



QUAD-DRIVE & BINARY-DRIVE (POWERED & MANUAL)

PARAFLOW PLATE HEAT EXCHANGER

COMMON USER MANUAL

About this manual:

This User Manual covers information specific to the powered and manual Quad-Drive and Binary-Drive Heat Exchangers and should be read in conjunction with the general **APV Paraflow Plate Heat Exchanger Instruction Manual**, supplied separately.

We recommend that you read all sections below where your frame is shown under **APPLICABLE FRAMES** (see **KEY** to identify your specific model). However, in case of difficulty, jump to the **Troubleshooting** procedures in the following sections:

Manual	Section	Section Title	Description
APV Paraflow PHE IM	6	Startup and operation	General PHE and process issues
This User Manual	11	Screen Operation	Screen, electrical and hydraulic issues
This User Manual	12	QD/BD Maintenance	Powered frame mechanical issues

KEY TO APPLICABLE FRAMES

QDP	QUAD-DRIVE POWERED
QDM	QUAD-DRIVE MANUAL
BDP	BINARY-DRIVE POWERED
BDM	BINARY-DRIVE MANUAL

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1 Frame

A typical, powered Quad-Drive Paraflow plate heat exchanger is shown in '5 POWERED QUAD-DRIVE FRAME'. Primary components consist of a stationary head and an end support, connected by a top bar and bottom bar. These components are bolted together to form a rigid frame that supports the thin, metal, heat transfer plates, moveable follower and four tie bars. Each plate is separated by a gasket and compressed between the head and follower by rotation of four tie bars located above and below the plate pack. Liquids are introduced to the heat exchanger through connections located in the head, follower and, when supplied, connector grid(s).

For details about plate sequence, number and type of connector grids, Divider Plates (available for some models) and flow arrangement, see the plate arrangement drawing that came with your Paraflow.

When Quad-Drive Paraflows are opened, the follower is drawn back along the top bar by four, simultaneously rotating tie bars to allow full access to each heat transfer plate, Divider Plate and grid.

Quad-Drive frames, designed for sanitary duties, are fabricated from stainless steel clad carbon steel and other sanitary, corrosion resistant alloys. The finish is primarily a #4 polish with certain components receiving a glass bead blast finish. Standard connections are sanitary tube fittings at all locations. Other fittings may have been supplied to special order.

Divider Plates (available for some models) may be used to divide a heat exchanger into separate sections. Divider Plates have no connections but do allow flow from one section to the next.

Connector grids may be used to divide a heat exchanger into separate sections to accommodate multiple duties within a single frame. General details of connector grids will be found in the 'CONNECTOR GRID' section of this User Manual.

2 Frame types

Quad-Drive frames are available in both manual and powered versions. The frames are also available in a number of different lengths, called frame sizes, to accommodate the required number of plates, grids and Divider Plates.

Except for the largest sizes (eg R5 Quad-Drive frame size 5 & 6) each frame size can accommodate the same minimum number of plates (generally 3) up to the designed maximum.

All but the longest frame is designed to be expandable in length by replacement of the top bar, bottom bar and tie bars. In certain cases, other components are also replaced or added for additional strength and support

Finally, manual frames can be easily upgraded to a powered version by replacing the end support assembly. No other frame components need to be changed.

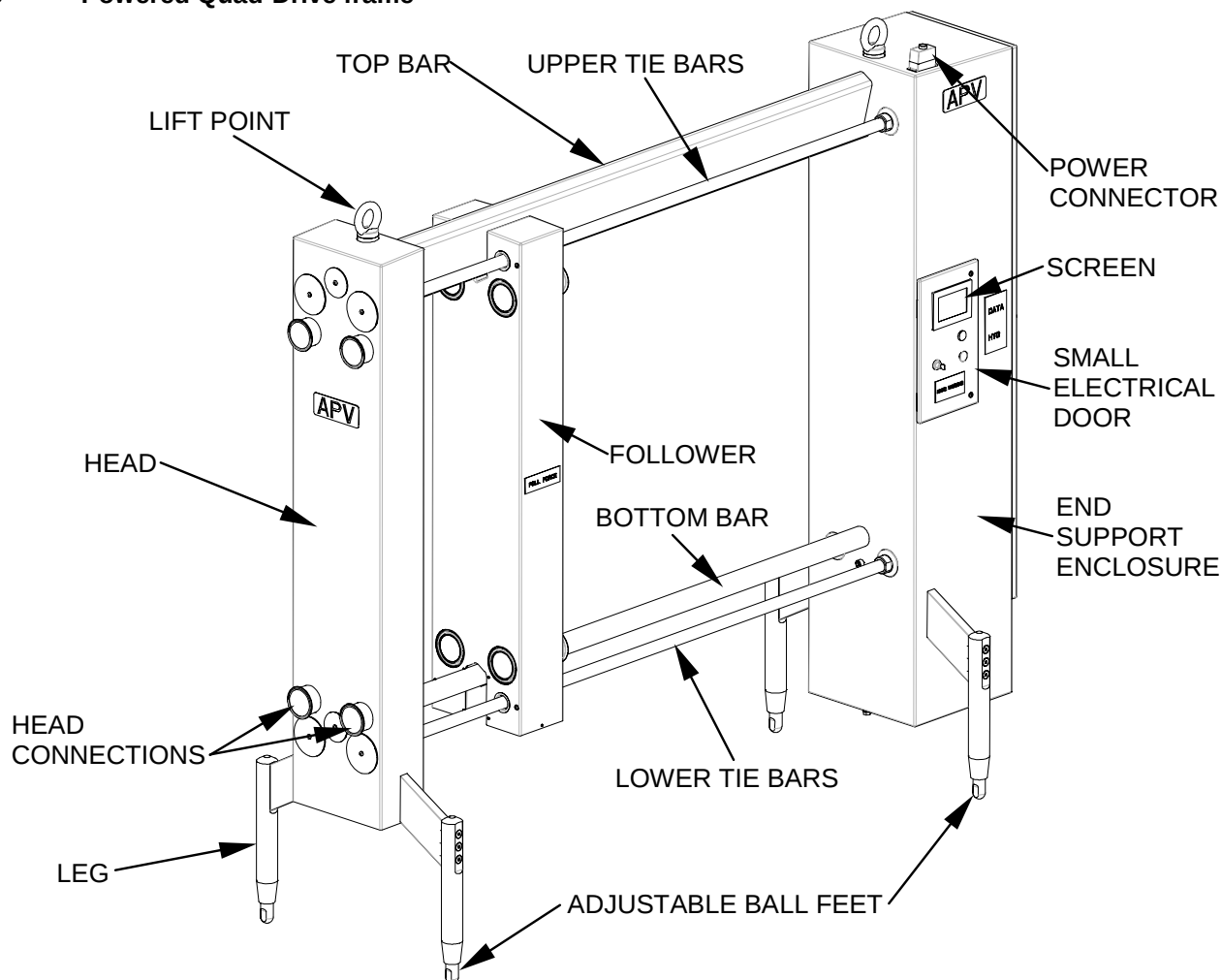
3 Manual end support

The manual end support frame is provided with two, single point closing shafts. The first, auxiliary closing shaft is located directly on one, lower tie bar. This is used to rapidly close the machine near to pitch. When tightening becomes difficult, the supplied wrench is moved to the primary closing shaft and the Paraflow finally brought to pitch. Quad-Drive technology is fully employed on the manual frame ensuring the follower remains parallel to the head at all times.

4 Powered end support

The powered Quad-Drive Paraflow provides completely automated frame opening and closing. An overall view of the powered frame is shown following. See 'ELECTRICAL SYSTEM' section for a description of the electrical system and how to connect the Quad-Drive to the power supply. See also 'HYDRAULIC SYSTEM' section for a description of the hydraulic system.

5 Powered Quad-Drive frame



6 Component items

The following PARTS TABLE lists the major frame components, including possible replacement items, together with their part numbers. A more detailed description of the majority of the assembly components is found within the 'FRAME ASSEMBLY' section. Should the need arise to replace parts for which the part number is not shown, please order by description giving quantity required together with the Paraflow name and serial number (eg: Tie bar sprocket, 4-pieces, R5 Quad-Drive Paraflow, serial number 2004XXXX).

7 Frame extensions and reductions

The following PARTS TABLE may also be used to determine the components needed to increase (or reduce) the frame size should this be necessary. Please note that certain machine parameters will need to be updated in the PLC by APV when frame sizes are changed. Quad-Drive frame extensions and reductions should only be performed by trained personnel to ensure correct disassembly and re-assembly.

8 Parts table

Description	Qty per Frame	Part Number	Remarks
Head assembly typ-2 (for FS. 1 – 4)	1	3900 1663	Includes legs and ballfeet
Head assembly typ-2 (for FS. 5 & 6)	1	3900 1638	Includes legs and ballfeet
Follower assembly	1	3900 1668	Includes slide strips but not rollers
End sup't encl. (FS.1 – 4) (460v Siemens)	1	3900 1609	Includes legs and ballfeet
End sup't encl. (FS.5 & 6) (460v Siemens)	1	3900 1619	Includes heavy duty legs and ballfeet
End sup't encl. (FS.1 – 4) (460v A/B L31)	1	3900 1607	Includes legs and ballfeet
End sup't encl. (FS.5 & 6) (460v A/B L31)	1	3900 1621	Includes heavy duty legs and ballfeet
End sup't encl. (FS.1 – 4) (460v A/B L32E)	1	3900 1909	Includes legs and ballfeet
End sup't encl. (FS.5 & 6) (460v A/B L32E)	1	3900 1911	Includes heavy duty legs and ballfeet
End support enclosure manual	1	3900 1592	Includes legs and ballfeet
Top bar 1500 long (FS.1)	1	3900 1464	Also order seal rings – 2 x 3900 1585
Top bar 2500 long (FS.2)	1	3900 1465	Also order seal rings – 2 x 3900 1585
Top bar 3500 long (FS.3)	1	3900 1466	Also order seal rings – 2 x 3900 1585
Top bar 5500 long (FS.4)	1	3900 1467	Also order seal rings – 2 x 3900 1585
Top bar 6500 long (FS.5)	1	3900 1469	Also order M36 bolts – 2 x 3900 1546 And M36 washers – 2 x 0225 8064. Also order seal ring – 2 x 3900 1585
Top bar 8000 long (FS.6)	1	3900 1471	Also order M36 bolts – 2 x 3900 1546 And M36 washers – 2 x 0225 8064. Also order seal rings – 2 x 3900 1585
Bottom bar 1500 long (FS.1)	1	3900 1475 + 3900 1269	Also order O-rings – 2 x 9041 3411
Bottom bar 2500 long (FS.2)	1	3900 1335 + 3900 1271	Also order O-rings – 2 x 9041 3411
Bottom bar 3500 long (FS.3)	1	3900 1337 + 3900 0331	Also order O-rings – 2 x 9041 3411
Bottom bar 5500 long (FS.4)	1	3900 1476 + 3900 1477	Also order O-rings – 2 x 9041 3411
Bottom bar 6500 long (FS.5)	1	3900 1684	Also order seal rings – 2 x 3900 1478
Bottom bar 8000 long (FS.6)	1	3900 1686	Also order seal rings – 2 x 3900 1478
Bottom tie bar detail (FS.1)	2	3900 1452	See Note 3
Top tie bar detail (FS.1)	2	3900 1453	See Note 3
Bottom tie bar detail (FS.2)	2	3900 1454	See Note 3
Top tie bar detail (FS.2)	2	3900 1455	See Note 3
Bottom tie bar detail (FS.3)	2	3900 1456	See Note 3
Top tie bar detail (FS.3)	2	3900 1457	See Note 3
Bottom tie bar detail (FS.4)	2	3900 1458	See Note 3
Top tie bar detail (FS.4)	2	3900 1459	See Note 3
Bottom tie bar detail (FS.5)	2	See remarks	Special linked assembly. See Note 7
Top tie bar detail (FS.5)	2	See remarks	Special linked assembly. See Note 7
Bottom tie bar detail (FS.6)	2	See remarks	Special linked assembly. See Note 7
Top tie bar detail (FS.6)	2	See remarks	Special linked assembly. See Note 7
Free nut Type-1	4	3900 1522	See Note 4
Free nut Type-2	4	3900 1677	See Note 5

Free nut Type-3	4	3900 1947	See Note 8
Tab washer	4	3900 1582	
Roller assembly	2	3056 0194	
Roller spindle	2	3056 0196	
Roller bolt (M12 x 40 csk soc. head)	2	3900 1542	
Follower slide block – Type 1	2	3900 1635	Not always fitted – see Note 1
Follower slide block – Type 2	2	3900 1654	Always fitted – see Note 2
Screw for slide block (M8 x 16 button head)	4	3900 1544	For Type-1 and Type-2
Ball foot (M42)	4	3900 1530	
Roller chain 60RIV – 84.75" inc master link	4	3900 1595	Used on powered and manual versions
Roller chain 80RIV – 55" inc master link	1	3900 1596	Use on powered versions only
M24 ratchet wrench	1	500902	
Socket wrench for 46 A/F socket	1	3900 1603	See Note 6
Socket 46 A/F	1	3900 1604	See Note 6
Drain screw for oil reservoir	1	3900 1557	M16 x 25 hex head S.S. screw
Copper washer for oil drain screw	1	3900 1558	M16

Note 1: Type-1 slide blocks (if installed) fit on followers that include the four (2 per side) M4 countersunk socket screws seen near the bottom, side edges of the follower.

Note 2: Type-2 slide blocks are always fitted on followers that have no M4 countersunk socket screws near the bottom, side edges of the follower.

Note 3: Tie bar detail part numbers are for single bars and exclude all other items (nuts, seals, bearings, keys, screws, etc). When changing frame sizes, all existing tie bar assembly parts may be reused except the Tab Washer which should be replaced and the Free Nut which, depending on usage, may also be replaced.

Note 4: Type-1 Free Nuts fit against followers that include the four (2 per side) M4 countersunk socket screws seen near the bottom, side edges of the follower.

Note 5: Type-2 Free Nuts fit against followers that have no M4 countersunk socket screws near the bottom, side edges of the follower.

Note 6: The Socket wrench and 46 A/F socket will tighten both the powered and manual versions. However, the powered Quad-Drive does not normally need this tool.

Note 7: Frame sizes 5 and 6 require a linked tie bar assembly and support arm system. Please refer to APV for the necessary parts when expanding to a frame size 5 or 6.

Note 8: Type-3 Free Nuts were introduced in August 2007 and are fully interchangeable with Type-2 Free Nuts.

9 Powered end support enclosure

For part breakdown of electrical and hydraulic systems see the following sections 'ELECTRICAL SYSTEM' and 'HYDRAULIC SYSTEM'.

1 Frame

A typical, powered Binary-Drive Paraflow plate heat exchanger is shown in '5 POWERED BINARY-DRIVE FRAME'. Primary components consist of a stationary head and an end support, connected by a top bar and bottom bar. These components are bolted together to form a rigid frame that supports the thin, metal, heat transfer plates, moveable follower and two tie bars. Each plate is separated by a gasket and compressed between the head and follower by rotation of two tie bars located above and below the plate pack. Fluids are introduced to the heat exchanger through connections located in the head, follower and, when supplied, connector grid(s).

For details about plate sequence, number and type of connector grids, Divider Plates (available for some models) and flow arrangement, see the Customer Drawing that came with your Paraflow.

When Binary-Drive Paraflows are opened, the follower is drawn back along the top bar by two, simultaneously rotating tie bars to allow full access to each heat transfer plate, Divider Plate and grid.

Binary-Drive frames are designed for sanitary duties and fabricated from stainless steel clad carbon steel and other sanitary, corrosion resistant alloys. The finish is primarily a #4 polish with certain components receiving a glass bead blast finish. Standard connections are sanitary tube fittings at all locations. Other fittings may have been supplied to special order.

Divider Plates (available for some models) may be used to divide a heat exchanger into separate sections. Divider Plates have no connections but do allow flow from one section to the next.

Connector grids may be used to divide a heat exchanger into separate sections to accommodate multiple duties within a single frame. General details of connector grids will be found in the 'CONNECTOR GRID' section of this User Manual.

2 Frame types

Binary-Drive frames are available in both manual and powered versions. The frames are also available in a number of different lengths, called frame sizes, to accommodate the required number of plates, grids and Divider Plates.

Each frame size can accommodate the same minimum number of plates (generally 3) up to the designed maximum.

All but the longest frame is designed to be expandable in length by replacement of the top bar, bottom bar and tie bars.

Finally, manual frames can be easily upgraded to a powered version by replacing the end support assembly. No other frame components need to be changed.

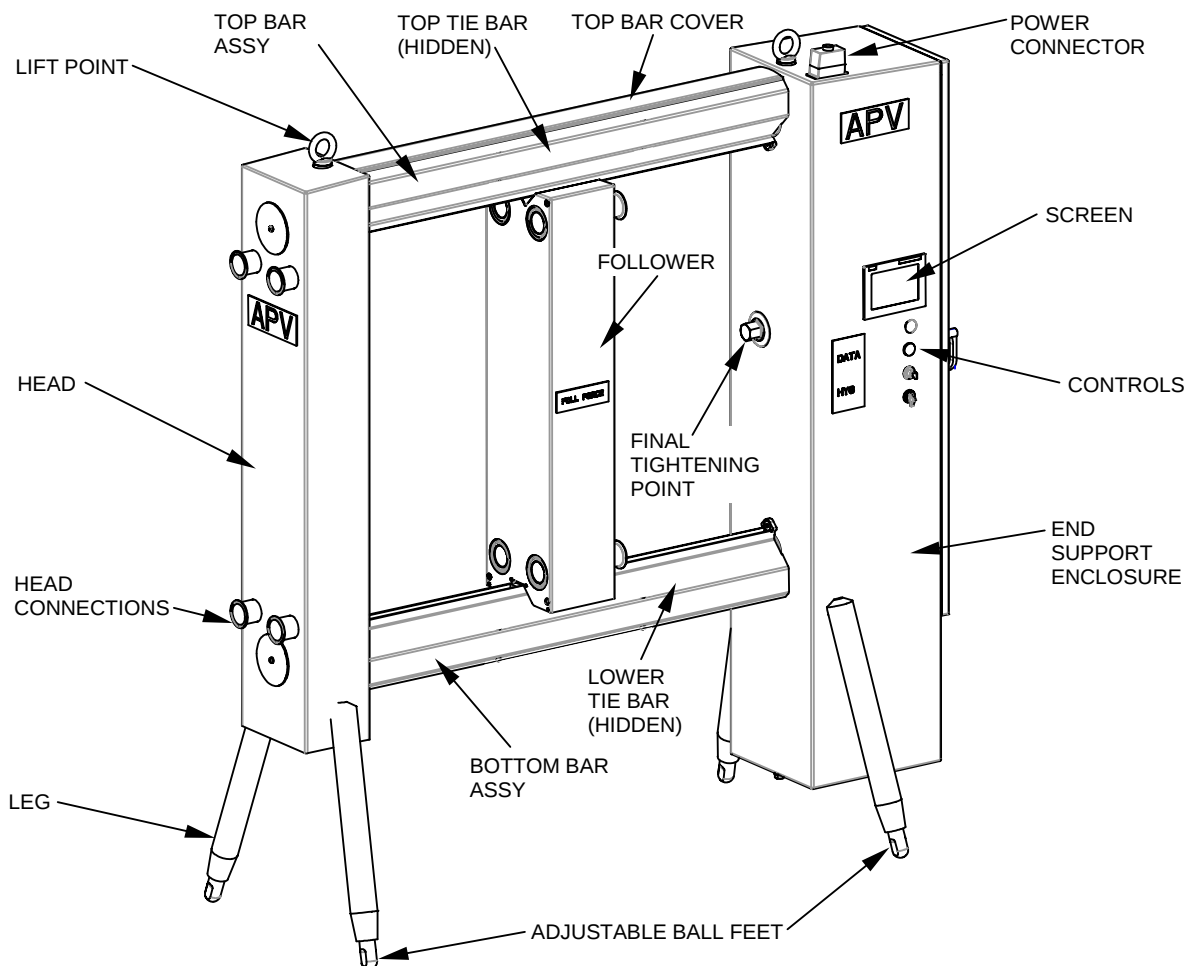
3 Manual end support

The manual end support frame is provided with two, closing points. The first, auxiliary closing point is a special driver assembly that must be located directly on the lower tie bar. This is used to rapidly close the machine near to pitch. When tightening becomes difficult, the supplied wrench should be moved to the primary closing shaft located on the outside of the end support and facing the follower. The Paraflow can then be brought to pitch. Binary-Drive technology is fully employed on the manual frame ensuring the follower remains parallel to the head at all times.

4 Powered end support

The powered Binary-Drive Paraflow provides completely automated frame opening and closing. An overall view of the powered frame is shown following. See 'ELECTRICAL SYSTEM' section for a description and breakdown of the electrical system and how to connect the Binary-Drive to the power supply. Also see 'HYDRAULIC SYSTEM' section for a description, assembly and breakdown of the hydraulic system.

5 Powered Binary-Drive frame



6 Component items

The following PARTS TABLE lists the major mechanical frame components, including possible replacement items, together with their part numbers. A more detailed description of the majority of the assembly components is found within the 'FRAME ASSEMBLY' section. Should the need arise to replace parts for which the part number is not shown, please order by description giving quantity required together with the Paraflow name and serial number (eg: Tie bar sprocket, 2-pieces, V028 Binary-Drive Paraflow, serial number 2006-XXXX).

Part numbers for replacement electrical items are shown in the ELECTRICAL SYSTEM section. Part

numbers for replacement hydraulic items are shown in the HYDRAULIC SYSTEM section.

7 Frame extensions and reductions

The following PARTS TABLE may also be used to determine the components needed to increase (or reduce) the frame size should this be necessary. Please note that certain machine parameters will need to be updated in the PLC by APV when frame sizes are changed. Binary-Drive frame extensions and reductions should only be performed by trained personnel to ensure correct disassembly and re-assembly.

8 Parts table

Description	Qty per Frame	Part Number	Remarks
Head assembly (Typ-2)	1	3900 2081	Includes legs and ballfeet
Follower assembly (Typ-2)	1	3900 2491	Does not include guide block or rollers
End sup't encl. (FS.1 – 3) (460v Siemens)	1	3900 2076	Includes legs and ballfeet
End support enclosure manual	1	3900 2075	Includes legs and ballfeet
Top bar assembly 1500 long (FS.1) typ-3	1	3900 2473	
Top bar assembly 2500 long (FS.2) typ-3	1	3900 2474	
Top bar assembly 3500 long (FS.3) typ-3	1	3900 2475	
Bottom bar assy 1500 long (FS.1) typ-3	1	3900 2480	
Bottom bar assy 2500 long (FS.2) typ-3	1	3900 2481	
Bottom bar assy 3500 long (FS.3) typ-3	1	3900 2482	
Carry Bar Seal O-Rings (dash-213)	8	3900 2100	
Tie Bar 1.75" ACME – 1860 LG (FS.1)	2	3900 1452	See Note 1
Tie Bar 1.75" ACME – 2860 LG (FS.2)	2	3900 1454	See Note 1
Tie Bar 1.75" ACME – 3860 LG (FS.3)	2	3900 1456	See Note 1
Free Nut type-4	2	3900 2487	See Note 2
Retaining screw for free nut	6	3900 2489	¼"-20 x ½" lg SS button head screw
Shim typ-2 for free nut	2	3900 2486	
Pinch nut assembly	2	3900 1948	See Note 1
Follower roller with bearing	4	3056 0194	
Follower roller spindle	4	3056 0196	
Follower roller bolt	4	3900 2101	M12 x 35 csk socket head SS screw
Follower Guide Block typ-2	1	3900 2484	
Follower Guide Block Screw	1	3900 2066	M8 x 30 csk socket head SS screw
Ball foot (M42)	4	3900 1530	
Roller chain 60RIV – 71.25" inc master link	2	3900 1595	Used on powered and manual versions
M24 ratchet wrench	1	500902	Chain adjustment only
M30 ratchet wrench	1	500666	See Note 3
Drain screw for oil reservoir	1	3900 1557	M16 x 25 hex head S.S. screw
Copper washer for oil drain screw	1	3900 1558	M16
Lip Seal	5	3900 1584	See Note 1
Roller bearing (100 x 65 x 18)	6	3900 1570	
Thrust bearing (100 x 65 x 27)	2	3900 1571	
Tie bar cover O-Ring (Dash-254)	2	3900 1627	

Note 1: Tie bar part numbers exclude all other items (nuts, lip seals, bearings, keys, screws, etc). When changing frame sizes, all existing tie bar assembly parts may be reused except the lip seals and O-Rings (-213), which should be replaced, and the free nuts which, depending on usage, may also need to be replaced.

