied Load (lbs. for #1 and kgs for #2)

N = Shaft Speed (RPM)

D = Pitch Diameter (in. for #1 and mm for #2) of Sheave

F = Load Factor
1.0 for Chain Drive or Gear Drive
1.5 for Timing Belts
2.5 for All V-belts
3.5 for All Flat Belts

SF = Service Factor
2.1 for Reciprocating Compressors and other severe shock drives
1.8 for Large Inertia Drives such as Crushers, Chippers, and Planers

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Selection Example:

To properly select a Power Take Off (PTO), the following information is needed:

1. Power transmission type: Inline or Side Load
2. Application engine horsepower @ speed
3. Peak engine torque
4. SAE bell housing size
5. New engine installation or retrofit to an existing engine
6. Duty selection: See chart "A", page 117
   Chart "A" gives application requirements ranging from "Light" to "Normal" duties (A to B) and "Heavy" to "Extra Heavy" duties (C to D)
7. Inertia of machine/load
8. Pitch diameters of drive and driven sheaves****
9. Width of drive sheave on Power Take Off shaft****

**** Not applicable to inline drives

Machine Requirement:

Machine Required:	Mud Pump – Triplex piston type
Installation:	New engine installation
Power Transmission Type:	Side load
HP & Speed:	300 HP @ 1,800 RPM
Engine Peak Torque:	1,120 lb.ft.
SAE Bell Housing Size:	SAE bell housing 1
PD* Driver Sheave on PTO:	12.5 in.
PD* Driven Sheave on Mud Pump:	15.0 in.
Width of Driver Sheave on PTO:	9-3/8 in. (8 grooves – 8V section Belt Sheave**)
WR^2 – Inertia of Pump:	108 lb.ft.^{2}

* PD is Pitch Diameter of sheave/pulley.
** See manufacturer for sheave details.

Calculations:

1. Application Torque = HP x 63,000/RPM = lb.in.
   300 x 63,000/1,800 = 10,500 lb.in.

2. Engine Peak Torque = lb. ft. x 12 = lb.in.
   1,120 x 12 =13,440 lb.in.

3. Mud Pump's Speed =

$$\frac{\text{Engine Speed x P.D. of PTO's sheave}}{\text{P.D. of Mud Pump's sheave}} = \text{RPM}$$

$$1{,}800 \times 12.5/15 = 1{,}500 \text{ RPM}$$

4. Reflect Pump's inertia up to PTO's shaft =

$$\text{Pump's Inertia} \times \left(\frac{\text{Pump's speed}}{\text{PTO's speed}}\right)^2 = \text{lb.ft.}^2$$

$$108 \times \left(\frac{1{,}500}{1{,}800}\right)^2 = 75 \text{ lb.ft.}^2 \text{ @ } 1{,}800 \text{ RPM}$$

5. PTO's clutch slip time, (sec.) =

$$\frac{WR^2 \times \text{PTO's speed}}{25.6 \times \text{Application Torque}}$$

$$= \frac{75 \times 1{,}800}{25.6 \times 10{,}500} = 1/2 \text{ sec.}$$

6. Estimate Side Load, (lbs.) =

$$\frac{\text{HP x 378,000}}{\text{Engines Speed x PTO's sheave PD}}$$

$$\frac{300 \times 378{,}000}{1{,}800 \times 12\text{-}1/2} = 5{,}040 \text{ lbs.}$$

How to Select:

Part 1. PTO Clutch Calculation Follows:

1. Select clutch duty from field of application =
   Reference chart "A", page 117, Petroleum production shows Mud Pump under duty "D"
2. Determine required HP/100 RPM duty capacity =
   Application torque/630 = HP/100 RPM
   10,500/630 = 16-2/3 HP/100 RPM
3. Select clutches based on duty =
   On clutch capacity chart, page 143, shows the following clutches have sufficient capacity.
   14" Pot, 15-1/2" Flat & 15-1/2" Flat HC
   a.) This is a new engine installation and Note 3 states that there may be an availability problem with the 14" Pot style clutch.
   b.) There is not an advantage in capacity to warrant the use of the 15-1/2" Flat HC style clutch. Therefore, preliminary selection of the clutch is the 15-1/2" Flat style clutch.
4. Peak torque verses clutch torque =
   On "C" and "D" duty applications, it is required that the clutch torque is greater than engine's peak torque.
   15-1/2" Flat clutch torque from clutch specifications chart on page 143 is 19,800 lb. in.
   Engine's peak torque is 13,440 lb.in.
   Clutch torque > Engine's peak torque
   19,800 lb.in. > 13,440 lb.in.
5. Speed =
   Clutch capacity chart shows that it has a speed limit of 2,100 RPM which is greater than the required speed of 1,800 RPM.
6. Clutch slip time, (sec.) =
   Clutch capacity chart shows maximum clutch slip time as 3 sec. which is greater than the calculated 1/2 seconds.

Part 2. Side Load Calculation Follows:

Center of sheave's side pull =
Sheave width/2 = (9-3/8)/2 = 4-11/16 in.

Locate dimension from Bell housing to shaft's end = 20-15/16 in.
Reference specific PTO drawing
15-1/2" Flat PTO side load, page 142.

Determine "X" distance on PTO =
(Bell hsg. to shaft's end dim.) - (Center of sheave's side pull)
(20-15/16) - (4-11/16") = 16-1/4 in.
Round "X" distance to the nearest whole number = 16 in.

Look up side load =
Check side load at PTO's speed and "X" distance
Page 142, allowable side load.
At "X" distance of 16 in. and 1,800 RPM, chart yields a side load capacity of 5,800 lbs.

Comparison on side load =
Side load capacity > Required side load
5,800 lbs. > 5,040 lbs.

Final Selection:

15-1/2 in. Flat power take off,
Side load version with SAE "1" Bell Housing

Power take off chart, page 143, lists the associated parts lists and drawings.

Parts Lists Number = 6-715-299-208-0
Drawing Number = 6-715-202-912-9