Note 2: Free Nuts Type-4 (from machine 2007-1006 onward) are constrained by three dowel pins, a shim and three ¼" button head screws each.

Note 3: The M30 ratchet wrench will tighten both the powered and manual versions. However, the powered Binary-Drive is not normally supplied with this tool.

1 Handling

Quad-Drive heat exchangers can be shipped either assembled or unassembled from the factory. When assembly is required, these instructions must be closely followed to assure safe and correct operation. The personnel undertaking the work must have proper training and experience. They must also be equipped with the proper tools and rigging equipment required for the assembly of large, heavy equipment.

2 Lifting

Quad-Drive frames are provided with two eyebolts to simplify lifting of individual components or the complete frame. You must use a spreader beam to lift an assembled frame with a 5500mm or longer top bar.

Warning:

The assembled heat exchanger (frame with plates and gaskets) must not be lifted and moved as a complete unit.

Weights of primary components:

Component	Weight lbs. [kg]
Head	1430 [649]
Follower	1190 [540]
End Support (powered) *	1230 [558]
End support (Manual)	968 [439]
Tie Bar for 1500 mm	52 [24]
Tie bar for 5500 mm	161 [73] †
Top Bar 1500 mm	92 [42]
Top Bar 8000 mm	2590 [1175]
Bottom Bar 1500 mm	111 [50]
Bottom Bar 8000 mm	562 [255]

* Without power pack.

† Heaviest for all frame sizes. (FS 5& 6 use eight shorter tie bars)

3 Assembling the Frame

Warning:

All lifting equipment must have the proper capacity and be in good condition. Personnel must follow safe rigging practices at all times.

Caution:

All components must be properly supported during all phases of assembly.

3.1 Preparation

Remove each item from its packing and check that all necessary parts have been supplied and are free of damage. Do this by reading through these instructions while identifying each component prior to actual assembly. Also refer to the Parts Table in the FRAME CONSTRUCTION section.

The following consumables are required for assembly (see **Appendix** at end of this section for recommended greases):

1. Food grade grease (seals, ballfeet, tie bars).
2. Black lithium grease (thrust bearings)
3. Clear RTV silicone sealant (cladding openings)
4. Loctite 246 (removable thread lock for fasteners)
5. Loctite 648 (some roller bearings)

Remove the end support door before proceeding; two people are required for this operation. With the end support enclosure in the horizontal position, open the door (turn the handle ¼ turn counterclockwise) and slide it off its hinges. Place the door in a safe location where it cannot fall or become damaged.

3.2 Legs

Prepare the head and end support enclosure by installing the leg assemblies in the following way.

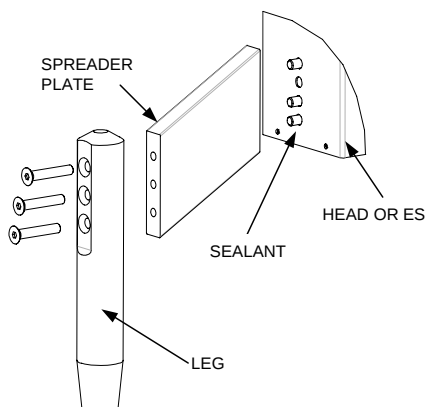


Figure 1

Remove the bottom cover from the head (M4 countersunk screws) and store the screws in a safe place. On both the head and end support enclosure, apply a ring of clear RTV sealant around the four 17mm diameter holes each side and install two leg spreader plates using M16 x 45 long socket head screws (FS 1-4: three for each plate – one hole each side is not used, FS 5&6 four for each plate). Use Loctite 246 and tighten fully. Remove excess RTV sealant. Attach the legs to the spreader plates using M16 x 90 long countersunk S.S. socket head screws (FS 1- 4: three for each leg, FS 5&6 four for each leg). Use Loctite 246 and tighten fully. If ballfoot assembly is necessary, thoroughly grease ballfoot thread and then fully install one into each leg

3.3 Head

Crane the head into an upright position using straps/chains through the lifting eyebolt or, for FS 5&6, straps through the upper tie bar openings.

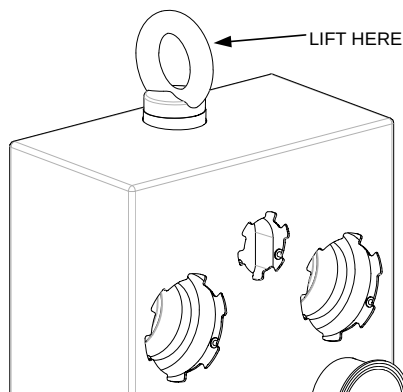


Figure 2

Once upright, it may be helpful to ensure that the two ballfeet are positioned at their intended final location to avoid later movement of the entire frame.

3.4 Bottom Bar

For FS 1-4, ensure that the bottom bar core is installed inside the outer tube and then insert the sealing o-ring in one end – a light coating of food grade grease will assist o-ring insertion. See Figure 3.

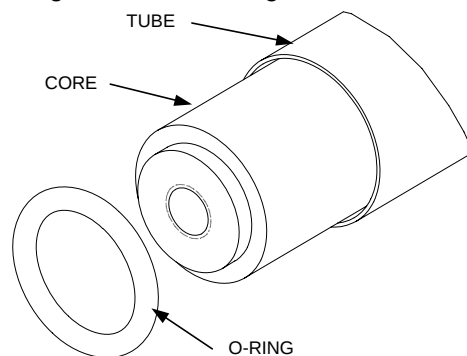


Figure 3

Bring the bottom bar assembly into position up to the head. FS 5&6 bottom bars are single piece but still require a special seal at each end. Support the bottom bar assembly with jack stands or, alternatively, blocks of the correct height, preferably at both ends of the bottom bar but at least 1ft [300 mm] from the free end. Ensure the bottom bar is square to the head and level and then fasten using the M24 x 70 mm long socket head bolt supplied. Use Loctite 246 and tighten fully.

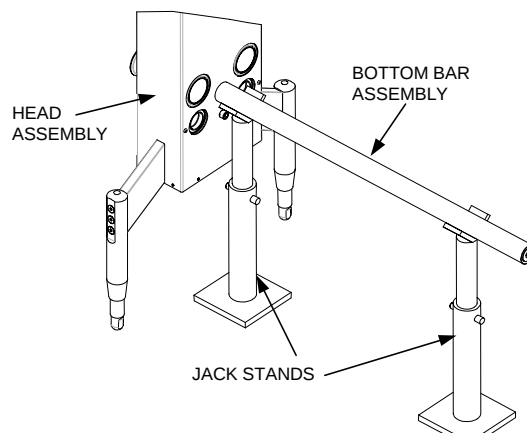


Figure 4

Ensure that the assembly is stable and cannot fall over when the strap/chain is removed - shorter

frame sizes will need additional rigging/support at this point. Remove the strap/chain from the head.

3.5 Top Bar

Insert an M36 x 160 mm long socket head bolt through the top bar bolt hole from the inside of the head and install a lightly greased, thick rubber washer (38mm I/D) over the protruding end of the bolt. Also, for FS 5&6, apply a ring of clear RTV sealant to the top of the lift pad. Fork lift or crane with a centrally placed strap (not chain) the top bar into position and screw the M36 x 160 mm long socket head bolt into the thread in the end of the top bar. Use Loctite 246 and tighten fully. For FS 5&6, also install the M36 x 130 long S.S. hex head bolt with plain S.S. washer through the top hole of the top bar anchor. Use Loctite 246 and tighten fully.

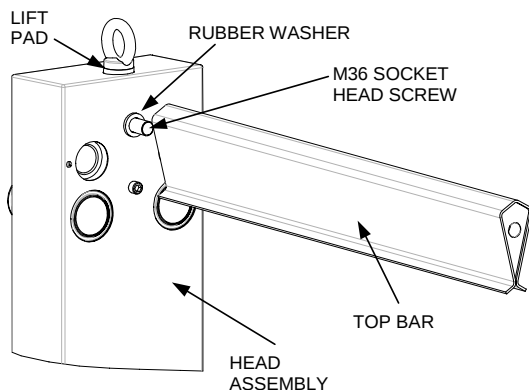


Figure 5

Ensure the top bar sits on top of the pre installed, S.S. socket head screw and that the end of the top bar fully contacts the inside surface of the head. The top bar must be square to the head in both horizontal and vertical directions. If a crane was used for top bar assembly, it must now be freed for follower assembly. Therefore install a support structure of sufficient strength about 1ft [300 mm] from the free end of the top bar. This support structure must carry ½ the top bar weight plus the follower weight.

3.6 Follower

Remove the two lower side covers from the bottom of the follower and store the screws in a safe place - leave the lower central cover in place. Confirm that both roller assemblies are correctly installed on the follower. Using straps (not chains) through the two upper ports or tie bar openings, crane the follower

onto the free end of the top bar and over the bottom bar. Liquid connections face away from the head. Lower the follower such that the rollers sit on the hanging surface of the top bar.

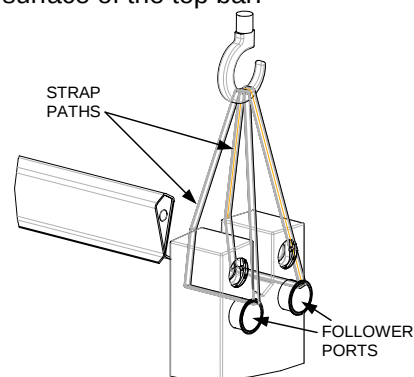


Figure 6

Prevent the follower from rolling off the free end of the top bar before removing the straps.

3.7 End Support

Crane the end support close to position using a strap/chain through the eyebolt provided or, for FS 5&6, straps through the upper tie bar openings and door opening (remove the top section of door seal to prevent damage). Install the upper rubber washer and lower o-ring/seal (both lightly greased) into their respective positions and bolt the end support to the top and bottom bars with M36 x 160 & M24 x 70 socket head screws. Use Loctite 246 and tighten fully. For FS 5&6, also install the M36 x 130 hex bolt and washer as described for the head end.

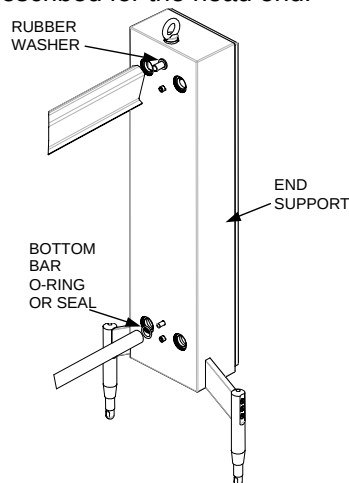


Figure 7

Remove all jacks, blocks, support structures and straps/chains.

If appropriate, confirm that the frame is in, or move it to, its desired final position and standing on spreader discs if necessary. Level the machine in both directions by turning the four adjustable ballfeet with a wrench (1.42" [36 mm] A/F). Each ballfoot is provided with +/- 2" [50 mm] adjustment. During adjustment, the ballfoot thread should never become visible.

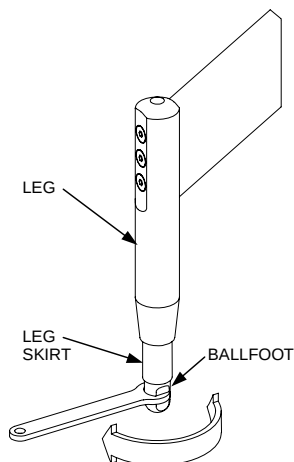


Figure 8

Push the follower to within about 1ft [300 mm] of the head or, for FS 5&6, about 2 feet [600mm] before the support arm blocks on the top bar.

4 Preparation for tie bar installation

Four fully threaded tie bars are supplied for each machine, two long and two slightly shorter. **Note that the longest tie bars must be installed at the top of the machine.** In addition FS 5&6 are supplied with four, mainly plain, equal length tie bars which are installed towards the head. For convenience, tie bars are numbered in this text according to their corresponding port. ie: while facing the head, the top left bar is No. 1. The remaining bars are numbered in a clockwise direction, 2, 3 and 4. Note that the head, follower or end support 'inner face' is the exterior surface that faces the plate pack.

NOTE: IT IS ESSENTIAL THAT EACH OF THE FOLLOWING STEPS BE PERFORMED IN ORDER AND WITHOUT OMISSION. FAILURE TO COMPLETE ANY STEP IN THE TIE BAR ASSEMBLY SEQUENCE WILL NECESSITATE ENTIRE

DISASSEMBLY AND REMOVAL OF THE TIE BAR(S) TO CORRECT THE OMISSION.

4.1 Bearing installation

Unless already in place, install one ball bearing (100 x 65 x 18) in each of the tie bar openings on the inner face of the head (4 total) using Loctite 638 on the outside diameter of the bearing only. Remove excess Loctite. Ensure each bearing is fully seated.

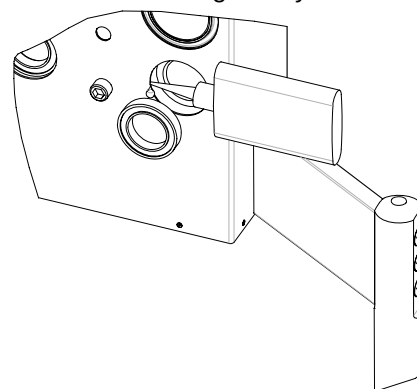


Figure 9

4.2 Lip seal installation

Prepare all 12 rubber lip seals by fully filling the internal v-groove with white, food grade grease. Just prior to installation, wipe a smear of clear RTV sealant around the full outside diameter of each seal and tap one seal into each of the tie bar openings on the inner face of the head and inner face of the end support. Note correct seal orientation. Wipe off excess sealant after insertion.

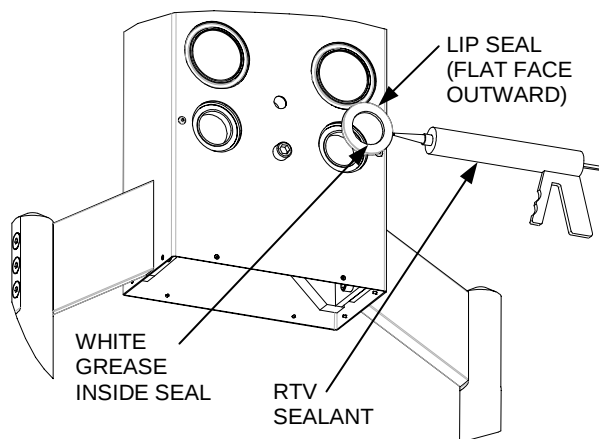


Figure 10

5 Installing tie bars

Locate and unpack the four thrust roller bearings (100 x 65 x 27). Install one 'housing' washer (which has the larger inside diameter – part number begins with 'G') into each tie bar opening through the outer face of the head. Ensure that each washer is properly seated inside the smaller diameter at the bottom of the counterbore and that the bearing face (without lettering) is facing outwards (ie: visible). A tie bar bush may help with insertion.

Push one pre-greased, lip seal, 'flat' face toward you, over the neck of each free nut. Lightly grease each 2.5" I/D o-ring and place into the groove on the contact face of each free nut.

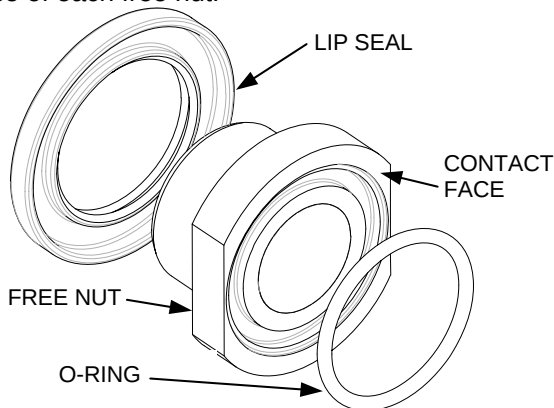


Figure 11

Screw one free nut, lip seal first, onto each fully threaded tie bar about 31.5" [800 mm] from one end.

Lift or crane one fully threaded tie bar at a time beside its location on the frame with the o-ring in the free nut facing the follower. Swing the tie bar end across, into and through the hole in the end support - avoid lip seal damage - until the end with the free nut can swing inward to align with the tie bar hole in the follower. Pass this end through the follower until the free nut prevents further tie bar insertion.

For FS 5&6 it is now necessary to install the tie bar support arms and link the 'plain' tie bars.

Load an M8 x 20mm long S.S. button head screw with a 22mm diameter, S.S., ball bearing and one plain, M8, S.S. washer. Note that the washer will be clamped between the bearing and support arm. Screw these small roller assemblies into each tapped hole in all

four tie bar support arms using Loctite 648. Screw an arm to each of the two top bar support blocks using two M12 x 40 mm long countersunk S.S. screws each. Screw the remaining two arms with similar fasteners to the two bottom bar support blocks. Attach the upper arm assemblies to the top bar spacer blocks using two M12 x 55mm long countersunk S.S. screws. The upper arms will be horizontal but not aligned with each other.

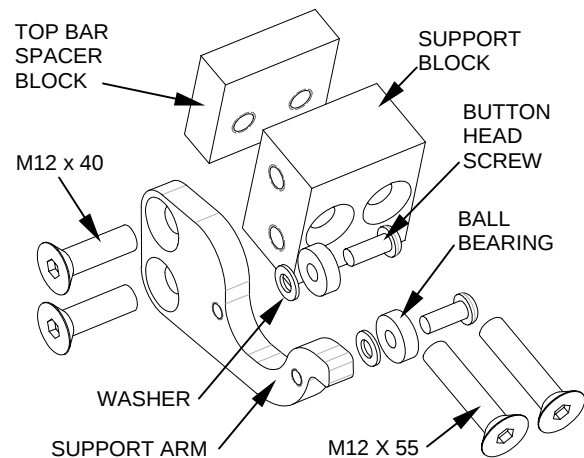


Figure 12

Attach the lower arm assemblies to the bottom bar in the holes provided using two M12 x 55mm long countersunk S.S. screws with M12 hex nuts and plain washers on the inside of the bottom bar. The lower arms will also be horizontal and not aligned with each other. Confirm that all support arm screws are tight

The 'plain' tie bars must now be installed. Refer to Figure 13.

Screw one link cap, flats first, about 10" [250mm] onto the end of each tie bar now protruding between the head and follower. Screw one link piece onto each tie bar until the tie bars are recessed inside the link pieces by 2" [50mm].

Rotate each link piece the minimum amount in either direction to align the keyways. Load a key (44mm long) into each keyway and slide into the link pieces. Install a link cap, flats first, 10" [250mm] onto one end of each 'plain' tie bar and feed the opposite ends through the inside of the head.

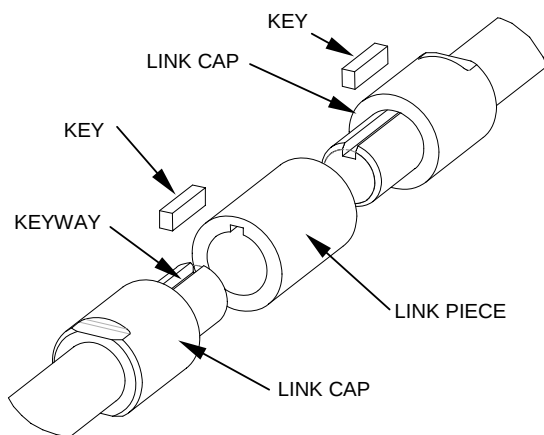


Figure 13

Screw each tie bar end into the corresponding link pieces until they touch the fully threaded tie bar. Unscrew each tie bar just enough to align the keyways and install the other 44mm long keys. Apply Loctite 648 to the full dia of the thread adjacent to the exposed keyways and tighten each pair of link caps hard against the link pieces. Use a wrench (2.165" [55mm] A/F) to ensure the link caps are tight. A section of each tie bar will be protruding from the outside face of the head.

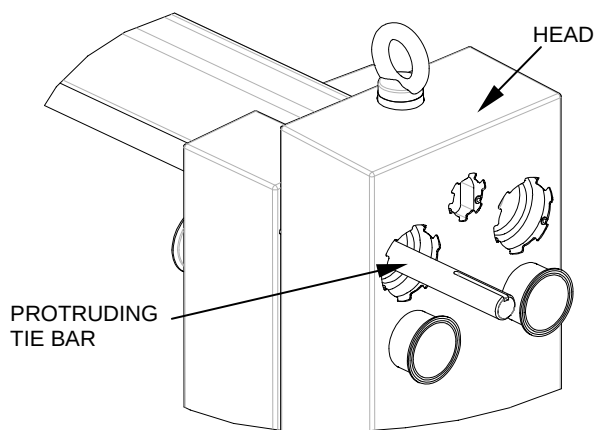


Figure 14

Apply a 1.5" [40 mm] length of food grade grease around the full diameter of the tie bar that protrudes from the head, starting 6.33" [161 mm] from the end. Screw one S.S. collar onto each tie bar leaving 6.33" [161 mm] of exposed thread. The S.S. collars are symmetrical.

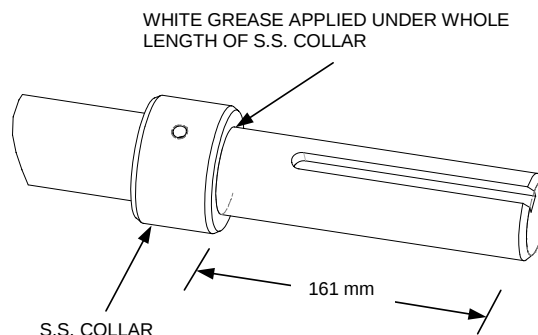


Figure 15

Install one ball bearing (100 x 65 x 18) onto the long neck of each fixed nut.

Install the 'shaft' washer from each thrust roller bearing onto the short neck of each fixed nut. Ensure that the bearing face (no lettering) is facing outwards (ie: visible). Pack each roller cage with black Lithium grease and install one next to each 'shaft' washer.

Screw one fixed nut assembly onto each tie bar, thrust bearing first, until the trailing face of the fixed nut is flush with the end of the tie bar. Now rotate the fixed nut anti-clockwise until the keyways align. Fully insert the key (1/2" x 3/8" x 120mm long).

If necessary, rotate the S.S. collar again to achieve a dimension of exactly 3.78" [96 mm] between the closest faces of the collar and fixed nut. Install and tighten the three M8 x 10 mm long setscrews using Loctite 246. Note that the setscrews on the fixed nuts protrude slightly to retain the ball bearings.

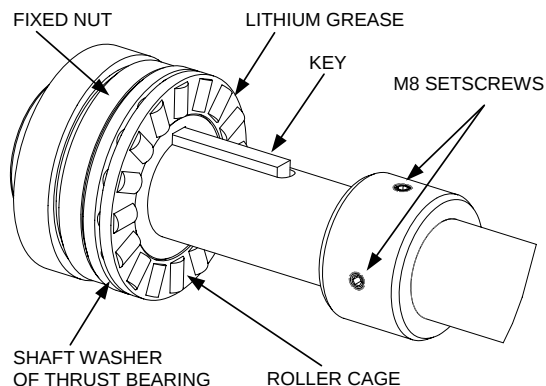


Figure 16

Remove any excess grease in front of the S.S. collar.

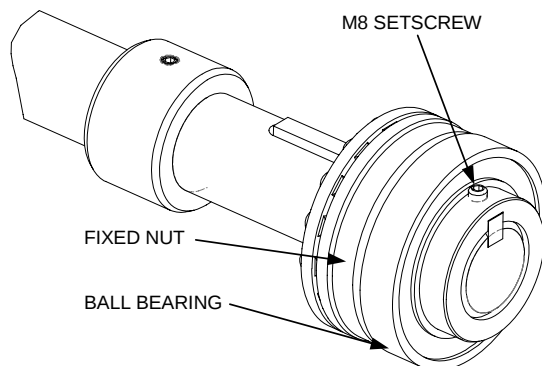


Figure 17

Push each tie bar towards and through their respective tie bar hole in the end support so that the S.S. collars engage with the inner head ball bearings. Apply a coat of white grease to the end support end of the tie bar and screw one tie bar bush, flats first, onto the end of the correct tie bar from inside the end support according to the following table.

Tie bar bush No.1 = 7.177" [182.3 mm] long
Tie bar bush No.2 = 8.427" [214.05 mm] long
Tie bar bush No.3 = 3.886" [98.71 mm] long
Tie bar bush No.4 = 5.927" [150.55 mm] long

Hand tighten each bush, ensuring that its neck passes inside the ball bearing.

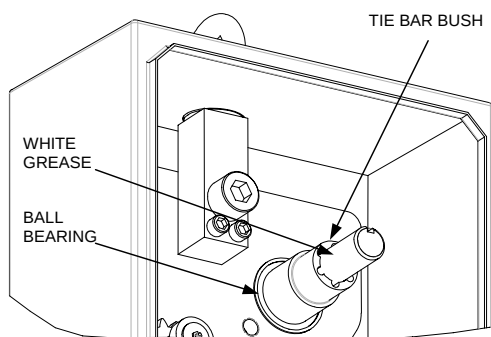


Figure 18

Leave the stepped face of the tie bar bushes about 6 – 12 mm (1/4" – 1/2") away from the ball bearings in the end support until the follower and tie bars are synchronized.

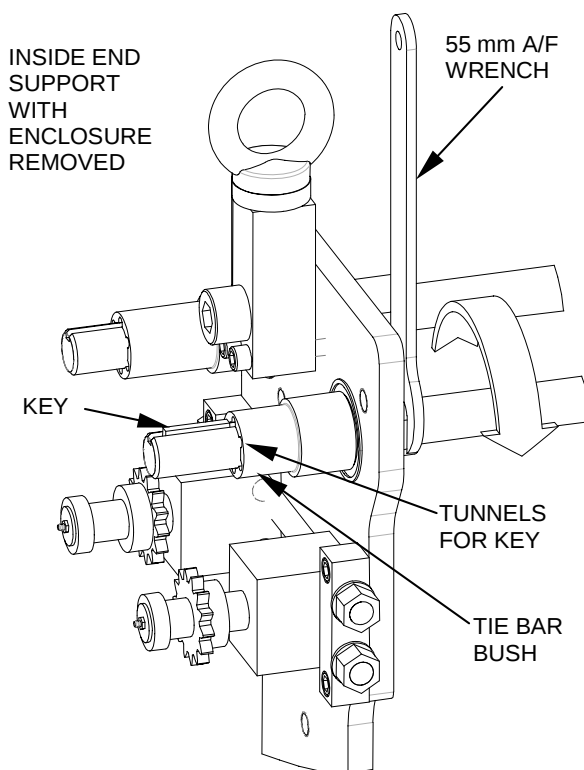


Figure 19

6 Tie bar synchronization

Specially designed synchronization jigs are recommended for this operation but a few plates, measured with a 12" [300 mm] digital caliper, tape measure or other measuring device is also useable for tie bar synchronization.

Roll the follower back to the free nuts and install one synchronization jig into each of the four ports on the inside of the head. If the jigs are unavailable, load 10 gasketed plates (alternating Right Hand, Left Hand) into the frame. In this case it is recommended that the first 10 plates of the intended plate arrangement be installed. Refer to the PLATES AND GASKETS section, 3. Installation of Plates, for details.

Push the follower hard up against the jigs or plate pack and check that all four o-rings are lubricated with white grease and correctly seated in the free nuts. Spin the free nuts up to the follower as far as possible and align them so that the nuts can engage into the respective recesses in the follower.

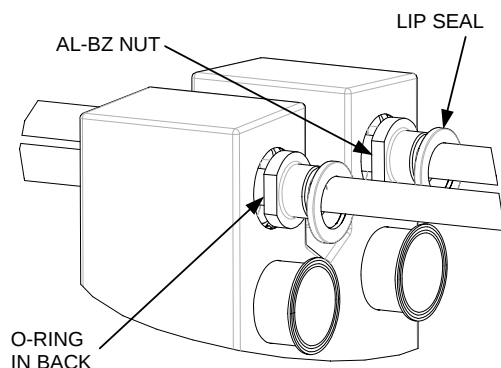


Figure 20

While preventing the free nut from rotating, rotate each tie bar in turn, (using the special socket tool) to fully seat each free nut into its follower recess. The lip seals will simply hang loose on the tie bars at this stage.

If the jigs are installed, continue tightening each tie bar until the head and follower firmly clamp each one.

If the first 10 plates are installed, using a digital caliper (or other device), measure between the head and follower adjacent to each of the four connections (ensure you measure inside the corner radius of the head and follower cladding).

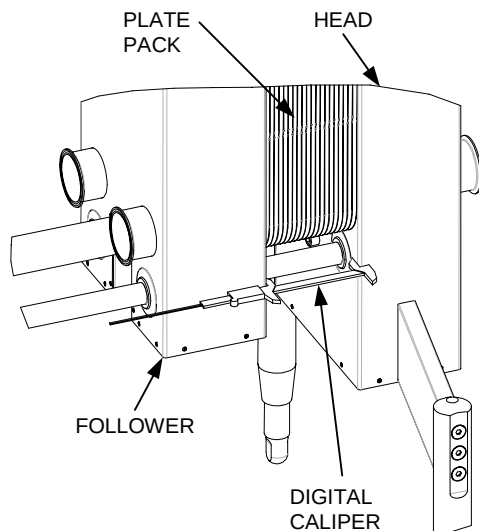


Figure 21

Continue to rotate each tie bar up to ½ a turn at a time until the plate pack measures about 2.677" [68mm] at

all four points with no more than 0.020" [0.5mm] between the largest and smallest dimension.

Warning: Resistance will dramatically increase as the gaskets on the plates start to compress or if the follower and head are forced out of parallel. For this reason, ensure that the follower remains parallel to the head within ¼" [6.4mm] during the synchronization process.

After clamping the jigs or plates, confirm that each thrust bearing assembly is properly seated in the head. When properly seated, each S.S. collar will protrude from the lip seal on the inside of the head by about 0.28" [7 mm].

If any S.S. collars are not now at the specified dimension, recheck the tie bar assembly and correct any problems before proceeding.

The four tie bars should not be further rotated until the chains are installed.

Install and tighten an M8 x 16 mm long button head screw and two, M8 large diameter plain washers on either side of each free nut, applying Loctite 246 to the screws. Note that the free nut will not be clamped by the screw/washer.

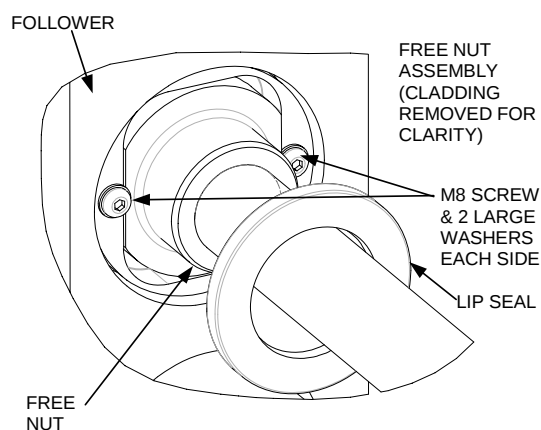


Figure 22

While preventing tie bar rotation using the special socket, tighten each tie bar bush with a wrench using the flats on the bush (2.165" [55mm] A/F) that protrude through the end support. Tighten in order No. 1, No. 3, No. 2 and No. 4 until the neck of the bush (inside end

support) mates with the face of the end support ball bearing. A rapid increase in resistance to tightening will be experienced once the shoulder is seated. Stop tightening when this force is felt. Do not over tighten.

Each bush will protrude from the face of the lip seal in the end support by about 1.5" [38.1 mm].

If any tie bar bushes are not now at the specified dimension, recheck the assembly and correct the problem before proceeding to the next step.

7 Loading tie bars

After installing all four tie bars, the tie bar preloading sequence can begin. **Do not attempt to load any tie bar unless all four tie bars are installed and their bushes are seated, as previously described, in the bearings.**

At tie bar No. 1, inside the end support, position the special socket tool over the tie bar such that it is prevented from rotating clockwise (react against inside of end support cabinet).

You will notice that each bush has six 'tunnels' any of which can receive the key – refer to Figure 19. Obtain help to tighten the bush using the flats (2.165" [55 mm] A/F) protruding through the inner face of the end support. Rotate the bush, clockwise viewed from the end support end, so that the next available 'tunnel' aligns with the keyway on the tie bar. Push the key (65mm long) into the 'tunnel' to lock the bush to the tie bar. Note that there will be about 1.25" [32mm] of key that will not enter the bush.

Repeat this step (Loading tie bars) for the remaining three tie bars in the following order, No. 3 – No. 2 – No. 4. Note that for tie bar No. 3 the 1/2" x 3/8" key is 65 mm long for the powered version and 120 mm long for the manual version.

8 Yoke plate assembly

Lightly grease and install a ball bearing (100 x 65 x 18) into each of the two yoke plates.

Place one yoke plate over tie bar bush No.1 so that the bearing passes over the corresponding diameter of the bush. While holding a standoff behind the yoke plate and aligning it with one of the two M24 tapings, loosely install one M24 x 100 mm long hex head screw

and M24 large (60mm) diameter washer using Loctite 246. Install the other standoff, bolt and washer also using Loctite 246. Fully tighten both M24 bolts.

Install the other yoke plate in the same way.

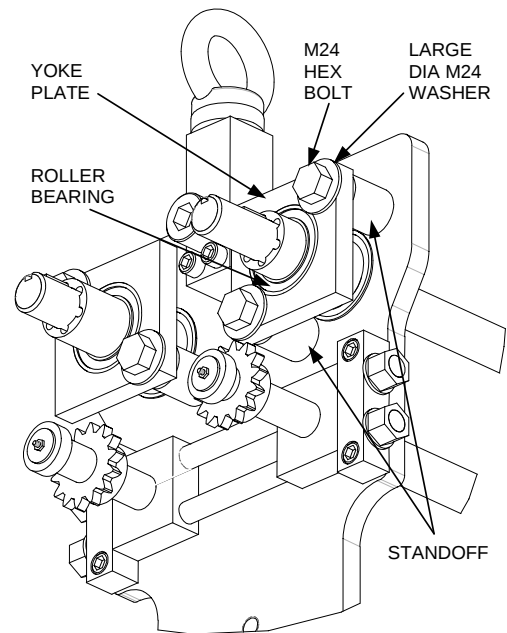


Figure 23

Install one tie bar sprocket on each tie bar ensuring engagement with the pre-installed key. The hub of all tie bar sprockets faces outward except sprocket No.3 on manual versions which faces the head of the HE.

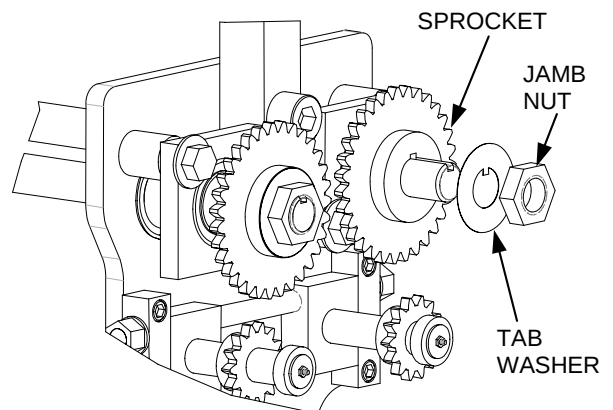


Figure 24

Install one tab washer and one hex jamb nut (2.5" [63.5 mm] A/F) on each tie bar – note: the manual version of the Quad-Drive does NOT require a washer and nut on tie bar No. 3. Tighten the nut to ensure the sprocket is hard against the tie bar bush.

Tighten the two setscrews (3/16" A/F) on each sprocket using Loctite 246.

De-adjust all four idler sprockets toward the vertical centerline of the machine (if not already in position) using the M24 ratchet wrench supplied. To move the idler for tie bar No. 1, turn the hex nut at either end of the correspondingly numbered threaded rod.

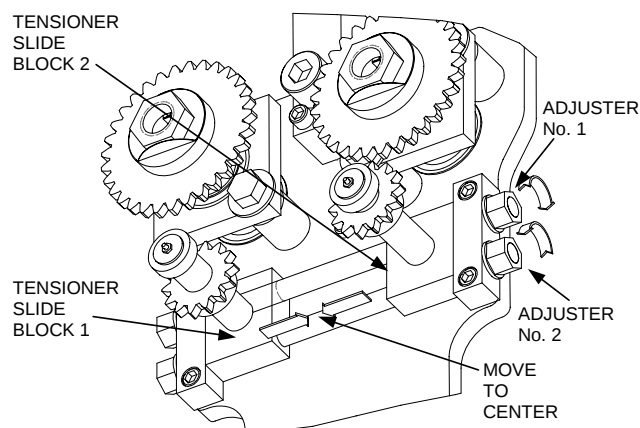


Figure 25

Locate and unpack the four, secondary drive chains and their connecting links. Install each chain as illustrated in Figures 26 ~ 28 in the sequence: No. 3, No. 4, No. 1, No. 2.

Each chain goes around a small central sprocket, a larger tie bar sprocket and a small idler sprocket on the adjustment mechanism. Install the connecting link from the back of the chain to ease spring clip assembly. You may need to rotate the tie bar up to ½ a tooth width to install the last three chains. Do not rotate the tie bar more than ½ a tooth width.

Adjust each idler sprocket with the M24 ratchet wrench until each chain has just become taught on all three sides. The chains should have approximately 2 x chain width of slack. Too much slack is **not desirable** since this is a bi-directional drive system.

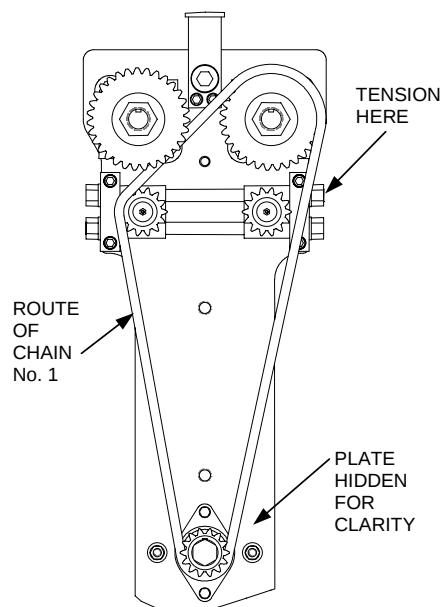


Figure 26

If plates were used for synchronization, rotate the central drive shaft (1.81" [46 mm] A/F) a single turn counterclockwise to tighten the follower further and recheck all four inside head to follower dimensions.

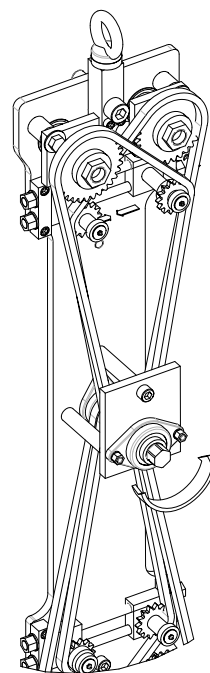


Figure 27

Should re-synchronization be necessary at this stage, any chain can be temporarily slackened enough to pass over the teeth by moving its idler sprocket toward the other. After slackening, adjust the follower position by rotating the tie bar using the flats on the tie bar bush. Again, ensure that the maximum difference between the smallest and largest dimension is no more than 0.020" [0.5mm] and re-tension the chain(s).

Lightly lubricate the tie bars with the recommended white food grade grease. Begin to open the plate pack manually by turning the central drive shaft clockwise (opposite to Figure 27) and confirm smooth operation of the follower and drive system. Do not continue to the next step unless everything is working correctly at this stage.

After confirming that everything is working correctly and the hex jamb nuts are still tight, deform one side of the tab washer on each tie bar by folding one segment up hard against one of the flats on the hex jamb nut. Use a flat bladed screwdriver to begin and complete the process with a drift and hammer.

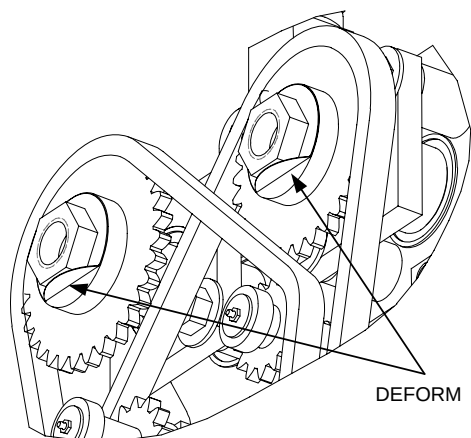


Figure 28

9 Final frame assembly

Carefully tap the four lip seals (currently loose on the tie bars) into the follower openings until they are seated on the heads of the internal pegs. Just before installation, apply a smear of clear RTV sealant around the outer diameter of the seal. Properly seated, the seal faces sit about 0.04" [1 mm] proud of the cladding. Remove any excess sealant.

The head is provided with four large openings for tie bar access and two smaller openings for top and bottom bar bolt access. The covers for each of these six openings are installed in a similar fashion.

First offer up the clamping plate to the hole in the cladding and rotate until it can pass through to the lock pins inside. After insertion, further rotate in a clockwise direction to 'lock' the clamp plate.

Without the o-ring, offer up the outer disk assembly with the M8 button head screw and nylon sealing washer so that the screw engages into the thread in the clamping plate. Tighten the screw until the cover disk is almost home.

Lightly grease the correspondingly sized o-ring with food grade grease and stretch it over the cover disk until it drops into the recess behind the face. Fully tighten the screw. The o-ring will remain visible. Repeat this step for the remaining five covers.

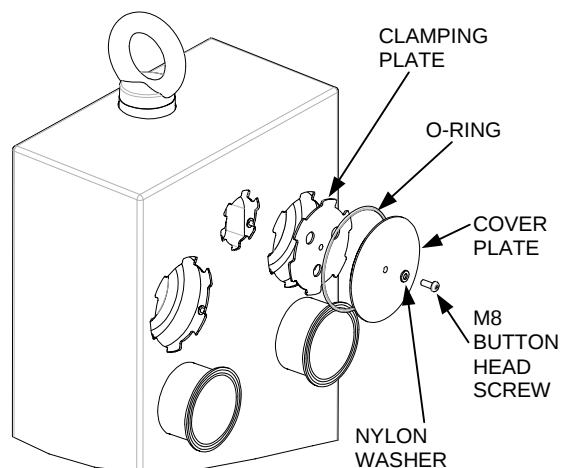


Figure 29

Replace the end support door onto the hinges and close it.

Replace the covers on the underside of the head (one) and follower (two). Use the M4 stainless steel countersunk screws removed and stored earlier.

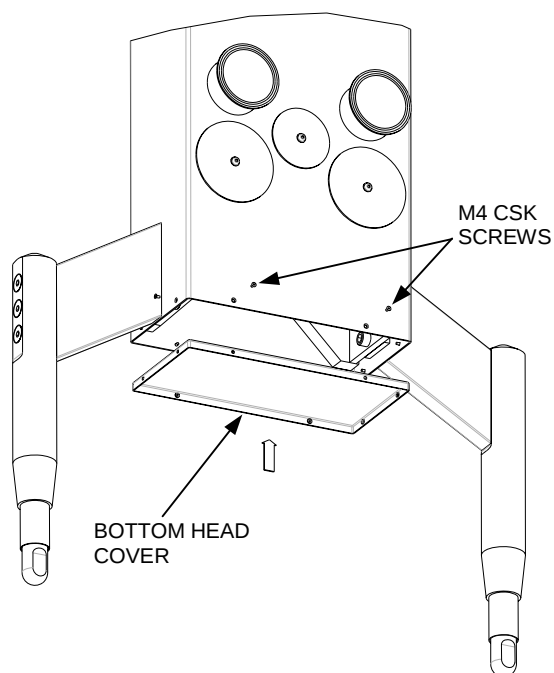


Figure 30

Remove the two lifting eyes, one at the head and one at the end support and close the two tapped holes with the 42 mm diameter black plastic bungs supplied. (Bagged and taped to inside of end support enclosure door). Apply a ring of clear RTV sealant around each hole before installing bungs. Remove excess sealant.

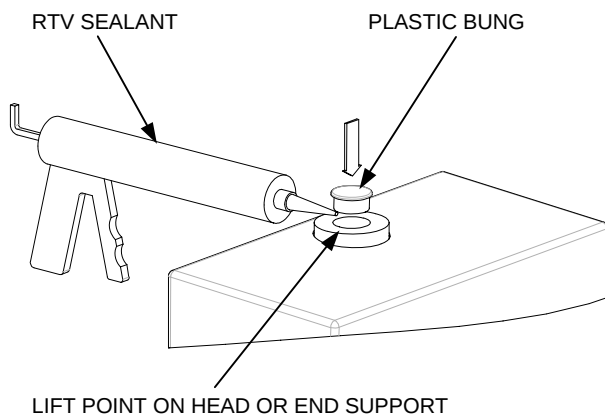


Figure 31

10 Completing frame assembly

If you purchased the powered version of the Quad-Drive frame please proceed with the power pack installation. See POWER PACK ASSEMBLY section for details.

If you purchased the manual version of the Quad-Drive frame please proceed with the manual drive assembly. See MANUAL DRIVE ASSEMBLY section for details.

11 APPENDIX

During frame assembly and for continued trouble free operation, the following greases are recommended. It is also recommended that you continue to use the same greases for maintenance as used in initial assembly.

11.1 Recommended food grade greases

a. Rocol Foodlube ® Multi Paste

15750	85g Tube
15751	400ml aerosol
15753	500g can
15756	5kg can

Ref: www.rocolnorthamerica.com

b. Loctite ® Food Grade Anti-Seize

51168 8-Ounce brush top can

Ref: www.loctite.us

c. Saf-T-Eze ® Food/Drug Anti-Seize

McMaster Carr part numbers

1404K11	8-Ounce brush top can
1404K12	14-Ounce Grease Gun Cartridge
1404K14	14-Ounce Container
1404K15	2 lb container
1404K16	1-gallon container

Ref: www.mcmaster.com

11.2 Recommended thrust bearing greases

a. Exxon Mobil Corporation Mobilith ® AW-2

Ref: www.mobil.com/USA-English/Lubes

b. Exxon Mobil Corporation Mobilgrease ® XHP 222

Ref: www.mobil.com/USA-English/Lubes

c. Bostik Never Seez ® Black Moly

NSB150	1 lb can
NSBC-1	14.1-Ounce cartridge
NSB-35B	35 lb pail

Ref: www.rocolnorthamerica.com

1 Handling

Binary-Drive heat exchangers are usually shipped assembled but can be shipped unassembled from the factory. When assembly is required, these instructions must be closely followed to assure safe and correct operation. The personnel undertaking the work must have proper training and experience. They must also be equipped with the proper tools and rigging equipment required for the assembly of large, heavy equipment.

2 Lifting

Binary-Drive frames are provided with two eyebolts to simplify lifting of individual components or the complete frame.

Weights of primary components:

Component	Weight lbs. [kg]
Head	767 [348]
Follower	500 [227]
End Support (powered) *	666 [302]
End support (Manual)	573 [260]
Tie Bar for 1500 mm	52 [24]
Tie bar for 3500 mm	105 [48]
Top Bar 1500 mm	67 [31] †
Top Bar 3500 mm	152 [69] †
Bottom Bar 1500 mm	60 [27] †
Bottom Bar 3500 mm	136 [62] †
Power Pack	150 [68]

* Without power pack.

† Complete top or bottom bar assembly.

3 Standing the Frame

Warning:

All lifting equipment must have the proper capacity and be in good condition. Personnel must follow safe rigging practices at all times.

Caution:

All components must be properly supported during all phases of assembly.

3.1 Preparation

Remove each item from its packing and check that all necessary parts have been supplied and are free of damage. Do this by reading through these instructions while identifying each component prior to actual assembly. Also refer to the Parts Table in the FRAME CONSTRUCTION section.

The following consumables are required for assembly (see **Appendix** at end of this section for recommended greases):

1. Food grade grease (seals, ballfeet, tie bars).
2. Black lithium grease (thrust bearings)
3. Clear RTV silicone sealant (cladding openings)
4. Loctite 246 (removable thread lock for fasteners)
5. Loctite 648 (some roller bearings)

Remove the end support door before proceeding. To do this, place the end support enclosure in the horizontal position, open the door (turn the handle ¼ turn counterclockwise) and slide it off its hinges. Place the door in a safe location where it cannot fall or become damaged.

3.2 Legs

Prepare the head by attaching the legs in the following way.

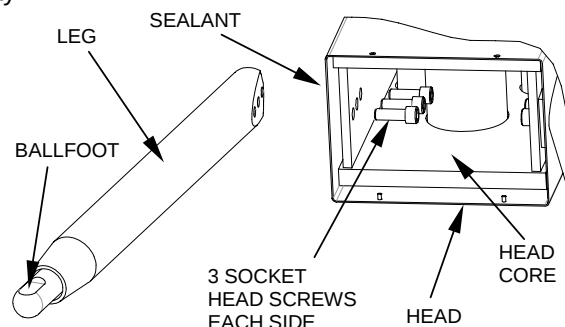


Figure 1

Remove the bottom cover from the head (2 x M4 countersunk screws) and store the screws in a safe place. Apply a ring of clear RTV sealant around the three 17mm diameter holes each side and attach each

leg using the M16 x 45 long socket head screws (from inside through core). Use Loctite 246 and tighten fully. Remove excess RTV sealant.

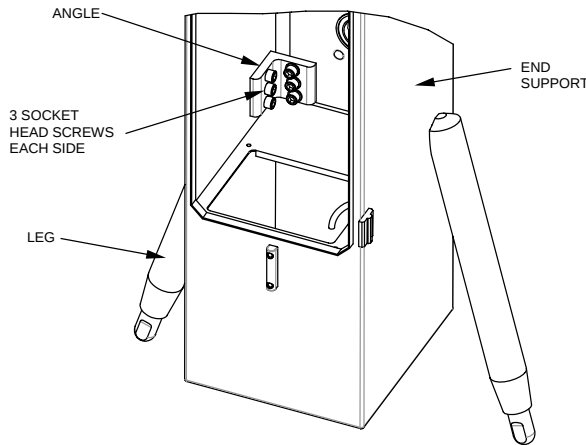


Figure 2

Apply a ring of clear RTV sealant around the three 17mm diameter holes each side and attach each leg using the M16 x 45 long socket head screws (from inside through angle). Use Loctite 246 and tighten fully. Remove excess RTV sealant. If ballfoot assembly is necessary, thoroughly grease (white, food grade) ballfoot thread and then fully install one into each leg.

3.3 Head

Crane the head into an upright position using straps/chains through the lifting eyebolt.

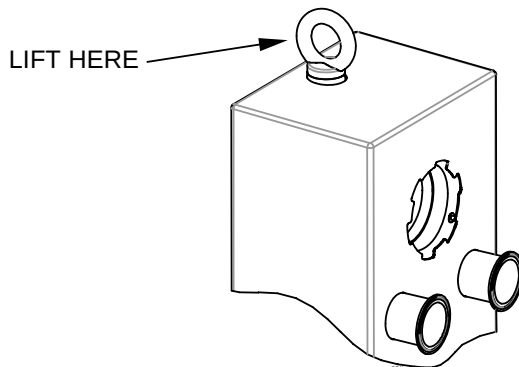


Figure 3

Once upright, it may be helpful to ensure that the head is positioned close to its intended final location to reduce later movement of the entire frame.

3.4 Top bar assembly preparation

Unless already in place, install one ball bearing (100 x 65 x 18) in the upper and lower tie bar openings on the inner face of the head (2 bearings total). Use Loctite 638 on the outside diameter of the bearings only. Remove excess Loctite. Ensure the bearings are fully seated.

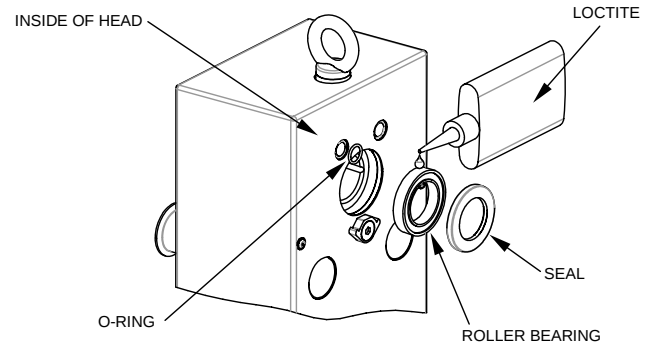


Figure 4

Prepare four rubber lip seals (two for head and two for end support) by wiping a smear of clear RTV sealant around their full outside diameter and gently tapping the seals into the top and bottom tie bar openings on the inner face of the head (these seals cover the bearings) and the corresponding recesses in the end support. Note correct seal orientation. A properly seated seal sits 2 mm proud of the cladding. Wipe off excess sealant after insertion. Fully fill the internal v-grooves of the seals with white, food grade grease.

Locate and unpack the two thrust roller bearings (100 x 65 x 27). Apply a liberal coat of black lithium grease to the bottom of both counterbores where the thrust bearings sit. Install one 'housing' washer (which has the slightly larger inside diameter – part number begins with 'G') into each tie bar opening through the outer face of the head. Ensure that each washer is properly seated inside the smaller diameter at the bottom of the counterbore and that the bearing face (without lettering) is facing outwards (ie: visible). A tie bar bush may help with insertion.

3.5 Top and bottom bar assembly

Apply a coating of white, food grade grease to two carry bar O-Rings (0.921" I/D x 0.139" sect) and insert them into the cladding recesses of the two bottom bar bolt holes.

IMPORTANT ASSEMBLY NOTE: Insertion of the tie bars into the top and bottom bars is described at this stage in case there is insufficient room beyond the head or end support to insert both of the tie bars later. However, if a complete tie bar length is available either beyond the head or end support, the tie bars can be inserted later.

If you need to insert the tie bars now, lightly grease (white, food grade) one tie bar while leaving 250 mm (10") grease-free at each end and carefully place it inside the bottom bar assembly (avoiding damage) with an overhang all at the end support end.

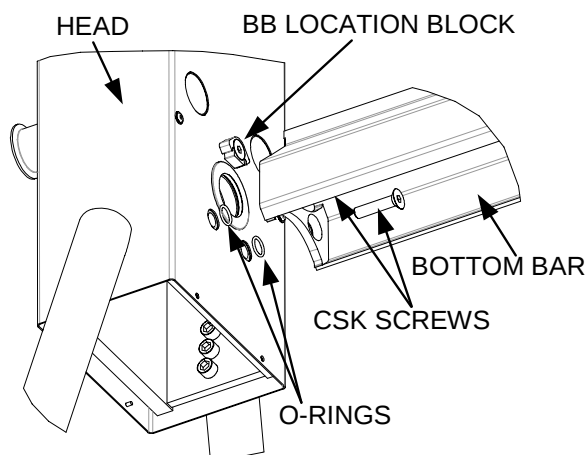


Figure 5

Crane or fork lift the bottom bar assembly (with tie bar overhang away from head if inserted) into position over the O-Ring sealed holes on the head. Engage the two upward facing plate guide rails into the downward facing slots of the bottom bar location block. Line up the two bolt holes with the tapings in the head.

Ensure the bottom bar is square to the head and level and then fasten using two M24 x 70 mm long S.S. countersunk socket head screws. Use Loctite 246 and tighten fully.

Maintain or apply support of/to the bottom bar no closer than 500 mm (20") from its free end using a jack stand.

The crane holding the head may now be released.

Repeat the above process for the top bar assembly except that the underside of the hanging surfaces on the top bar rest on the location block.

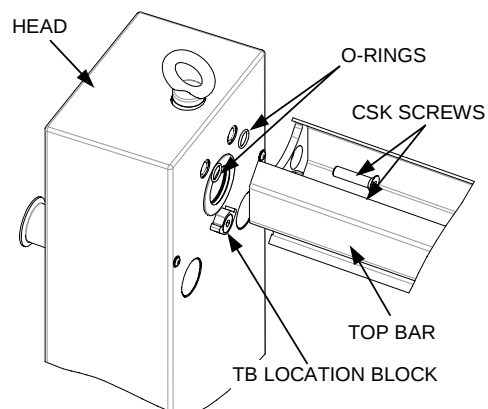


Figure 6

Maintain or apply support of/to the top bar no closer than 500 mm (20") from the free end using a fork lift.

3.6 Follower installation

Ensure the two covers on the bottom of the follower are in place. Install the four roller assemblies onto the top 'diamond' of the follower using Loctite 246.

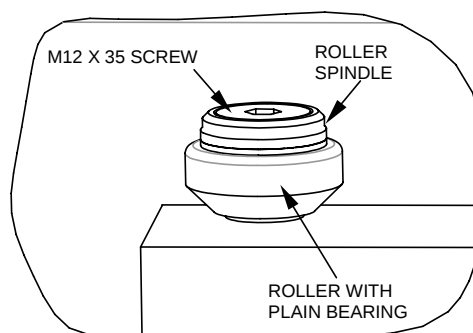


Figure 7

If inserted, carefully push the tie bars through the holes in the head such that they are at least 500 mm (20") in from the free ends of the top and bottom bars.

With two straps, one passing through each upper port, crane the follower into position at the free end of the top and bottom bars. Ensure correct orientation. The top and bottom 'diamond' of the follower will enter the inside of the top bar and bottom bar respectively.

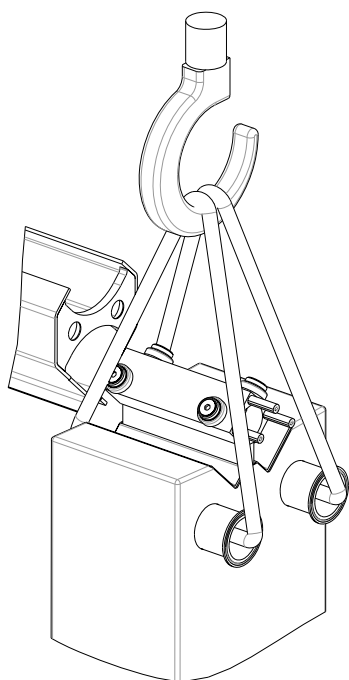


Figure 8

Lower the follower slightly such that the side facing the head is about 500 mm (20") from the free end of the top/bottom bars. The rollers will rest on the inside of the top bar. The crane and straps may now be removed.

4 Tie bar assembly

If the tie bars have not yet been inserted AND there is space at the head end to insert both top and bottom tie bars, it will be easier to perform the following fixed nut assembly procedure before installing the tie bars. In this case, skip the next paragraph.

If the tie bars have not yet been inserted AND can only be installed from the end support end, lightly grease them (white, food grade) while leaving 250 mm (10") grease-free at each end and carefully insert one in each top and bottom bar assembly, through the follower 'diamonds' and extending past the head about 300mm (1ft). A strap may be helpful to lift the tie bars through the 'diamonds' in the follower.

4.1 Fixed nut assembly

At the head end, screw one S.S. collar onto the protruding end of each tie bar leaving about 6.33" [161

mm] of exposed thread. The S.S. collars are symmetrical.

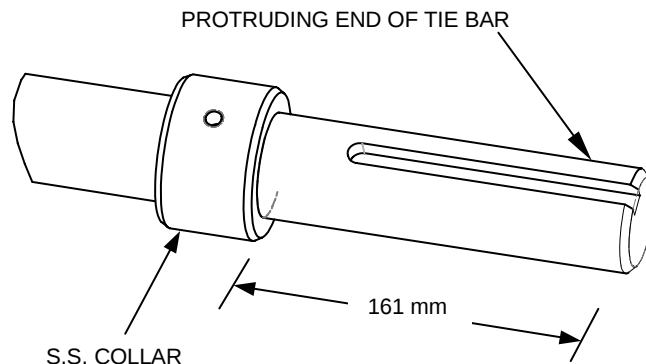


Figure 9

Lightly grease (white, food grade) and install one ball bearing (100 x 65 x 18) onto the long neck of each fixed nut.

Install the 'shaft' washers of the thrust roller bearings onto the short neck of the fixed nuts. Ensure that the bearing face (no lettering) is facing outwards (ie: visible). Pack the roller cages with black Lithium grease and install next to the 'shaft' washers.

Screw the fixed nut assemblies onto the tie bars, thrust bearing first, until the trailing face of the fixed nuts are flush with the ends of the tie bars. Now rotate the fixed nuts anti-clockwise until the keyways align. Fully insert the keys (1/2" x 3/8" x 120mm long).

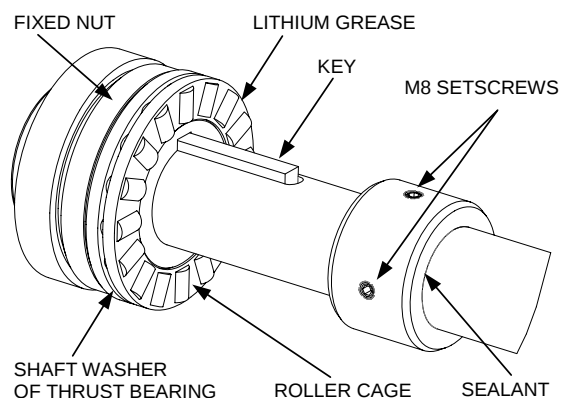


Figure 10

Rotate the S.S. collars again to achieve a dimension of 3.54" [90 mm] between the closest faces of the collar and fixed nut. Mark the tie bars adjacent to the

front face of the collar (eg: use a black marker or tape). Back the collars toward the fixed nut about 1-3/4" (40mm) and apply a full ring of clear RTV sealant around the tie bars immediately behind the marks (toward the collar).

The sealant provides a liquid barrier and helps to retain the collars in position. Wind the collars forward over the sealant and stop at the 3.54" [90mm] dimension described above. Use a 90 mm rod as a gauge.

Install and tighten the three M8 x 10 mm long setscrews on each assembly using Loctite 246. Note that the setscrews on the fixed nuts protrude slightly to retain the ball bearings. Remove excess sealant from the front faces of the collars.

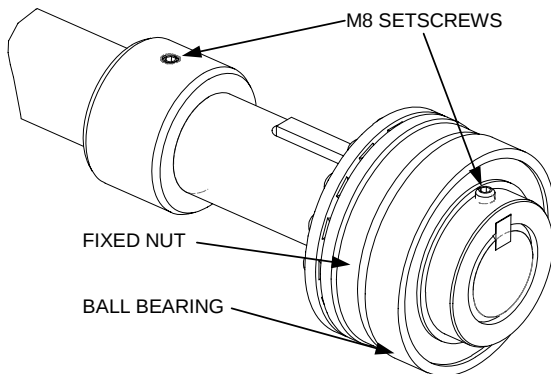


Figure 11

If the tie bars are not yet installed, lightly grease them (white, food grade) while leaving 250 mm (10") grease-free at each end and carefully install each one through the head and through the follower 'diamonds'.

Confirm that the thrust bearing 'housing' washers are still properly seated at the bottom of the counterbores in the head. Push the tie bars 'home' so that the fixed nut/thrust bearing assemblies seat in the deep counterbores in the head and the S.S. collars pass through the inner ball bearings and lip seals. Ensure that the thrust bearings are fully seated.

4.2 Free nut installation

Lubricate with white, food grade grease the leading and trailing faces of the two Al/Bronze free nuts and wind them onto the top and bottom tie bars until they almost touch the end of the top and bottom bars.

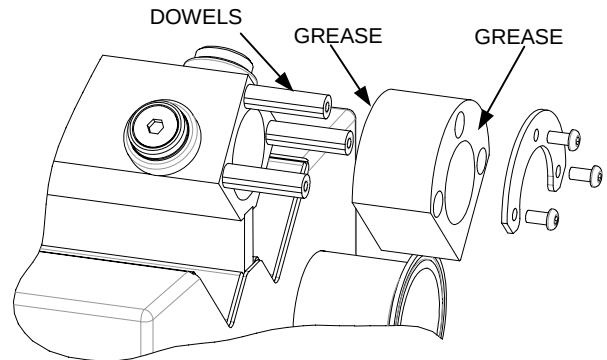


Figure 12

Align the 'V' points of the free nuts to face each other and using the special tie bar socket tool *, rotate the tie bars counter-clockwise while assisting the free nuts past the end of the top/bottom bars and towards the follower. Continue rotating until the three holes in each nut engage over the three dowel pins protruding from the follower 'diamonds'. * A sprocket and key may be used as a substitute for the special tie bar socket tool, rotated with gloved hands.

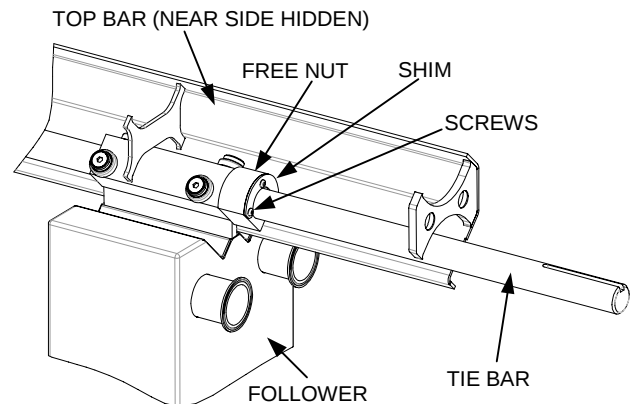


Figure 13

Install the two 'horseshoe' shims onto the ends of the dowels using 1/4"-20 S.S. x 1/2" long socket head button screws (use 5/32" A/F hex key). Three screws are used per shim and installed with Loctite 246. Note that a 0.5mm gap will result so the free nuts will not be clamped by the shims.

4.3 Initial synchronization

Ensure that the leading edge of the top and bottom free nut measure the same distance from the head before continuing. Rotate the top tie bar to bring the free nuts into alignment if necessary.

5 End support assembly

Confirm that the tie bar roller bearings have been installed on the inside of the end support in the 'dogbone'. This helps protect the lip seals during end support assembly. If bearing installation is necessary, lightly grease (white, food grade) two bearings (100 x 65 x 18) and place one in each counterbore. (No Loctite is required). Confirm that the two tie bar lip seals are installed.

Apply a coating of white, food grade grease to the remaining four carry bar O—Rings (0.921" I/D x 0.139" sect) and insert them into the four cladding recess of the top and bottom bar bolt holes in the end support.

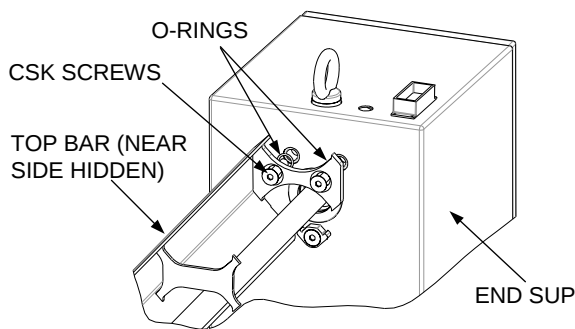


Figure 14

Crane the end support close to but not touching the free ends of the top and bottom bars (eg: 20 mm away) using a strap/chain through the eyebolt provided. Line up the top bar bolt holes and loosely engage two M24 x 70 mm long countersunk socket head screws applying Loctite 246. Line up the bottom bar bolt holes and loosely engage the last two M24 x 70 mm long countersunk socket head screws applying Loctite 246.

With both the top bar and bottom bar screws engaged, evenly tighten all four, ensuring that the top and bottom bars engage with their respective location blocks.

The straps/chains may now be removed from the end support.

6 Machine leveling

It is now important to level the machine before continuing, even if subsequent relocation and leveling is expected.

Starting with all ballfeet fully inserted, level the machine in all three planes by turning the flats with a wrench (1.42" [36 mm] A/F). Use a bubble (spirit) level on the side and 'drive nut face' of the end support. Also check the bottom bar. Each ballfoot is provided with +/- 2" [50 mm] adjustment. During adjustment, the ballfoot thread should never become visible.

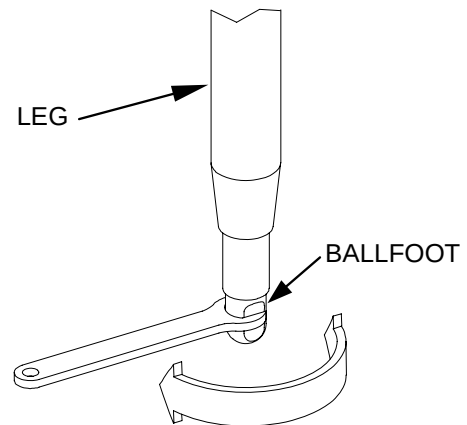


Figure 15

7 Tie bar bush assembly

Screw the long tie bar bush, flats first, onto the end of the top tie bar from inside the end support.

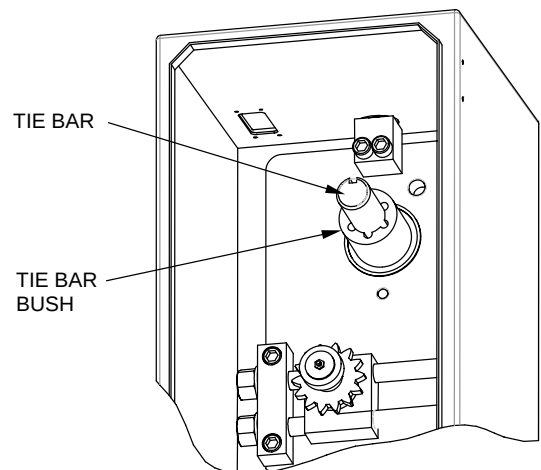


Figure 16

Screw the short tie bar bush, flats first, onto the end of the bottom tie bar from inside the end support.

Hand tighten the bushes home, ensuring that their necks pass inside the ball bearings and through the seals. The bushes will protrude from the face of the lip seal by about 1.75" (45mm).

7.1 Loading the tie bars

Rotate the top tie bar bush to provide access for an open ended wrench to engage with its flats (2.165" [55mm] A/F). Obtain help to hold the wrench in this position.

Using the special tie bar socket tool (manual Binary-Drive frames are supplied with a tightening tool which may be used for this purpose) rotate the tie bar anticlockwise as far as possible, by hand, using a 300 to 450 mm (1ft to 1'-6") long wrench. It is helpful to use an extension rod to place the wrench handle outside of the cabinet. Powered cabinets need at least 14" (350mm) extension. Manual cabinets need at least 5.25" (135mm) extension.

Line up the nearest tunnel with the keyway on the tie bar by applying a little more force if very close or backing off slightly. Push the key (3/8" x 1/2" x 65 mm long) into the 'tunnel' to lock the bush to the tie bar.

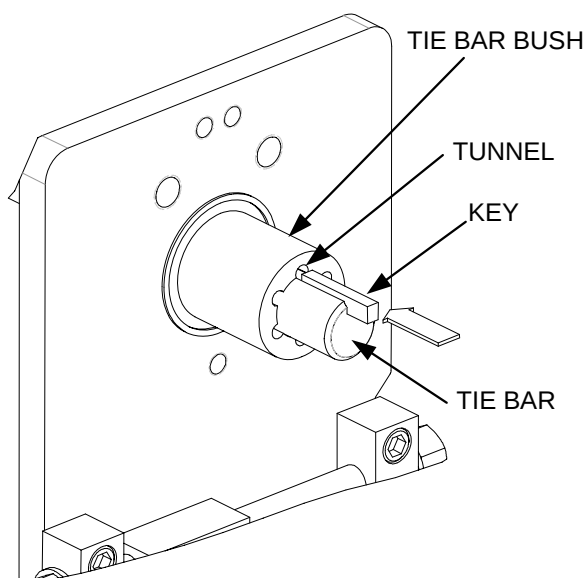


Figure 17

Note that there will be about 1.25" (32mm) of key that will not enter the bush. Repeat this step for the lower tie bar.

8 Drive assembly

Install one large sprocket on each tie bar ensuring engagement with the pre installed key. The hubs of the sprockets face outward.

Locate the two square pinch nuts and ensure that the M6 socket head screws are not tightened. Install a pinch nut (2.5" A/F [63.5mm]) on each tie bar and tighten each nut to ensure the sprocket is hard against its tie bar bush.

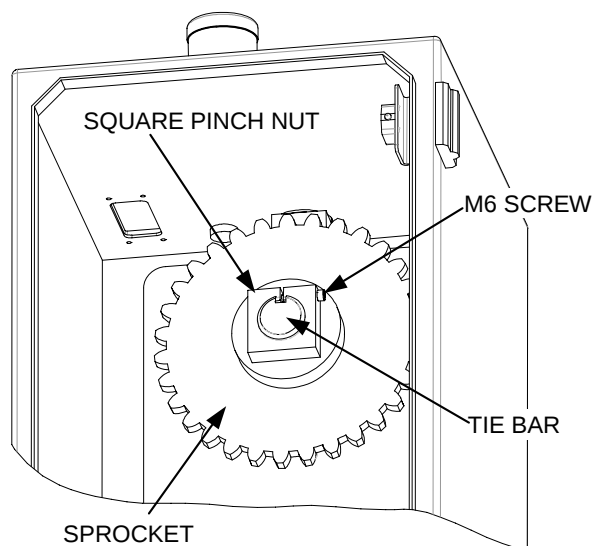


Figure 18

Tighten the M6 socket head cap screw (5mm A/F), applying Loctite 246, on each pinch nut to prevent rotation on the tie bar.

Tighten the two setscrews (3/16" A/F) on each sprocket applying Loctite 246.

De-adjust both idler sprockets toward the left side of the machine (if not already in this position) using the M24 ratchet wrench supplied.

To move the upper idler, turn the lower hex nut on the right, anticlockwise (off). To move the lower idler, turn the upper hex nut on the right, anticlockwise (off). See following illustration for locations.

8.1 Chain assembly

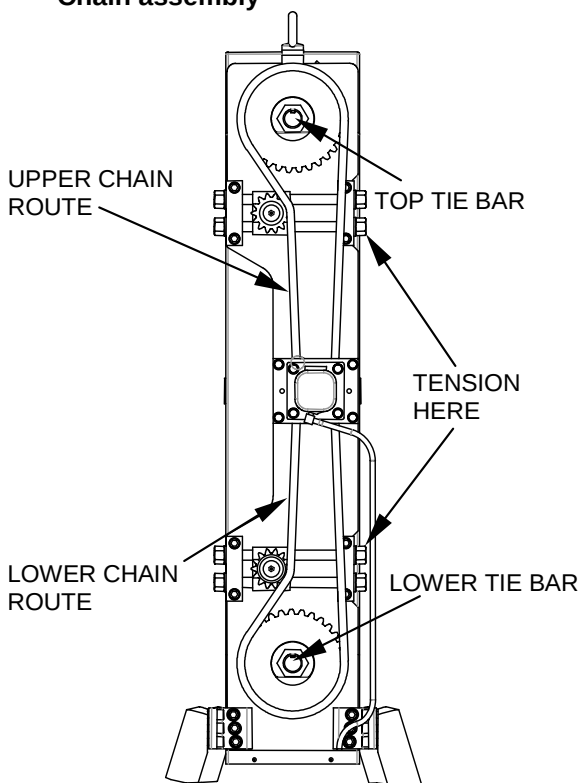


Figure 19

Before installing the two chains, confirm that the follower has not moved out of parallel to the head by measuring the distance between the leading edges of top and bottom free nuts and the head. Correct if necessary.

Locate and unpack the two drive chains and their master links. Install the lower chain and then the upper chain as illustrated above. Each chain goes around a small central sprocket, a larger tie bar sprocket and a small idler sprocket on the adjustment mechanism. Avoid rotating the tie bars while installing the chains.

Install the master link from the back of the chain to ease spring clip assembly.

Adjust each idler sprocket with the M24 ratchet wrench until each chain has become nearly taught on all three sides. The chains should have approximately 2 x chain width of slack in their longest length. Too much slack is **not desirable** since this is a bi-directional drive system.

Final synchronization can only be achieved with some compression on the follower and so will be performed after the plate pack has been installed.

9 Tie bar bush sealing

It is now necessary to seal the tie bar bushes. Obtain assistance to rotate the central drive shaft protruding through the inside face of the end support. Turn by hand wrench (1.81" [46mm] A/F).

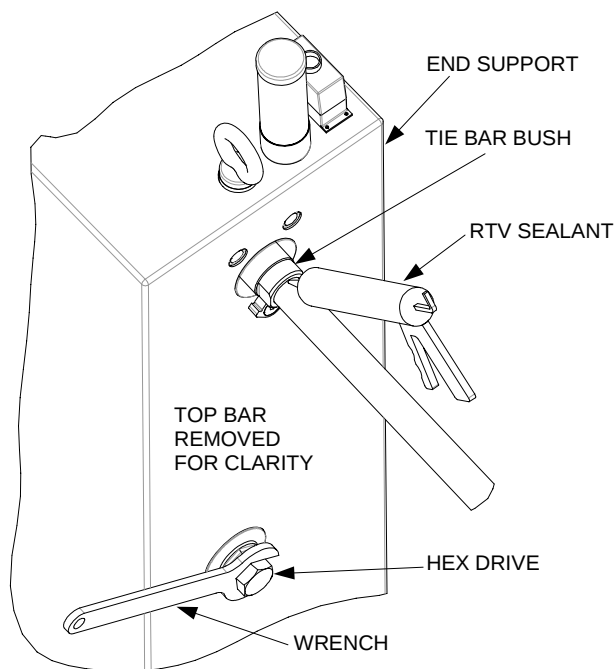


Figure 20

Apply a full ring of clear RTV sealant at the junction of the top tie bar and tie bar bush as the tie bar is rotated. Form a smooth radius and wipe off excess. Repeat this step for the lower tie bar.

10 Follower guide block

Apply a spot of white food grade grease to the two faces of the guide block that will be in contact with the inside of the bottom bar.

Install the follower guide block on the leading edge of the follower using the M8 x 30 mm long countersunk socket head screw (5mm A/F). Use Loctite 246 and tighten fully. If insertion between the bars is difficult, gently pry the bottom bar halves apart.

The guide block is square and so may be rotated 90 deg at a later date to provide additional wear life.

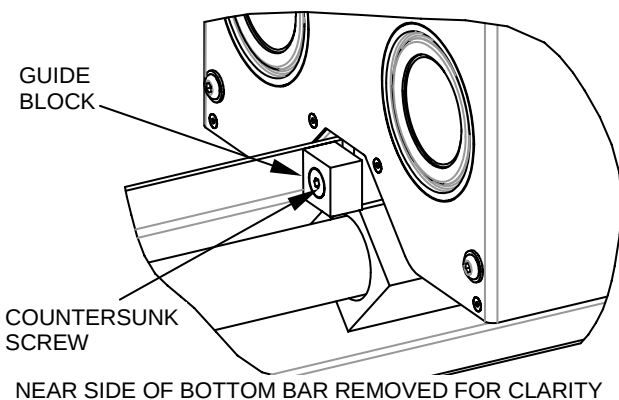


Figure 21

11 Greasing

Lightly lubricate the following surfaces with the recommended white, food grade grease. (See appendix at end of this document for grease recommendations).

- a) Top and bottom tie bars (if additional grease is necessary)
- b) Plate hanging surfaces of the top bar
- c) Outside vertical plate guide surfaces of the bottom bar
- d) Inside vertical plate guide surfaces of the bottom bar

12 Drive system

Before continuing with this procedure, install the appropriate drive system as follows:

If you purchased the powered version of the Binary-Drive frame, please proceed with the power pack installation. See POWER PACK ASSEMBLY section for details.

If you purchased the manual version of the Binary-Drive frame, please proceed with the manual drive assembly. See MANUAL DRIVE ASSEMBLY section for details.

Once the drive system is in place, return to this procedure to complete the frame assembly.

13 Final synchronization

Install the plate pack including any grids and other items.

Warning: Machine damage will occur while closing or opening if the follower and head are out of parallel by more than about 1/8" [3 mm]. For this reason, check that the follower remains parallel to the head within this band during the initial tightening process. If head and follower are out of parallel by more than the above figure prior to or during closing, stop tightening and make the following adjustment IMMEDIATELY.

Out of parallelism can occur if a thrust bearing was not properly sealed when initially synchronized and the machine is closed to pitch.

In service mode (if powered) or with the supplied ratchet wrench (if manual), close the machine to a point where the plate pack is clearly bound. This will place tension on the tie bars and remove any slack in the system.

Determine if the head and follower are parallel by measuring just below the top ports and just above the lower ports using a tape measure.

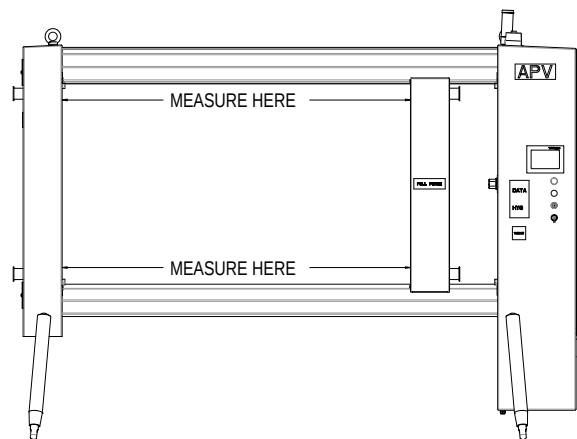


Figure 22

Measure on both sides of the machine. The machine is considered synchronized if the largest of the four dimensions is no more than about 0.040" (1 mm) larger than the smallest dimension. Ensure you measure inside the vertical corner radius of the head and follower cladding.

If the head and follower are parallel within the prescribed amount, you do not need to make further adjustment – go on to **Final frame assembly**. If the average difference between the top and bottom measurement is over 1 mm (0.040") a small adjustment is necessary.

Note the difference between the bottom and top using a negative figure if too tight at the top or positive figure if too loose at the top. Leave the bottom of the follower as the reference point.

One revolution of tie bar = 6.35 mm (1/4") of follower movement. Examples:

(a) If the top of the follower is 2 mm too tight (-2), you will need to rotate the sprocket about 1/3 revolution in a clockwise direction.

(b) If the top of the follower is 3 mm too loose (+3), you will need to rotate the sprocket about 1/2 turn in a counterclockwise direction.

Before attempting to rotate the sprocket, open the follower to fully relieve plate pack compression and then remove the top tie bar chain.

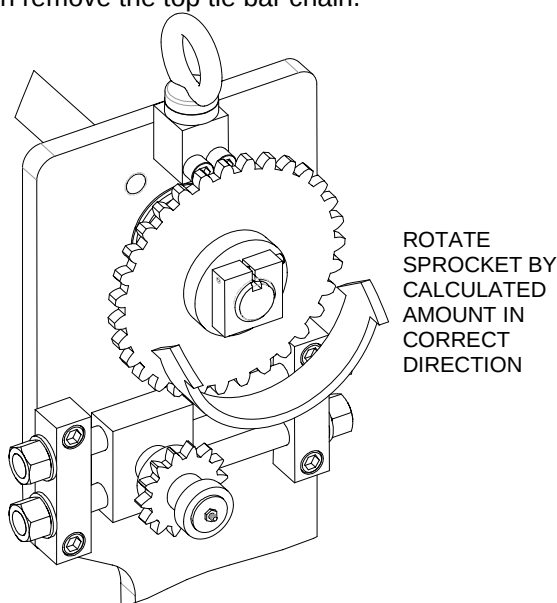


Figure 23

Rotate the top sprocket with gloved hands in the correct direction by the calculated amount and replace the chain and master link, re-adjusting its tension as necessary.

Now close the machine to the NOMINAL plate pack pitch and recheck the dimensions. Repeat the above procedure if necessary (extremely unlikely).

14 Final frame assembly

A few external items now need to be installed to complete assembly.

14.1 Top cap

Carefully squeeze and tap the grey plastic top cap into place between the top edges of the top bar. The cap occupies the full length of the top bar. A water spray will assist with installation but no sealant is necessary.

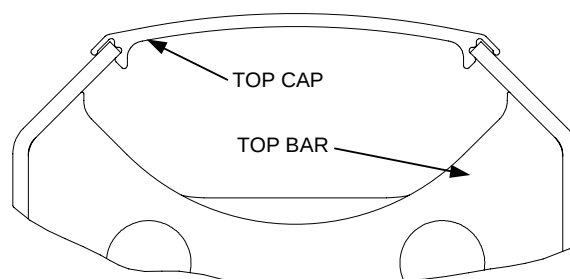


Figure 24

14.2 Tie bar covers

The head is provided with two large openings for tie bar access. A special cover assembly is provided to seal each of these openings.

First offer up the clamping plate to the hole in the cladding and rotate until it can pass through to the lock pins inside. After insertion, further rotate in a clockwise direction to 'lock' the clamp plate. Without the o-ring, offer up the outer disk assembly with the M8 button head screw and nylon sealing washer so that the screw engages into the thread in the clamping plate. Tighten the screw until the cover disk is almost home.

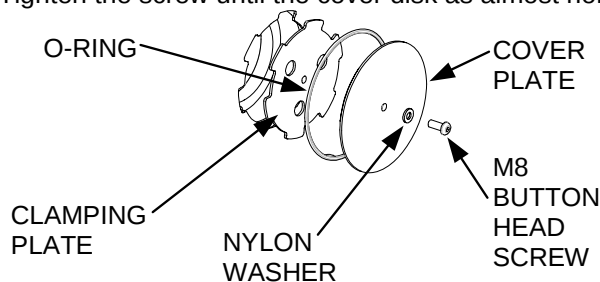


Figure 25

Lightly grease the O-Ring with white, food grade grease and stretch it over the cover disk until it drops into the recess behind the face. Fully tighten the screw. The O-Ring will remain visible. Repeat this step for the other cover.

14.3 Head cover

Install the lower head cover (correctly oriented – see Figure 26) on the underside of the head. Slide the cover over the location pegs and raise the cover into place. Secure the cover in place by using the two M4 stainless steel countersunk screws removed and stored earlier.

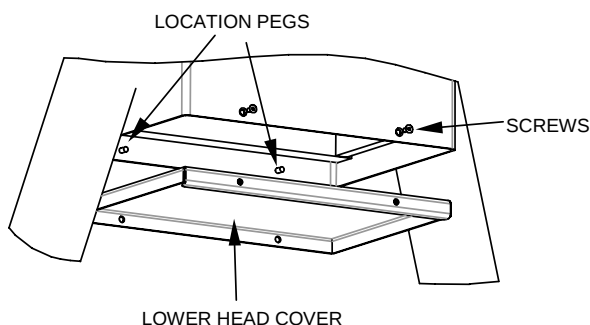


Figure 26

14.4 Sealing bungs

Once the machine is situated at its final location, the two lifting eyes, one at the head and one at the end support, should be removed and replaced with the supplied 30 mm diameter black plastic bungs (bagged with the customer drawing).

Apply a ring of clear RTV sealant around each hole before installing bungs. Remove excess sealant after installation.

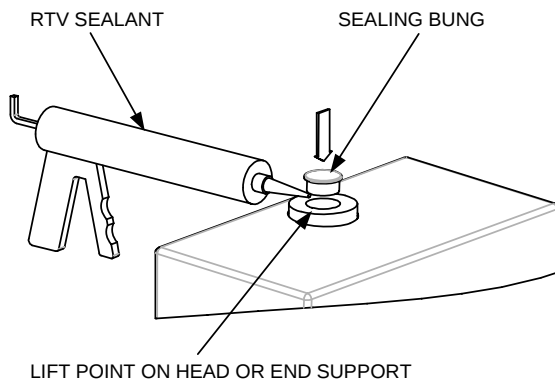


Figure 27

15 APPENDIX

During frame assembly and for continued trouble free operation, the following greases are recommended. It is also recommended that you continue to use the same greases for maintenance as used in initial assembly.

15.1 Recommended food grade greases

a. Rocol Foodlube ® Multi Paste

15750 85g Tube

15751 400ml aerosol

15753 500g can

15756 5kg can

Ref: www.rocolnorthamerica.com

b. Loctite ® Food Grade Anti-Seize

51168 8-Ounce brush top can

Ref: www.loctite.us

c. Saf-T-Eze ® Food/Drug Anti-Seize

McMaster Carr part numbers

1404K11 8-Ounce brush top can

1404K12 14-Ounce Grease Gun Cartridge

1404K14 14-Ounce Container

1404K15 2 lb container

1404K16 1-gallon container

Ref: www.mcmaster.com

15.2 Recommended thrust bearing greases

a. Exxon Mobil Corporation Mobilith ® AW-2

Ref: www.mobil.com/USA-English/Lubes

b. Exxon Mobil Corporation Mobilgrease ® XHP 222

Ref: www.mobil.com/USA-English/Lubes

c. Bostik Never Seez ® Black Moly

NSB150 1 lb can

NSBC-1 14.1-Ounce cartridge

NSB-35B 35 lb pail

Ref: www.rocolnorthamerica.com

1 Installing the hydraulic motor

The hydraulic motor is normally supplied pre-installed in the end support for both assembled and unassembled frames. However, follow this procedure should assembly be necessary.

Locate and attach the two identical (larger diameter) flexible hydraulic hoses to the hydraulic motor using one short and one long elbow. Arrange the hoses as illustrated.

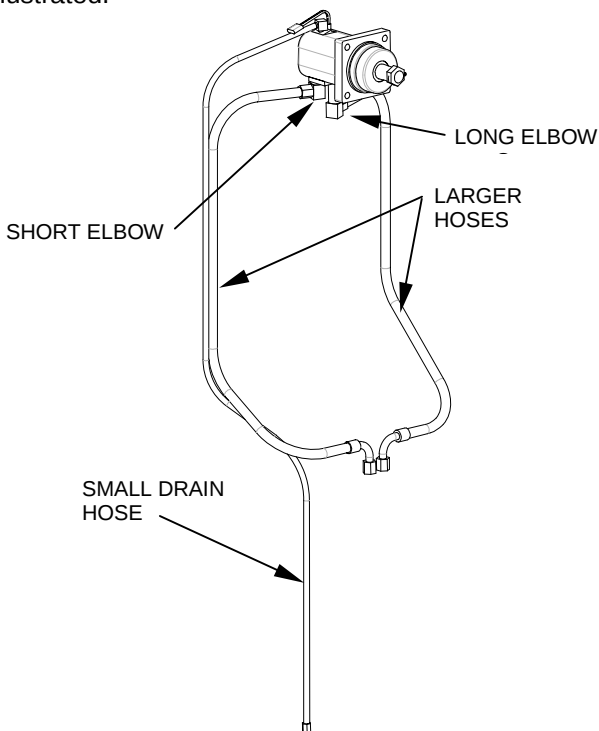


Figure 1

Locate and attach the smaller flexible hydraulic hose to the hydraulic motor.

Attach the hydraulic motor to the back of the motor plate (the side with the M24 hex nut) using four M12 hex bolts, nuts and 8 washers.

Warning:

All lifting equipment must have the proper capacity and be in good condition. Personnel must follow safe rigging practices at all times.

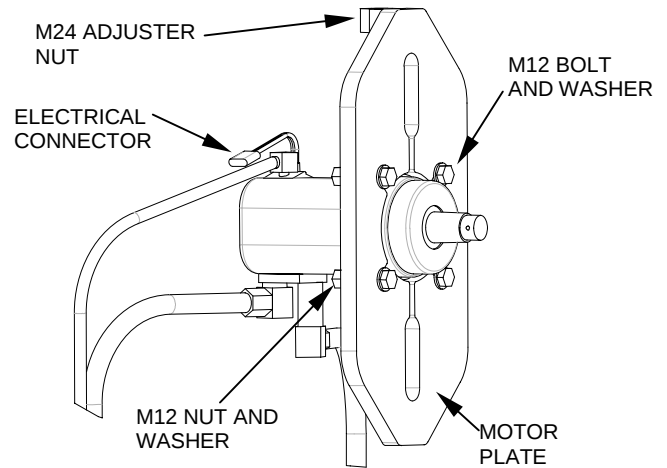


Figure 2

Pass the three hoses through the opening in the drive plate, feeding them downward in the back corners of the end support cabinet (larger ones on both sides, smaller one on left) and attach the motor plate to the drive plate using two M24 hex bolts, large washer (60mm O/D) and spring lock washers. Leave bolts slightly loose. Install one M24 hex bolt and large washer vertically into M24 adjuster nut on back of motor plate – do not tighten. A mechanical lift is recommended for this step. Assembly weight of motor and plate is 75 lbs [34 kg].

Join the three-conductor electrical connector (on the short cable that exits from the hydraulic motor) to its mating socket (on the long trailing cable that exits from the inner electrical box). Route the cable close to the left side hydraulic hose. Install sufficient cable ties to ensure the cable can never fall into the path of a chain.

Install the tapered hub sprocket and key on the hydraulic motor. Install and tighten the castle nut and cotter pin. Bend both legs of the cotter pin to prevent the nut from turning.

2 Installing the power pack

Inspect the inside of the end support to ensure that a strip of sealing tape has been applied around the perimeter of the opening which accepts the power pack. Confirm the presence of the oil level gauge and tightness of drain plug and copper washer. Ensure the oil tank is free of all loose items and is clean inside.

Pass a long lift strap between the back of the hydraulic manifold and vertical, steel pipe so that the strap can sit on the underside of the manifold support angle. Using this strap, lift the power pack into the opening at the bottom of the end support enclosure. Align the base plate bolt holes and install four corner bolts with washers. Remove the lift strap. A mechanical lift is recommended for this step. Assembly weight of power pack is 140 lbs [63.5 kg].

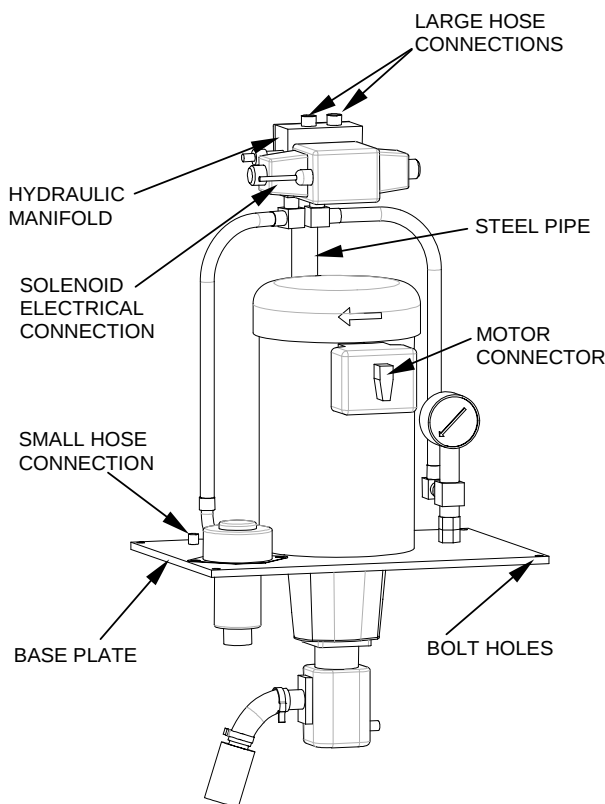


Figure 3

Connect the free end of each larger hydraulic hose to its respective port on the top of the solenoid valve. Connect the free end of the smaller hydraulic hose to the receptacle on the base plate behind the oil filler. See Figure 3.

Connect the free end of the electrical cord that exits from the left side of the solenoid to the receptacle on the underside of the inner electrical box labeled "SOL"

Connect the free end of the electrical cord that exits from the underside of the inner electrical box (labeled "MOTOR") to the receptacle on the front of the electric motor terminal box.

Install the large sprocket, hub outward, on the central drive shaft using the ½" square key provided. Align the outside face of this sprocket with the corresponding face of the small sprocket mounted on the shaft of the hydraulic motor. Use a straight edge to confirm alignment. Tighten the two setscrews on the large sprocket. Use loctite 246.

Wrap the chain around the large and small sprockets and install the connecting link from the back. Install the plate and two split pins. Bend both legs of both cotter pins outward to prevent accidental chain disassembly.

Confirm that the small sprocket on the hydraulic motor is properly retained with its hex nut and cotter pin.

Adjust the vertical, M24 chain tensioner hex bolt until the chain is fully taught and back off ¼ turn. Tighten both front facing M24 hex bolts fully.

Install sufficient cable ties to ensure that all cables and hoses can never fall into the path of a chain.

3 Hydraulic oil

Remove the black filler/filter cover from the power pack base plate and remove the installed filter.

Fill the tank with approximately 20 US gallons (75.7 litres) of A/W 32 hydraulic oil. Confirm that the oil is level with the upper fill line in the oil level gauge. Do not overfill. Clean any oil spills inside the enclosure.

Replace the filter and filler/filter cap securely.

At this point all frame and power pack assembly work should be complete. Make one final check that everything is in order, that no tools or other loose items are inside the end support enclosure and replace the M24 ratchet wrench in the provided holder.

Complete the power pack assembly by filling the oil reservoir with the recommended oil to the upper level on the externally mounted oil level/temperature gauge (just below large door). Refer to the HYDRAULIC SYSTEM section for the recommended hydraulic oil type and capacity. Clean any spills and close the end support door after filling the reservoir with oil.

Complete the electrical connections according to the details in the ELECTRICAL SYSTEM section.

1 Preparation

Before commencing with this section it is necessary to have fully completed the frame assembly work first. Both MANUAL and POWERED version assembly instructions are found in the FRAME ASSEMBLY section of this user manual.

2 Assembly

Locate and unpack the manual drive extension piece.

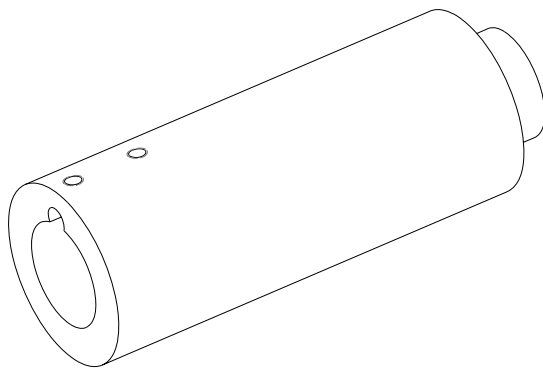


Figure 1

If the M30 x 60 mm long hexagon head S.S. screw has not been pre assembled into the extension piece, locate and unpack the screw also.

Insert the M30 x 60 mm long hexagon head screw into the tapped spigot using Loctite 277 and tighten fully.

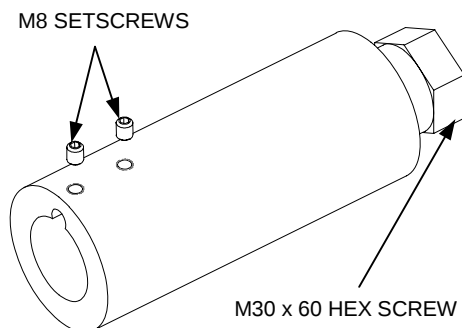


Figure 2

Install two M8 x 10mm long cup point setscrews into their respective tapped holes.

Slide the extension assembly over tie bar number 3 (lower left corner while looking into the end support cabinet) aligning the 'tunnel' with the key on the tie bar. Ensure that the end of the extension butts up to the face of the sprocket and tighten the two M8 setscrews hard onto the key using Loctite 246.

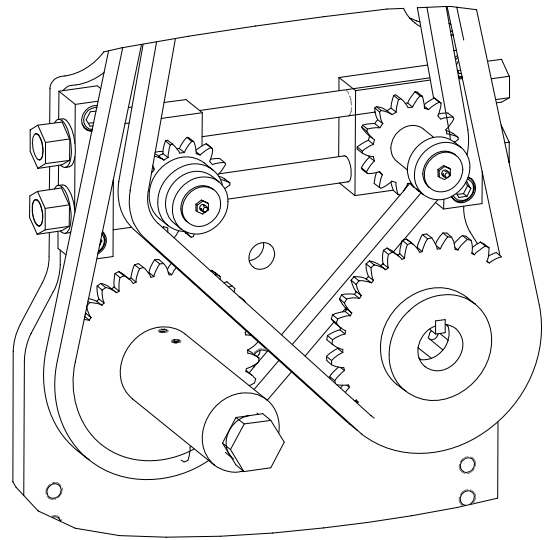


Figure 3

3 Use

This tightening position may now be used for rapid opening and closing of the frame.

During machine closing, once sufficient resistance is felt to make movement difficult, transfer the wrench to the central drive spindle and continue to close the machine to the required pitch.

To open the machine, use the central drive shaft first until movement becomes relatively easy and then transfer the wrench to tie bar number three and continue to open the machine.

1 Installing the hydraulic motor

The hydraulic motor is normally supplied pre-installed in the end support for both assembled and unassembled frames. However, follow this procedure should assembly be necessary.

Locate and attach the two identical (larger diameter) flexible hydraulic hoses to the hydraulic motor using one short and one long elbow. Arrange the hoses as illustrated.

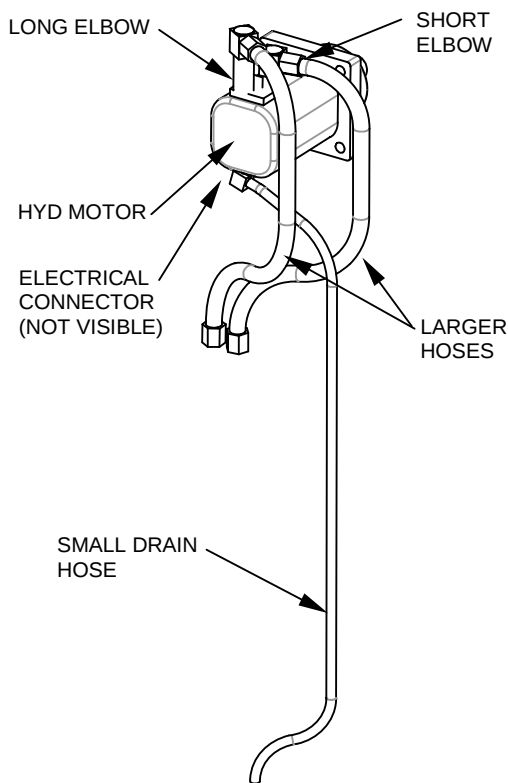


Figure 1

Locate and attach the smaller flexible hydraulic hose to the hydraulic motor. Orient elbow as shown.

If not yet installed, attach the four standoffs to the dogbone using Loctite 246 and then attach the motor plate to the standoffs with four M12 x 40 long hex head screws, four lock washers, four plain washers and Loctite 246.

Warning:

All lifting equipment must have the proper capacity and be in good condition. Personnel must follow safe rigging practices at all times.

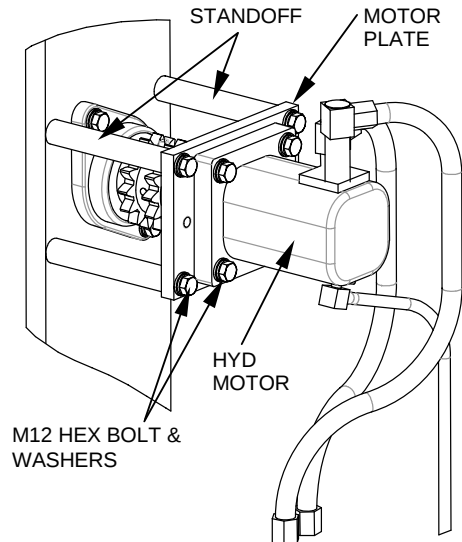


Figure 2

Fully insert the motor shaft into the drive shaft ensuring the supplied key on the motor shaft is aligned with the keyway in the drive shaft. Attach the correctly oriented hydraulic motor to the motor plate using four M12 x 40 long hex head screws, four lock washers, four plain washers and Loctite 246. See illustration above.

Join the three-conductor electrical connector (on the short cable that exits from the hydraulic motor) to its mating socket (on the long trailing cable that exits from the inner electrical box). Route the cable well away from the chains and sprockets. Install sufficient cable ties to ensure the cable can never fall into the path of a chain.

2 Installing the power pack

Inspect the underside of the Power Pack to ensure that a rubber seal strip has been applied and is in tact. Confirm the presence of the oil level gauge and tightness of drain plug and copper washer. Ensure the oil tank is free of all loose items and is clean inside.

Pass a long lift strap between the electric motor and the vertical steel pipe so that the strap can sit on the underside of the manifold support angle. Using this strap, lift the power pack into the opening at the bottom of the end support enclosure. Align the base plate bolt holes and install four corner screws (M8 button head screws) with plain washers. Remove the lift strap. A mechanical lift is recommended for this step. Assembly weight of power pack is 140 lbs [63.5 kg].

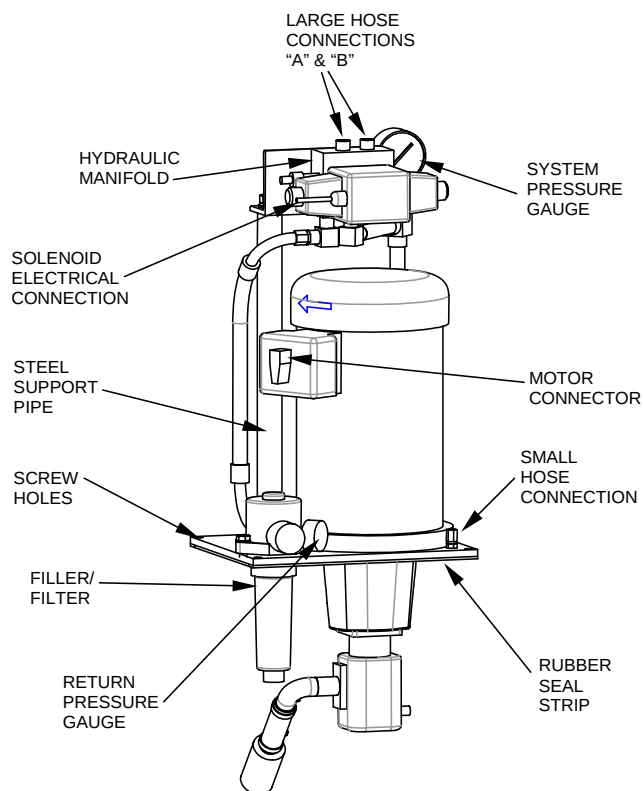


Figure 3

Connect the free end of each larger hydraulic hose to its respective port on the top of the solenoid valve ("A" & "B"). Connect the free end of the smaller hydraulic hose to the receptacle on the base plate to the front and right of the motor. See Figure 3.

Connect the free end of the electrical cord that exits from the left side of the solenoid to the receptacle on the front side of the inner electrical box labeled "SOL"

Connect the free end of the electrical cord that exits from the back of the inner electrical box to the receptacle on the front of the electric motor terminal box.

Install sufficient cable ties to ensure that all cables and hoses can never fall into the path of a chain.

3 Hydraulic oil

Remove the filler/filter cover from the power pack base plate and remove the installed filter.

Fill the tank with approximately 20 US gallons (75.7 litres) of A/W 32 hydraulic oil. Confirm that the oil is
UM-BDP POWER PACK ASSEMBLY 02.doc
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level with the upper fill line in the oil level/temperature gauge. Do not overfill. Clean any oil spills inside the enclosure.

Replace the filter and filler/filter cap securely.

At this point all frame and power pack assembly work should be complete. Make one final check that everything is in order, that no tools or other loose items are inside the end support enclosure and replace the M24 ratchet wrench in the provided holder.

Reinstall and close the end support door.

STOP: Although the frame assembly is now complete it is essential that **correct motor rotation** is established BEFORE running the machine. See the procedure described in '3.2 Motor rotation' in the ELECTRICAL SYSTEM section. Also complete the electrical connections described in this section.

1 Preparation

Before commencing with this section it is necessary to have fully completed the frame assembly work. Both MANUAL and POWERED version assembly instructions are found in the FRAME ASSEMBLY section of this user manual.

2 Tie bar extension piece

Locate and unpack the manual tie bar extension piece which should be found and can be stored inside the end support cabinet.

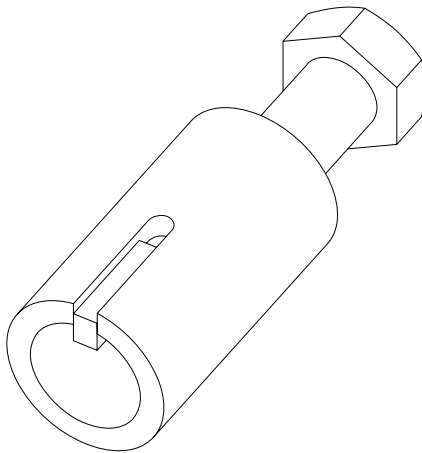


Figure 1

The extension is provided with an M30 hexagon at one end (46mm A/F) and a socket with integral key at the other. The hexagon is long enough to protrude past the door opening allowing full access for tightening and loosening.

3 Installation

It is not necessary to remove the door but if extensive tightening or loosening is anticipated, especially with the wrench on the door side, the end support door may be removed by lifting it off its hinges. Place the door in a location where it cannot be damaged or fall.

With the end support door open (or removed), offer the extension piece up to the exposed portion of the lower tie bar. Rotate the extension until the key engages with the keyway on the tie bar. Push the extension up against the jamb nut.

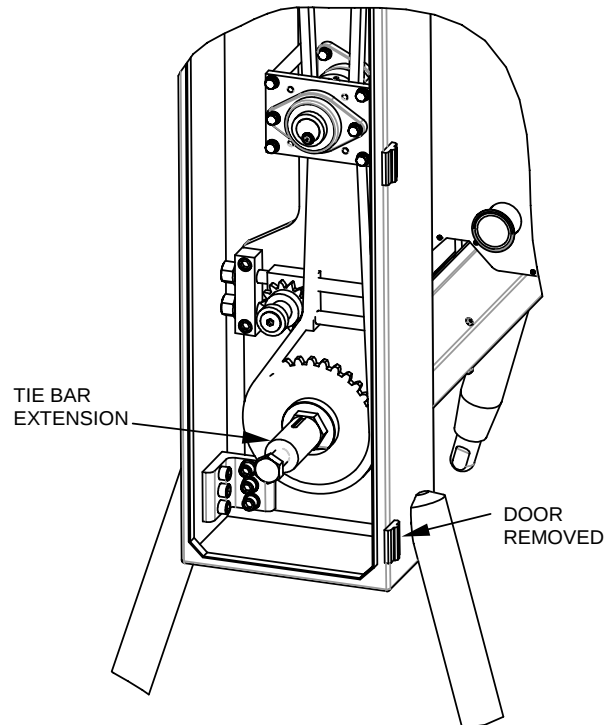


Figure 2

4 Use

Use the supplied ratchet wrench, which should also be located and stored inside the end support. This tightening position may now be used for rapid opening and closing of the frame.

During machine closing, once sufficient resistance is felt to make wrench movement difficult, transfer the wrench to the central drive shaft (also M30), located on the outside of the end support, facing the follower, and continue to close the machine to the required pitch.

To open the machine, use the central drive shaft first until movement becomes relatively easy and then transfer the wrench to the tie bar extension and continue to open the machine.

Remove the tie bar extension and close (or replace and close) the end support door before operating or cleaning the machine.

1 Description

The Quad/Binary-Drive electrical system is primarily housed inside the small electrical cabinet(s) on the side(s) of the end support enclosure. The system is UL508/CUL compliant.

Power is supplied to the Quad/Binary-Drive Paraflow via an hermetically sealed connector situated on the top of the end support enclosure. A mating connector is supplied with each machine. See '2 VOLTAGE' for standard voltage and current ratings available. See '3 WIRING DETAILS' for Quad/Binary-Drive electrical connection.

The backlit, touch screen LCD display on the side of the end support provides a user interface to control the system and feedback to the user. See SCREEN OPERATION section for instructions on how to operate the Quad/Binary-Drive Paraflow.

Below the screen are situated a key switch (2 keys supplied) for switching on the electric motor (which energizes the hydraulic system), a green light (which confirms that the electric motor is running) and a red emergency stop button which cuts power to the electric motor (effectively halting all mechanical movement).

A safety cutoff switch is situated behind the large end support enclosure door to disable mechanical movement should the door be opened during operation. The door must be in the closed position for the electrical and therefore hydraulic system to function.

The Siemens PLC (Programmable Logic Control) and electrical components are housed inside the small internal electrical cabinet. The cabinet door (external for the Quad-Drive) or cover (internal for the Binary-Drive) is secured by two M8 button head screws (5mm A/F key) and sealing washers.

The Allen Bradley PLC and screen are housed in an externally mounted NEMA 4X enclosure on the opposite side to the internal electrical cabinet. The remaining electrical components are distributed between this external enclosure and the internal cabinet.

The PLC sends and receives information to provide accurate follower positioning. Should it be necessary to open the door or cover of the internal electrical cabinet, ensure that the sealing washers are replaced with the screws.

A service mode is provided to facilitate machine setup and offer continued operation should there ever be any failure of the PLC, screen or associated components. See **4 Service Mode** for details.

It is quite acceptable to power down the machine after operation for an indefinite period of time. The PLC is designed to permanently store all critical data.

2 Voltage

Standard powered Quad/Binary-Drive machines may be supplied to suit one of the voltage options as follows.

460 VAC 3-phase 60Hz 15 amp
400 VAC 3-Phase 50Hz 18 amp (European)
(Non-standard 230 VAC Single-phase 60Hz 30 amp)

3 Wiring details



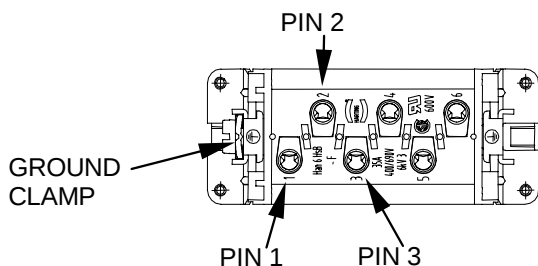
WARNING! RISK OF ELECTRIC SHOCK

The following operations must be performed by a qualified electrician.

The customer is required to provide a suitably sized drop lead, conforming to all local and national electrical codes, and a breaker box situated within sight of the Paraflow and easily accessible in case of emergency. Do not lay electrical cable on the floor.

3.1 Power in connector

Remove the mating connector from the top of the end support enclosure by pressing down firmly on the clips at each end of the connector. Remove the connector block from the hood. The following illustration shows the back of the connector block.



Connect the cables as follows:

460VAC and 400VAC SYSTEMS

Line 1 to Pin 1

Line 2 to Pin 2

Line 3 to Pin 3

Ground to Ground clamp

230VAC SYSTEM (No longer offered as standard)

Hot to Pin 1

Neutral to Pin 2

Ground to Ground clamp.

Ensure that all wires are properly fastened in their correct positions and no loose or bare wires are present. Replace hood and secure cable gland to prevent ingress of liquid. Connect the cable to its mating receptacle on the top of the enclosure.

3.2 Motor rotation

Before any powered operation, it is essential that correct motor rotation be established.

Unlock, but don't open the large door handle to provide quick access to the enclosure. Next, briefly operate the key switch on and off to energize the motor and immediately open the enclosure door to observe the fan rotation direction (seen through the motor cowling).

If the rotation does not match the rotation indicator arrow (clockwise looking down on the motor cowling), then the motor polarity must be reversed. If you need to reverse motor direction, disconnect power from the machine first! Then disconnect the power cable from the motor junction box and remove the cover plate on the junction box (the cover plate houses the motor connector receptacle). Swap any two of the white motor wires and replace the cover plate securely. Reconnect the motor power cable and restore the power to the machine.

Perform the motor rotation check once again to confirm a correct wire swap. Close and lock the enclosure door. The Quad/Binary-Drive Paraflow is now ready for normal operation.

4 Service mode

The service mode switches are provided for factory setup and customer emergency situations. This mode should only be used if the PLC or screen has failed (For example from lightening strike, power surge, incorrect voltage or physical damage) and the machine must be opened or closed.

WARNING! When the Paraflow is placed in service mode, the PLC is totally uncoupled from the system and no longer updates the position of the follower when moving. In addition, all safeguards programmed into the PLC, which prevent machine or component damage, will not function in service mode.

NOTE: If the follower is moved, even briefly, in the service mode, returning to normal PLC/screen operation will require the FOLLOWER POSITION to be reset. See SCREEN OPERATION section for details.

Service Mode operation:

Before running in 'Service Mode' it is helpful to note the CLOSED DIMENSION on the OPERATION screen.

Open the large End Support door and locate the 'Service Mode' switch on the left side of the cabinet (mounted on the side of the electrical box). Turn the switch to the ON position. The hydraulic system will start running. Close the door.

On the front panel, below the keyswitch, locate the 'Service Mode' OPEN and CLOSE switch.

Before operating the machine ensure that all personnel are clear of the follower and plate pack. Operate this switch as required noting that a tape measure will be required to close the machine to it's correct pitch using the CLOSED DIMENSION noted above.

When operation is complete, return the 'Service Mode' switch inside the End Support to the OFF position (overheating and machine damage can occur if left running). Ensure that the large end support door is closed.

5 PLC software upgrade

From time to time, APV may upgrade the PLC and HMI (screen) software to add functionality or address user issues.

Upgrades can be provided to the customer in the form of an exchanged PLC, a memory cartridge module from which the new software is transferred or fully installed by APV personnel from a laptop running the source software.

Upgrading from memory cartridge requires installing the supplied cartridge onto the PLC. Once installed, the new software will be transferred to the PLC on power up. Clear, step-by-step instructions are available and will be provided with the memory cartridge (see document UM-XDP MEMORY CARTRIDGE). After upgrade the cartridge MUST be removed from the PLC and should be returned to APV.

6 Fuses

If a fuse blows, it must be replaced with one of the same type and rating. If a new fuse blows immediately after replacement, contact APV for assistance in identifying the cause.

All fuses are located inside the internal electrical cabinet or external enclosure opposite depending upon make of PLC (Siemens or Allen-Bradley). Refer to the '8 Electrical arrangement' photos for exact locations.

7 Spares

Electrical spares for your specific machine will vary depending upon the manufacturer of the control system (Siemens or Allen-Bradley). Consult the following list as applicable.

Fuse 1 & 2

Rating: 1 AMP 460 V

Location: On the transformer

Notes: If either one of these fuses fail, no power will be supplied to transformer, PLC, screen, solenoid valve or motor starter.

These fuses provide protection to the transformer and are typically the last fuses to fail.

Fuse 3

Rating: 2 AMP 120 V

Location: On the transformer

Notes: If this fuse fails, no power will be supplied to the transformer, PLC, screen, solenoid valve or motor starter.

This fuse provides protection to the PLC / Solenoid Valve / motor starter.

Fuse 4 & 5

Rating: 2 AMP 120 V

Location: Left and centre fuse holder

Notes: If these fuses fail, no power is supplied to the solenoid valve. Although the electric motor will run, the hydraulic system will not work.

These fuses provide protection to the solenoid valve.

Fuse 6

Rating: 1 AMP 120 V

Location: Right fuse holder

Notes: If this fuse fails, no power is supplied to the motor starter. The electric motor cannot be started.

This fuse provides protection to the motor starter.

Note that fuses have not been allocated APV Part Numbers. Any spare fuses supplied with the machine will be located inside the small electrical cabinet.

7.1 Siemens Spares

Part	Description	APV Part No.
Screen (type 1 #)	SIEMENS TP070 HMI FOR S7-200 PLC WITH PROJECT	3900 2170
Screen (type 2 #)	SIEMENS TP177micro HMI FOR S7-200 PLC WITH PROJECT	3900 2169
PLC	SIEMENS PLC - S7-200 CPU-222 (AC/DC RELAY) WITH PROJECT	3900 2168
Transformer	DONGAN TRANSFORMER 100VA HC-0100-4100	3900 2167
Motor Starter Protector	SIEMENS MOTOR STARTER/PROTECTOR 3RV1011-1HA10 1MSP	3900 2166
Motor starter	SIEMENS MOTOR STARTER 3RT1016-1AK61	3900 2165
Relay	SIEMENS RELAY 3TX7144-1E6	3900 2164

The type installed in your machine is shown on the back of the screen.

7.2 Allen-Bradley Spares

A/B controlled machines can be supplied with a variety of PLC's. Please confirm the specific PLC model number before requesting spares by Part Number. It is also possible that an alternative to those shown below is supplied. APV records the PLC type with your machine data and can furnish this information if the heat exchanger serial number is known.

Part	Description	APV Part No.
Screen	A/B PANELVIEW PLUS 600 2711P-T6M2OA	
PLC L31	A/B PLC - COMPACTLOGIX PROCESSOR – 1769 L31	3900 2190
PLC L32E	A/B PLC - COMPACTLOGIX PROCESSOR – 1769 L32E	3900 2191
Power supply	A/B POWER SUPPLY - 1768-PA3	
I/O Module	A/B 6 IN 4 OUT COMBINATION MODULE - 1769-IQ6X0W4	
Motor starter protector	A/B 6.3-10A - 140M-C2E-C10	
Contactors	A/B 9A 120V CONTACTOR - 100-C09D10	
Relay	A/B DPDT 120V RELAY - 700-HF32A1	
Power supply	Rhino 24V DC power supply - PSP24-024S	

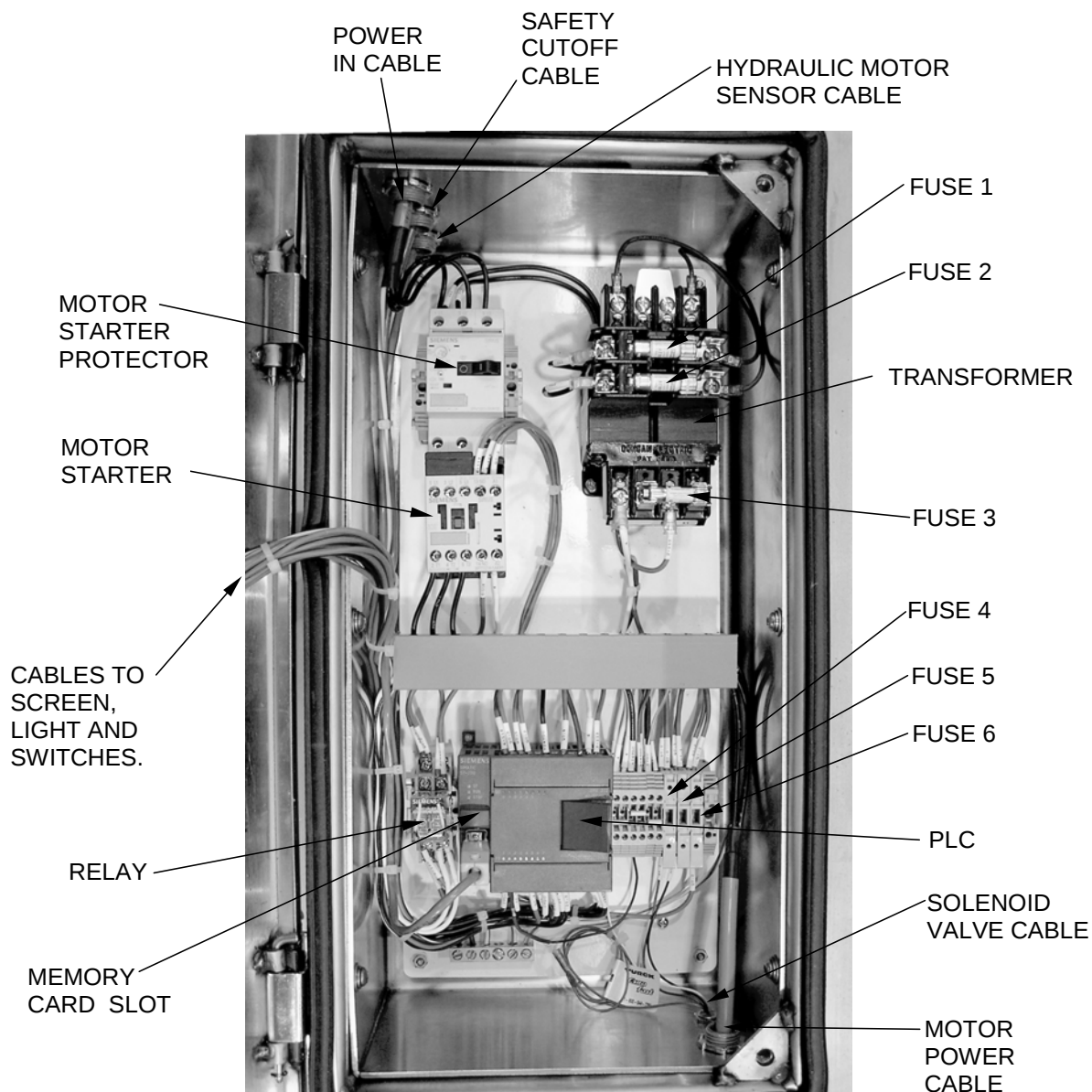
8 Electrical arrangement

The exact locations of the electrical components vary according to which frame they are installed on (Quad-Drive or Binary-Drive) and the manufacturer of the primary components (Siemens or Allen-Bradley).

8.1 Siemens

The following photo identifies the major electrical components within the internal electrical cabinet.

Quad-Drive (and some Binary-Drives): Illustrated (the door is opened from outside of the end support)
Most Binary-Drives: The same components are located in a generally straight vertical line. The cover is removed from the inside of the end support.



8.2 Allen-Bradley

A/B versions distribute the control components between the inner enclosure and outer Hoffman enclosure.

1 Description

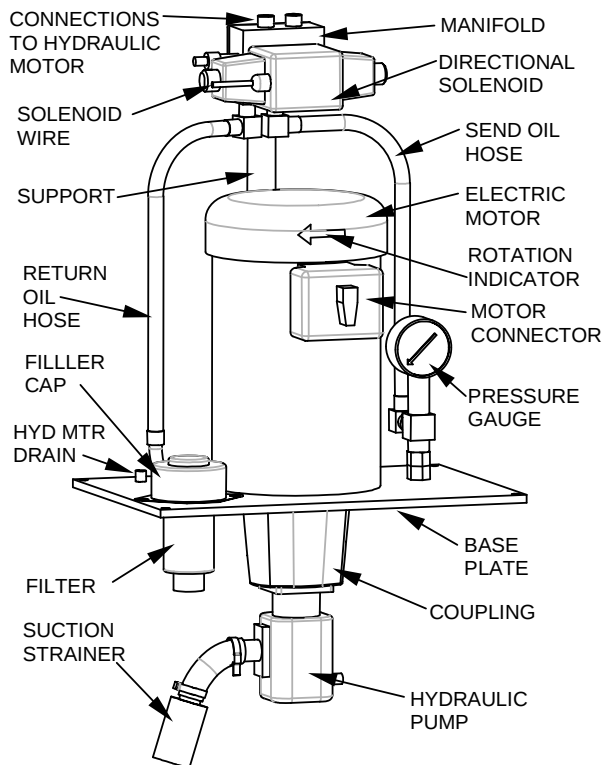
The Quad/Binary-Drive hydraulic system comprises two main components: a self-contained, power pack and an hydraulic motor. Three hydraulic hoses connect the hydraulic motor to the power pack. The lower portion of the end support enclosure acts as the hydraulic oil reservoir whose large surface area assists in cooling the oil.

An externally mounted oil level gauge with integral thermometer allows easy viewing of oil level, quality and temperature.

Oil is returned to the reservoir via a surface mounted cartridge type filter. A pressure gauge is mounted on the oil feed (high pressure) side of the hydraulic system.

An electronic sensor is incorporated into the hydraulic motor and is used by the PLC to ensure correct follower position.

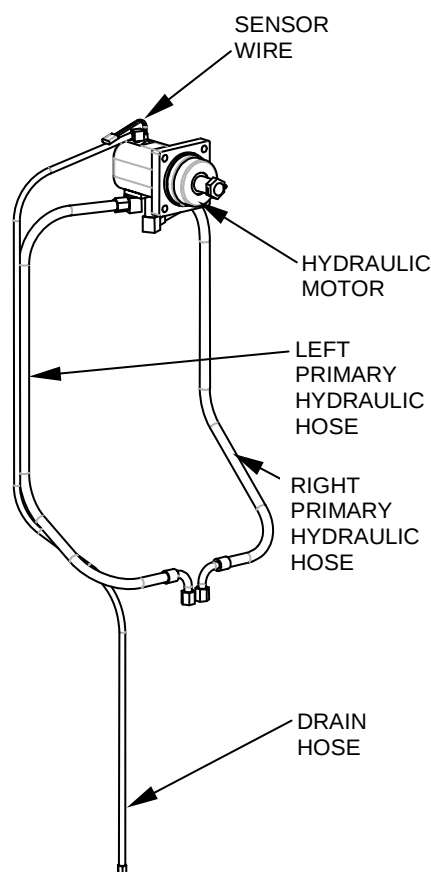
2 Power Pack components



Although more compact, the Binary-Drive Power Pack comprises almost the same components but with a slightly different layout.

3 Hydraulic motor

The following illustration shows the hydraulic motor and the three attached hoses as they would be routed inside the Quad-Drive end support enclosure. For Binary-Drive configuration, refer to the POWER PACK ASSEMBLY section, 1. Installing the hydraulic motor.



4 Principle of operation

The hydraulic system is energized by turning the key switch to the ON position (situated below the screen). The green light, also below the screen, will confirm that the system is running. When energized, the electric motor drives the hydraulic pump. In this condition, oil is circulated but not passed to the hydraulic motor. When the 'CLOSE' button is pressed

on the screen, the solenoid valve is energized which directs oil through the manifold via one of the two primary hydraulic hoses to the hydraulic motor. The solenoid valve is bi-directional enabling forward and reverse oil flow.

The power pack is a two-speed system that provides rapid Paraflow closing until about one inch (25mm) of the final compressed dimension. At this point, oil pressure is increased and the follower gradually slows until the PLC determines that the machine is at the final pitch. At pitch, the PLC de-energizes the solenoid and the hydraulic motor stops.

The hydraulic system continues to run while bypassing oil, until it is operated again ('OPEN' or 'CLOSE' is pressed) or switched off with the key.

The system will also shut itself off 5 minutes after the last screen operation.

The left and right primary hydraulic hoses feed the oil to and from the hydraulic motor while the third, smaller, hydraulic hose provides a return for bypassed oil from the hydraulic motor to the oil tank.

5 Manual Closing/Opening

If there is a failure in either the electrical supply/system or hydraulic system and it is necessary to open or close the heat exchanger, a manual procedure can be applied to achieve this. The procedure varies depending upon the type of machine in question.

An M30 (46mm A/F) socket and ratchet wrench is required for manual opening/closing. These items are not supplied as standard on powered machines. These options may, however, be purchased from APV using the following part numbers:

Description	APV P/N
Ratchet wrench 1" sq drive, 30" long	3900 1603
46mm A/F socket, 1" sq drive	3900 1604

5.1 Quad-Drive Procedure

a. Disconnect power (in case it should be restored during manual opening/closing)

b. Open end support door.

c. Remove the primary drive chain that runs between the hydraulic motor and large primary sprocket (carefully store the master link and two split pins)

d. Using an M30 wrench on the hexagon protruding from the primary drive sprocket, open or close the machine. Removal of the large end support door (by lifting it off its hinges) will assist with wrench access.

e. Before running in normal powered operation, replace the primary drive chain and rehang and close the end support door. See also **5.3 Caution** below.

5.2 Binary-Drive procedure

a. Disconnect power (in case it should be restored during manual opening/closing)

b. Open end support door.

c. Locate the ball valve at the top and to the right of the power pack (in front of the pressure gauge). The valve has a black handle and should be pointing towards you.

d. Rotate the handle ¼ turn to the right so that it points towards the right side of the cabinet. This allows pass through of hydraulic fluid when the hydraulic motor is rotated.

e. Using an M30 wrench on the hexagon protruding from the end support (facing the follower), open or close the machine.

f. Before running in normal powered operation, return the ball valve handle to its forward position and close the end support door. See also **5.3 Caution** below.

5.3 Caution

It will be necessary to perform a FOLLOWER POSITION reset operation after manual movement of the follower.

See the, SCREEN OPERATION section, SETTINGS, FOLLOWER POSITION for details.

6 Hose and fitting details

DESCRIPTION	NOMINAL HOSE SIZE	HYDRAULIC MOTOR FITTING TYPE	ATTACHMENT TO HYDRAULIC MOTOR	POWER PACK FITTING TYPE	ATTACHMENT TO POWER PACK
Left side primary hose	1/2" # QD=4', BD=2' 3000 psi rated	'O' Ring boss 90° male adaptor. 6801-08-10 90°	Port 'A'. (Closer to back of hydraulic motor)	Straight male adaptor 2404-08-08	Port 'A' on manifold. (On left side)
Right side primary hose	1/2" # QD=4', BD=2' 3000 psi rated	'O' Ring boss 90° male extra long adaptor. 6801-LL-08-10 90°	Port 'B'. (Farther from back of hydraulic motor)	Straight male adaptor 2404-08-08	Port 'B' on manifold (On right side)
Drain hose	1/4" * QD=65", BD=34" Low pressure.	'O' Ring boss 90° male adaptor. 6801-04-04 90°	Case drain point (Adjacent to sensor wire exit)	Straight male adaptor 2404-04-08	QD=Back left BD=Front right of base plate

Both primary hoses are identical with a straight 3/4-16 JIC female at one end and a 90° swivel 3/4-16 JIC female elbow at the other.

* The drain hose has a straight 7/16-20 JIC female thread at each end.

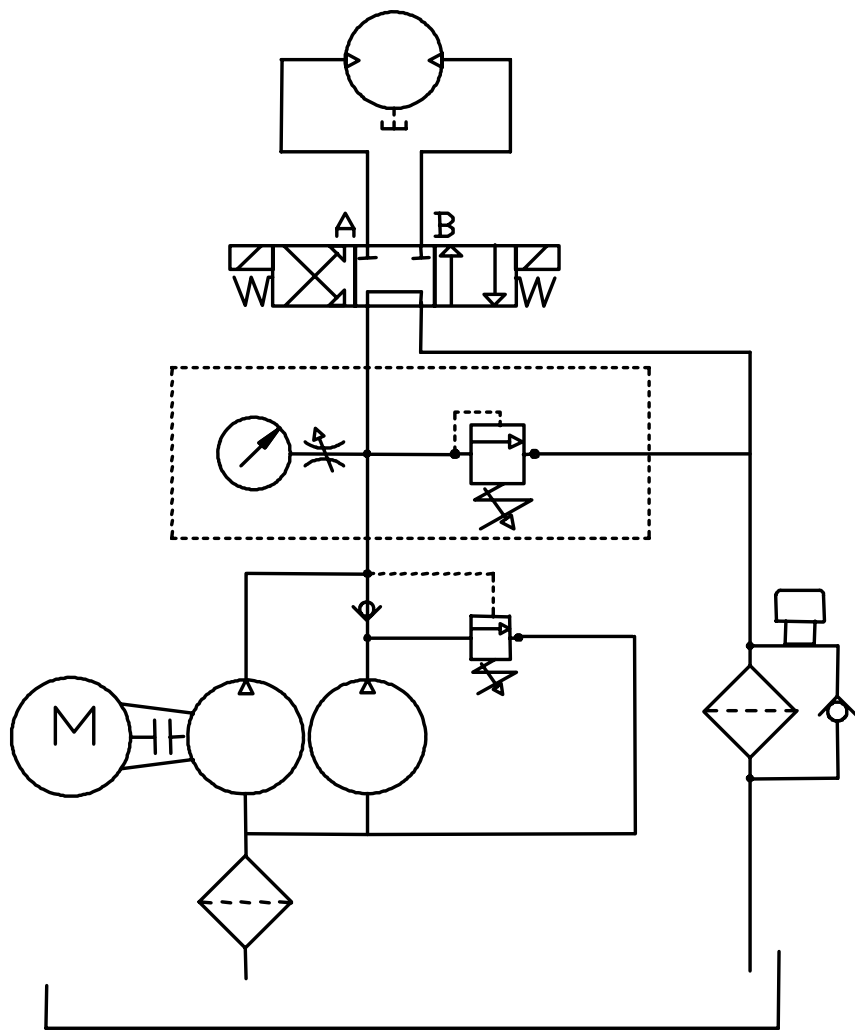
Replacement hoses and fittings can usually be obtained locally (refer to above table). However, should the need arise, a complete hose kit or other hydraulic system component can be supplied by calling APV service.

7 Spares

Part	Description	APV Part Number
Hydraulic oil (QD & BD)	20 US Gallons (75.7 litres) A/W 32	TA70445 (5 gal container) 4 required
Replacement filter cartridge (QD & BD)	ERB21NCC by UFI (Universal Filter International)	3900 1601
Complete hose and fitting kit	Three pieces as described in '5 Hose and fitting details' above.	3900 1572 (Quad-Drive) 3900 2021 (Binary-Drive)
Quad-Drive power pack 460V Binary-Drive power pack 460V Quad-Drive power pack 230V Binary-Drive power pack 230V Binary-Drive power pack 400V (EU)	Complete, self contained, drop in unit.	3900 1586 (Quad-Drive) 3900 2018 (Binary-Drive) 3900 1587 (Quad-Drive) 3900 2019 (Binary-Drive) 3900 2071 (Binary-Drive)
Hydraulic motor Quad-Drive Hydraulic motor Binary-Drive	Char-Lynn 2000 series with pulser	3900 1562 (Quad-Drive) 3900 2020 (Binary-Drive)

See MAINTENANCE QD & BD section for frequency of replacement and/or inspection for above items.

8 Hydraulic system schematic (Binary-Drive bypass not shown)



1 Introduction

The powered Quad/Binary-Drive Paraflow is equipped with a Programmable Logic Control (PLC) device and a backlit, high-resolution, LCD touch-screen display. When navigating the touch-screen, press the 'buttons' firmly.

See **5.0 Settings** to adjust screen contrast or change the units (inches or mm).

There are three user accessible screens for machine operation plus an opening screen. To change screens touch the appropriate tab at the top.

There are also SERVICE screens, which are only accessible via a password and used by APV to assist with setup and on-site service.

The screen shots in this section often include 'boxes' containing '00000...'. These boxes display information for the user.

IMPORTANT: Certain safeguards are built in to the PLC that prevent machine damage; however, before you operate this Paraflow, you must familiarize yourself with the location of the EMERGENCY-STOP (red button below the screen) and the SAFETY section within this manual.

1.1 Before you begin

- a) If the machine/screen does not respond as expected, see **7 Troubleshooting** at the end of this section.
- b) Ensure that the number of plates, grids and Divider Plates are correctly stored. See **4 Enquiry** for details.
- c) Ensure that the length of any pipe-work left on the follower connections when the machine is opened is correctly stored. This includes the case where blanks (port supports) are left on the machine when opened (most heat exchangers fall in this category). See **5.6 Fitting Length** for details.
- d) Ensure all personnel are clear of the tie bars, follower and plate pack before operation.

- e) Ensure that the End Support door is properly closed as it incorporates a safety cutoff switch.

1.2 Hydraulic system

The hydraulic system must be energized with the key switch, located below the screen, prior to powered opening or closing. A green light, below the screen, will indicate that the hydraulic system is running.

If the hydraulic system is left to idle for five minutes, it will automatically stop. To restart, switch the key 'OFF' and then 'ON' again.

It is recommended that the key be removed from the Paraflow after powered operation to prevent unauthorized or accidental operation or key breakage.

1.3 Screen Saver

The screensaver is usually set at the factory to 30 minutes but should this need to be changed or disabled follow these steps:

Whenever the machine is powered up, three buttons briefly appear during the boot sequence; Transfer, Start and Control Panel.

- a. Select the Control Panel button and double-tap the screensaver icon.
- b. Enter the required number of minutes and press enter. (The 30 minute setting ensured the screensaver would not activate during a normal open or close cycle). A zero will switch off the screensaver.
- c. Touch **ok** in the top right corner of the screen saver.
- d. Touch **X** in the top right corner of the Control Panel.
- e. Touch **Start** button to continue to initial screen.

When the screensaver appears, simply touch the screen anywhere to clear it and return to the previous screen.

Note that the password function only provides the means to restrict access to Control Panel options.

1.4 Memory backup

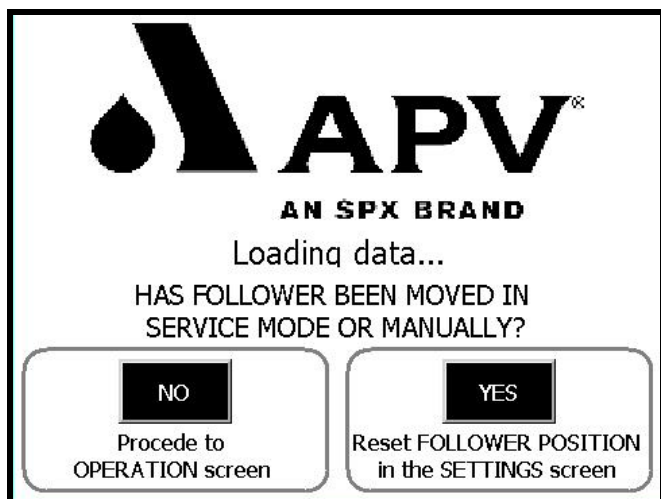
It is quite acceptable to power down the machine after operation for an indefinite period of time.

Although there is only a short-term (days) 'super capacitor' backup for RAM, all volatile machine data are stored to permanent memory when powered down.

Should the machine be switched off for extended periods of time (months), any data lost will be restored from permanent memory at the next power up.

2 Initial screen

After the boot sequence, the initial screen displays a Loading data... message followed by the machine type. Below this, a question is asked "HAS THE FOLLOWER BEEN MOVED IN SERVICE MODE OR MANUALLY?"



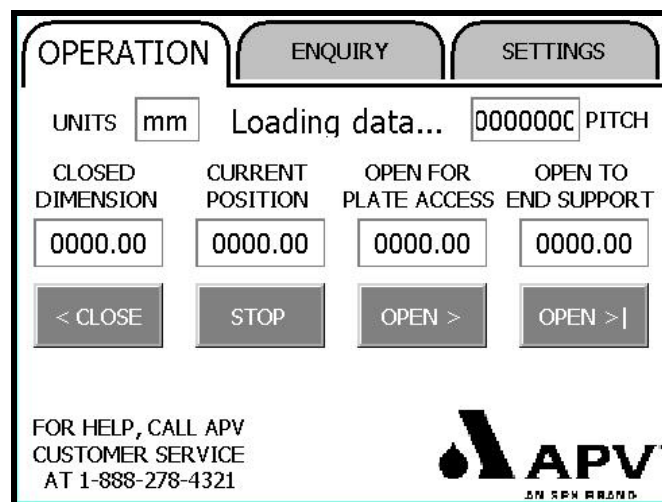
Press the **NO** button if the follower has not been moved since last normal operation. You will be taken to the OPERATION screen.

Press the **YES** button if the follower has been moved either in service mode (with power) or manually (using a wrench). You will be taken to the SETTINGS screen (via a warning message) where you will need to enter the new follower position.

If you move to the next screen while data is still loading, the Loading data... message will continue to show until data loading is complete.

3 Operation

This is the screen that will be displayed most of the time. Here you can perform the basic tasks of opening the Paraflow to access the plates and closing the machine to pitch.



3.1 Warning Strobe Light

Your machine is fitted with a movement warning system. A 5 second countdown appears on the screen prior to follower movement and a strobe light is activated during countdown and movement.

3.2 Open And Close

To **open** the machine:

- Turn the key to the 'ON' position (pump will start)
- Press **OPEN >** for plate access - OR Press **OPEN >|** to move follower to end support
- Turn key to 'OFF' when follower stops (pump will stop).

To **close** the machine:

- Turn the key to the 'ON' position (pump will start)
- Press **< CLOSE**
- Turn key to 'OFF' when follower stops (pump will stop).

To **prematurely stop** the machine:

- Press **STOP**
- Turn key to 'OFF' (pump will stop)

3.3 Information Shown

The two remaining tabs at the top of the screen take you to the other screens.

UNITS: Displays either inches or mm. All figures shown on the OPERATION screen are in the selected units. (TIP – touch the units to go to the SETTINGS screen if you wish to make a change).

Loading Data...: The frame type is displayed after the data has been loaded.

PITCH: The currently selected compressed plate pitch. See 5.4 PLATE PITCH for details. (TIP – touch the pitch to go to the SETTINGS screen if you wish to make a change).

CLOSED DIMENSION: The distance between the inside of the head and follower when the machine is closed.

CURRENT POSITION: The current distance between the inside of the head and follower. This is continuously updated as the follower moves.

OPEN FOR PLATE ACCESS: The distance between the inside of the head and follower when the machine is open sufficiently for access to any plate.

OPEN TO END SUPPORT: The distance between the inside of the head and follower when the machine is open fully. The follower (or attached pipework) will automatically stop 5mm before the End Support.

The text box below these buttons is used to inform you which operation is being performed or provide warning messages.

4 Enquiry

Touch the ENQUIRY tab to access the enquiry screen. This screen allows you to view (but not change) most parameters or settings within the machine.

OPERATION		ENQUIRY		SETTINGS	
DISPLAY PREV. PLATE	DISPLAY NEXT PLATE	MAXIMUM OPEN DIM 0000.00 ACTUAL FITTING LEN 0000.00 MAX FITTING LEN 0000.00 CURRENT UNITS mm			
0000000000 NONE		BUILD MONTH DAY YEAR DATE 00 00 0000			
PLATE QUANTITY 0000 UNCOMP PITCH mm 00.000 NOMINAL PITCH mm 00.000 MINIMUM PITCH mm 00.000		OPEN+CLOSE HOURS 00000 MACHINE LOCKUPS 000 PLC S/W VERSION 00000 HMI S/W VERSION V4.3			
GRID QUANTITY 00 DIVIDER PLATE QTY 00 OTHER ITEMS mm 0000.00 PLATE REMOVAL mm 0000.00					
MACHINE NUMBER 0000					

4.1 Display Prev./Next Plate Buttons

Up to three different types of plate can be installed in your machine but usually you will have just one type.

The data displayed below these buttons shows the plate number (1/3, 2/3 or 3/3) the plate type (name, thickness and material) and the associated quantity and pitch data (always in mm).

Press the **DISPLAY NEXT PLATE** button to see data for the next plate if you have more than one type installed.

Press the **DISPLAY PREV. PLATE** button to show the previous plates' data.

4.2 Other Installed Components

GRID QUANTITY: Total number of grids installed in the frame

DIVIDER PLATE QTY: Total quantity of solid Divider Plates installed in the frame.

OTHER ITEMS: The total dimension of any other installed component(s) apart from plates, grids or Divider Plates (always in mm) or compensation for non-standard thickness grids or Divider Plates.

PLATE REMOVAL: The space reserved to remove a plate from the Paraflow when it's in the OPEN FOR PLATE ACCESS position (always in mm).

4.3 Machine Number

The last four digits (without leading zeros) of the machine serial number. This will agree with the last four digits of the serial number shown on the Data Plate.

4.4 Parameters

MAXIMUM OPEN DIM: The maximum distance available between the head and follower when fully opened. This figure takes into account any pipework (FITTING) attached and a safety space of 5mm.

ACTUAL FITTING LEN: The actual fitting length stored by the user (if entered).

MAX FITTING LEN: The maximum length of pipe-work that may be left on a follower connection when **OPEN >|** is pressed. This figure varies depending upon the frame size and plate pack dimension.

CURRENT UNITS: Currently selected units in inches or millimeters. The above three figures are displayed in the current units.

4.5 Build Date

APV Manufacture (or ship) date of the Paraflow.

4.6 Usage Information

CLOSE + OPEN HOURS: The total number of hours that the follower has been moving (opening or closing in normal mode) since manufacture or refurbishment. This is useful for determining periodic maintenance.

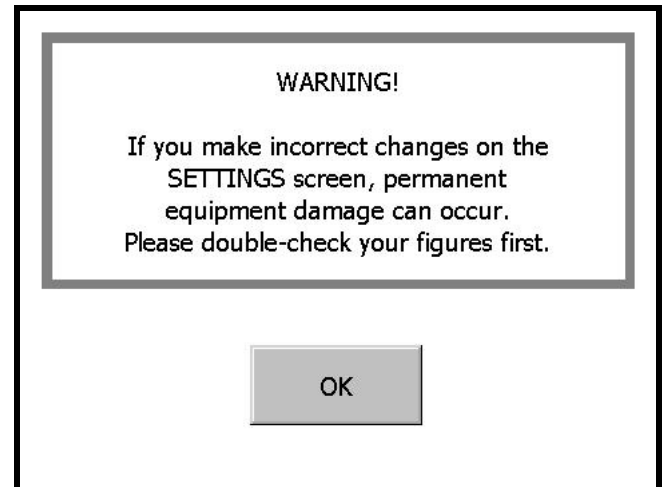
MACHINE LOCKUPS: The number of times that the PLC has detected a fault condition where the follower has been instructed to move but the PLC is not receiving pulses. See **7 Troubleshooting** for more details.

PLC S/W VERSION: Revision of the project that is loaded in the PLC.

HMI S/W VERSION: Revision of the project that is loaded in the screen (Human Machine Interface).

5 Settings

Touch the **SETTINGS** tab to access the settings screen. Prior to opening the **SETTINGS** screen, a warning is displayed as follows.



Entering fewer plates than actually loaded, not identifying a fitting left on the follower when opened or entering a larger follower position dimension than actual can lead to the indicated damage.

Once you have read and understood the warning, press **OK** to enter the **SETTINGS** screen.

This screen allows you to **change** certain data. Ensure that correct figures are entered.

OPERATION		ENQUIRY		SETTINGS	
UNITS = mm touch to change		SCREEN CALIBRATION		CONTRAST -	CONTRAST +
PLATE PITCH	ORDER = INITIAL <> 2nd <> 3rd <> 4th <> FINAL				
	RELAX	0000000	TIGHTEN		
PLATE QUANTITY	NONE	NONE	NONE		
	0000	0000	0000		
FITTING LENGTH	MAXIMUM LENGTH AVAILABLE = 0000.00				
	0000.00	mm	ACCEPT		
FOLLOWER POSITION	CURRENT FOLLOWER POSITION = 0000.00				
	0000.00	mm	ACCEPT		

5.1 Units

Touch this button to swap between inches or millimeters.

5.2 Screen Calibration

Touch this button to recalibrate the screen. Follow the on-screen instructions.

5.3 Contrast - / Contrast +

Touch either of these buttons to reduce or increase the contrast of the screen.

5.4 Plate Pitch

As gaskets age while subject to compression and elevated temperatures, they tend to suffer 'compression set' which reduces their sealing ability. This screen allows you to compensate for this effect by incrementally reducing the pitch from nominal (INITIAL) to its minimum value in five even steps. In this way, gasket life can be extended to the maximum possible.

When adjustment becomes necessary, which is usually provoked by the onset of a small plate pack leak, press the **TIGHTEN** button once. A new closing dimension is calculated by the PLC and stored. When the **CLOSE** button is pressed, the follower will move to the slightly reduced pitch.

It is permitted to make a pitch adjustment by pressing **CLOSE** while in the closed position but not while under pressure or hydraulic lock (ie: inlet and outlet valves closed on any section). After adjustment, confirm that the leak has been eliminated. If the machine still leaks, do not continue to reduce the pitch in this way, call APV for assistance.

This procedure can be repeated over the life of the gasket until FINAL is shown in the display. From this point, the Paraflow may continue to be used until a leak develops again. At this point no further reduction is possible.

DO NOT ATTEMPT TO DEFEAT THIS FEATURE SINCE IRREPAIRABLE PLATE DAMAGE CAN OCCUR.

To minimize machine downtime, it is recommended that gasket replacement is considered once the 4th or FINAL pitch has been reached.

Once new gaskets have been installed, reset the pitch by repeatedly pressing **RELAX** until INITIAL is displayed.

5.5 Plate Quantity

From time to time it is necessary to change the number of plates in a Paraflow. It is essential that the new installed quantity is correctly stored in this screen.

To change the quantity, touch the current figure below to the appropriate plate type. A 'keypad' will be displayed. Enter the new figure and press the enter button. The new plate quantity will be stored. Confirm that the correct figure is displayed.

The screen will allow you to increase this quantity before physically adding the plates, even if the follower is below the new closed dimension. However, if you press the **CLOSE** button in this condition, the follower will actually *open* to the new, larger closed dimension (no message is displayed during this movement).

5.6 Fitting Length

Sometimes it is desirable to leave one or more fittings in place on the follower connections when a machine is opened (eg: to avoid repeated removal of sensitive equipment such as a thermometer or pressure gauge).

By entering a figure here, you tell the PLC to take such 'permanently' attached pipe-work into account when opening to the end support, thus avoiding damage.

The length of pipe-work left on a machine when opened can be no greater than the space available. This is automatically calculated and displayed for you above the **ACCEPT** button.

Determine the length of the longest piece of pipe-work (blank, tee, elbow, bush etc.) you wish to permanently leave on the follower. The figure is the distance between the face of the follower connection and the end of the your pipework (or the point which will touch the End Support enclosure first).

Touch the current figure and enter the new number in the current units on the 'keypad'. Press enter and then **ACCEPT** if correct.

IMPORTANT: In most cases, a blank (port support) will be the only fitting left on the follower when the

machine is opened. A figure of 25mm must be entered in this case.

If your figure is greater than the space available, no change is accepted and a warning message is displayed at the bottom of the screen.

5.7 Follower Position

If the follower has been moved by any method other than the **OPEN** and **CLOSE** buttons on the OPERATION screen or if an 'ABNORMAL FOLLOWER STOP...' message is issued then the new current follower position *must* be measured and entered. Undetected follower movement can happen (a) manually (with a wrench) (b) in service mode (with power) (c) under a fault condition (where pulses are not detected).

Measurement should be performed with the follower at or near the closed position. To do this, note the closed dimension figure on the OPERATION screen and then place the machine in service mode (see **4 Service Mode** in the ELECTRICAL SYSTEM section).

Close near or to the closed dimension figure while measuring the distance between the inside of the head and follower. Ensure the tape measure does not sag and is parallel with the machine.

A good method is to tape a steel rule or similar to the inside of the head and follower, extending about 50mm (2") past the side of the machine, just above the lower ports. Measure across the two rules, close to the side of the machine. Measure to one decimal place in mm or two places in inches.

If the measured figure is even slightly below the current closed dimension the figure will be rejected, open the machine a little and re-measure.

Switch back from service mode to normal operation and wait for the OPENING screen to appear. Select **YES** to go to the SETTINGS screen (via the warning message).

Touch the current follower position figure and a 'keypad' will appear. Enter the actual measured figure, and press enter. Confirm that the figure is correct and press **ACCEPT**. The current follower position figure will be updated if a legal distance is entered.

It is essential that a correct figure be entered. Double-check your measurement and any unit conversion calculation.

If you enter an out-of-range figure, a warning will appear at the bottom of the screen and the figure will not be changed.

6 APV Service

Password protected SERVICE screens are available to allow APV personnel to change some settings and adjust data. Note that, for safety and security reasons, it is not APV's policy to allow access to end-users.

7 Troubleshooting introduction

If the machine does not respond as you expect while using the screen, ensure you have pressed the screen button firmly and perform a power cycle one time. If this does not resolve the issue, refer to the following troubleshooting guide before contacting APV.

WARNING! A qualified electrician must perform solutions accompanied by the following symbol.



In certain cases you are directed to access electrical panels. Before doing so and whenever directed to DISCONNECT POWER in these troubleshooting procedures, you must **DISCONNECT POWER BY APPLYING APPROVED LOCKOUT/TAGOUT PROCEDURES**. Close the door or replace the cover and reinstall screws before restoring power unless instructed otherwise.

The following troubleshooting procedures apply primarily to the Siemens versions. If you have an A/B version, the wiring logic is almost the same but component locations and PLC connections will differ. Contact APV if such deviations prevent diagnosis.

To access the electrical panels, open the small electrical door containing the screen (for Quad-Drive) or remove the electrical box cover behind the screen (for Binary-Drive) by removing the two, M8, button head socket screws (use 5 mm A/F key). Replace the two M8 screws and nylon washers after closing door or replacing cover.

In certain cases you are directed to check a fuse. See

ELECTRICAL SYSTEM section for fuse locations and sizes. After replacing a blown fuse, restore power and try operation again. If a replacement fuse blows, call APV.

Before using the troubleshooting tables from 7.2 onwards, perform the following quick checks (refer to ELECTRICAL SYSTEM section to identify components and their location).

7.1 Troubleshooting quick checks

(1) If the screen is entirely dark (no backlight, no text) but power is being supplied to the machine check:

a. there is at least one LED lit on the PLC to confirm that it is receiving power. If no LED is lit on PLC, after DISCONNECTING POWER, check that the RELAY is installed and pushed home securely. Also check fuses 1FU, 2FU 7& 3FU.

b. the two-conductor, green power cable plug is properly inserted into bottom edge of screen and the wires are properly gripped in the plug.

c. With power applied, 24VDC is seen across the two terminals on the plug of the screen power cable.

If a, b & c check OK, the screen has failed and will need to be replaced. Contact APV.

(2) If many of the boxes on the screens are filled with #####, the communication cable has become loose (or is possibly faulty or missing). DISCONNECT POWER, and re-secure each end of the COM cable that enters the face of the PLC and underside of the screen. Use a small, flat bladed screwdriver to tighten the two screws on each plug. If the ##### display persists after tightening the screws, temporarily substitute the communication cable with a straight through DB9 male/male cable of 'any' length. If the substitute works a replacement data cable is required.

(3) If OPEN and CLOSE does not work and you cannot change the pitch step, follower position or fitting length, the PLC may have been left in 'STOP' mode. DISCONNECT POWER and open the small door on the right side of the face of the PLC. Move the small switch fully to the up (RUN) position and close

the door. When power is restored, the green 'RUN' LED will be lit.

(4) If the PLC is in RUN mode (the green RUN LED will be lit) but the OPEN and CLOSE buttons do not operate as expected, refer to the following table of green status LED's that appear on the PLC (when power is applied). If (2) and (3) above check OK, any variation from this table indicates a PLC fault (hardware or software).

There are two rows of green LED's, an UPPER row and a LOWER row. Each row is numbered from the left starting at 0.

<i>Operation</i>	<i>Status LED's lit</i>
Keyswitch OFF	Upper row: none Lower row: none
Keyswitch ON, fault condition (screen will indicate which fault)	Upper row: none Lower row: 3
Keyswitch ON, no fault	Upper row: 2 Lower row: 3
Keyswitch ON, OPEN + count	Upper row: 2, 5
Keyswitch ON, OPEN + move	Upper row: 0, 2, 5
Either of above	Lower row: 3
Keyswitch ON, CLOSE + count	Upper row: 2, 5
Keyswitch ON, CLOSE + move	Upper row: 1, 2, 5
Either of above	Lower row: 3

count = during 5 second countdown period
move = while the follower is moving

7.2 Open Or Close Does Not Work

I pressed **OPEN** or **CLOSE** but the follower has not moved.

NOTE: After these 7.2 checks, also perform the steps shown in **7.6 No or Unidirectional Operation** if the problem is not resolved.

Pump/oil related problems can often be confirmed by incorrect oil pressures. Check the large pressure gauge inside the cabinet while running in service mode. The normal readings are as follows:

- a) Idle pressure (not closing or opening) 250 psi
- b) Maximum pressure when closing 2200 psi

CAUSE OR CONDITION	SOLUTION / MESSAGE		
Hydraulic pump is not running and green light is off.	Switch key to 'ON' or 'OFF' and 'ON'. Message: MOTOR OFF / OPERATE KEY SWITCH		this condition can lead to plate damage. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
Hydraulic pump is not running and green light is on.	 DISCONNECT POWER. (a) Ensure the switch on the Motor Starter Protector is in the ON position. (b) Ensure the current setting on the Motor Starter Protector is correct. Siemens: about 7.5 amps, Allen Bradley: about 10 amps. (c) Ensure the trip button in the middle of the Motor Starter is depressed. (d) Check fuse 6FU. Replace if blown. (e) Ensure that the motor power plug is securely connected. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE	The follower was moved without using the PLC	Measure the inside head to follower dimension and check against the figure shown below the CURRENT POSITION on the OPERATION screen. If the numbers do not agree, go back to 5.7 FOLLOWER POSITION and follow the instructions. Message: FOLLOWER MOVED MANUALLY - RESET POSITION
Hydraulic pump is rotating in wrong direction	Check the rotation is in agreement with arrow on electric motor. See 3.2 Motor Rotation in the ELECTRICAL SYSTEM section. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE	Hydraulic system has developed a leak.	Inspect the hydraulic hoses inside the end support enclosure for rupture or fitting leaks. Tighten or reseal leaking fittings and replace ruptured hoses. See HYDRAULIC SYSTEM section for hose and fitting sizes. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
Follower is already at an open or the closed position.	The follower will not move further in this direction. Message: ALREADY ARRIVED AT THIS POSITION	Oil is extremely low or empty. (Not at fill line of oil level gauge)	Refill with new A/W 32 hydraulic oil to upper fill line. Investigate cause of oil loss (Check drain plug and oil level gauge for leaks. Note that oil can remain at the bottom of the level gauge even if the tank is empty giving the appearance that the level is simply low. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
Follower is past the open for plate access position.	The follower will not open further with this button. Use the open to end support button. Message: ALREADY PASSED THIS POSITION	Customer's fittings jammed against end support because length has not been stored in PLC.	Remove fittings or enter the dimension of the longest fitting into fitting length. See '5.6 FITTING LENGTH'. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
The E-Stop has been pressed	Pull out the emergency stop button. Message: E-STOP ENGAGED	Closing system is jammed.	Inspect tie bars and free nuts for excessive wear/seizure (ensure tie bars are greased). Inspect inside end support for chain slippage/breakage, mechanical interference or binding idler sprockets. Refer to APV for help. You MUST NOT attempt to open or close the unit under these circumstances. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
The main door is open	Close the main door on the end support. Message: MAIN DOOR OPEN		
The plate quantity has been reduced but plates have not been removed.	Ensure that the stored plate quantity agrees with the number of installed plates. (Also check that grids or Divider Plates have not been removed). WARNING:		

7.3 Machine Will Not Close To Pitch (or open)

I pressed CLOSE or OPEN but the follower has stopped or appears to have stopped too soon. ie: the follower did move but stopped almost immediately or stopped before the indicated closed or open dimension. The machine may be leaking and/or the plate pack dimension measures too much.

CAUSE OR CONDITION	SOLUTION / MESSAGE
The follower stopped after about 5 seconds of movement.	 (a) The 'pull down resistor' is missing or has become disconnected. DISCONNECT POWER and locate the resistor. On Siemens units, one end enters terminal '0.0' on the lower edge of the PLC. The other end enters terminal block 3 (or 4) at the bottom. For Allen Bradley units, one end terminates at input terminal '0' of the PLC. The other end enters the terminal block below the PLC (TB2) at terminal 8. The resistor is a 1k ohm, ¼ watt, carbon film type and sheathed in black shrink wrap. OR (b) The inline, 3-pin plug/socket is disconnected or a wire is broken. DISCONNECT POWER and locate the cable exiting from the hydraulic motor. Check and correct if necessary the connector security and wire integrity over full length of cable. OR (c) The hydraulic motor sensor has failed. The sensor is installed from the outside of the hydraulic motor and is user replaceable. Contact APV for further help. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
Currently selected plate pitch is too high. (Gaskets have aged & 'set')	Tighten the plate pitch one step. See 5.4 PLATE PITCH.

Additional plates were installed or some removed.	Remove / add plates or correct the plate quantity. See 5.5 PLATE QUANTITY.
Non-APV plates have been installed.	The Quad/Binary-Drive is only set up for APV plates. Please use genuine APV OEM plates.
Motor starter has tripped.	 DISCONNECT POWER. Depress the motor starter reset button. Ensure the current setting on the Motor Starter Protector is correct. Siemens: about 7.5 amps, Allen Bradley: about 10 amps. Restore power and try operation again. If the starter trips a second time, call APV. Message: ABNORMAL FOLLOWER STOP – CHECK CAUSE
Machine has become unsynchronized. (can only happen if there has been a serious mechanical failure)	The machine must be repaired and resynchronized before operation. Call APV for help. You MUST NOT attempt to open or close the machine in this state.

7.4 Machine Is Over Compressing Plates

The plates are beginning to exhibit slight depressions on the crest of the corrugations. However, the actual plate, grid and divider plate quantities agree with the stored settings.

CAUSE OR CONDITION	SOLUTION / MESSAGE
Current follower position has been entered incorrectly.	Re-measure and reenter the figure. See 5.7 FOLLOWER POSITION.
Wrong plate type (not APV plates)	Replace with genuine APV plates and gaskets.

7.5 The Screen Will Not Accept My Data

CAUSE OR CONDITION	SOLUTION / MESSAGE
You are trying to enter a new higher follower position but the figure will not change after pressing	You are trying to set the follower above the open to end support dimension. Message: FIGURE ABOVE

ACCEPT.	MAX OPEN DIM - NO CHANGE MADE
You are trying to enter a new lower follower position but the figure will not change after pressing ACCEPT.	You are trying to set the follower below the current closed dimension. Message: FIGURE BELOW CURRENT CLOSED DIM - NO CHANGE MADE
You are trying to relax the pitch but the setting will not change.	The follower is at a lower dimension than the new closed dimension. Open the follower a little first. Message: OPEN PAST CLOSED DIMENSION FIRST
You are trying to enter a new fitting length but the figure will not change after pressing ACCEPT.	The space available is less than the fitting length. If the fitting is actually the length you are trying to enter you will have to remove this fitting from the follower before opening the machine. Message: FITTING LENGTH TOO LONG – NO CHANGE MADE

7.6 No or Unidirectional Operation

If the follower will only travel in one direction or not at all, after going through the steps in **7.2 Open Or Close Does Not Work**, perform the following sequence of checks. **NOTE: These steps require a qualified electrician.**

(1) Run the Machine in service mode, checking both directions (Open and Close). See '4 Service mode' in the 'ELECTRICAL SYSTEM' section.

(2) If the machine operates correctly in both directions in service mode, proceed to step (5). If Service mode also operates incorrectly, continue with step (3).

(3) If the frame does not both open or close in Service mode, perform the following sequence of checks (3a and following). A multi-meter is necessary for these checks. Ensure the machine is in Service mode

(3a) Check the Turk male/female connector is properly connected and that the wires are in good condition entering the fixed socket and at the plug end of the cable. The cable exits the small electrical box with the Turk connector and is hardwired into the solenoid valve on the top of the power pack. The Turk connector pin outs are as follows:

Pin 1	Brown	OPEN
Pin 2	White	COMMON
Pin 3	Black	CLOSE
Pin 4	Blue	NOT USED

(3b) Remove and check the solenoid valve fuses. Fuse number 4FU controls OPEN and fuse number 5FU controls CLOSE. Replace if blown.

(3c) Check that 120 VAC is available at the input contacts of the 3-position OPEN/CLOSE switch. Power to the input will be present regardless of switch position. If no reading, check and correct if necessary the integrity of the wire running from the RELAY to the input of the OPEN/CLOSE switch.

(3d) Check that 120 VAC is available at the inputs to the solenoid valve fuse blocks. Switching to OPEN energizes the wire labeled Q0.0 running from the switch to the top of fuse block 4FU. Switching to CLOSE energizes the wire labeled Q0.1 running from the switch to the top of fuse block 5FU. If no reading, check and correct if necessary the integrity of the wires.

(3e) Check that 120 VAC is available at the solenoid valve itself (facing you on the top of the power pack). First observe the directional lights on the solenoid valve cover when OPEN and CLOSED are switched. If one or both lights fail to light when OPEN/CLOSE switch is operated, check and correct if necessary the integrity of the wires running from the bottom of the fuse blocks 4FU and 5FU, through the Turk panel connector and to the solenoid valve. If lights still do not work, perform step (3f). If both lights operate, go to step (3g).

(3f) Remove the four small screws on the solenoid valve cover (near the cable entry). Power should be seen at the BROWN wire when OPEN is operated and BLACK wire when the CLOSE is operated. If no reading, check the tightness of the screw connections including the WHITE common wire. Note that the BLUE wire is not used.

(3g) If correct operation is now observed in Service mode, go to step (5). If electrical circuits are sound but failure persists, continue to step (4).

(4) Verify the mechanical operation of the solenoid valve. **Keep hands and clothing away from chains and other moving parts.** At each end of the solenoid valve there is a small 'button'. With the pump running, briefly actuate the button (depress sufficiently to overcome the spring force) with an Allen key for example. This will demonstrate if forced movement of the valve will rotate the tie bars. If you have verified that 120 VAC is being received at the solenoid valve but it will only operate with manual depression, the solenoid valve must be replaced. Contact APV.

(5) If service mode works, return machine to normal operation and check OPEN and CLOSE on the screen again. If a failure persists, check that 120 VAC is available as follows:

Pressing OPEN energizes the wire labeled Q0.0 running from output 0 at the top of the PLC to the top of fuse block 4FU.

Pressing CLOSE energizes the wire labeled Q0.1 running from output 1 at the top of the PLC to the top of fuse block 5FU.

If no reading(s), check and correct if necessary the integrity of the wire(s).

(6) The above procedures will generally reveal any problems but if failure persists, please contact APV for assistance. See Parts and Service section in the APV Paraflow PHE Instruction Manual for telephone numbers.

1 Introduction

The Quad/Binary-Drive Paraflow frame is designed to give many years of trouble free service and require minimal maintenance. The following list shows the recommended inspection and maintenance actions required to keep the unit performing at its best. Details that apply only to the powered Quad/Binary-Drive are noted.

APV is also equipped to maintain your Quad/Binary-Drive in top condition. Please call APV Service at 1-888-APV-4321 (1-888-278-4321)

2 Maintenance schedule

2.1 Tie Bars

The section of tie bars where the follower travels must maintain a light coat of food grade grease whenever the machine is powered open or closed. Check **before powered operation**. If external machine cleaning has removed such grease, a fresh application must be made. Frequency of lubrication will be dependant upon the type and frequency of external machine cleaning and the frequency of opening/closing. An elevated free nut temperature and/or a high-pitched whine will be audible when closing the machine if there is insufficient lubrication on any tie bar. Aggressive and/or frequent machine cleaning will increase the need for such lubrication.

2.2 Carry Bars

A light coat of food grade grease should be maintained on the carry bars, where the plates touch the hanging strip on the top bar and on the sides of the bottom bar whenever the machine is powered open or closed. Additionally, the Binary-Drive requires the inside, upper vertical faces of the bottom bar halves to be greased. Check **before powered operation**. Frequency of lubrication will be dependant upon the type and frequency of external machine cleaning and the frequency of opening/closing. A loud clicking noise will be audible when closing the machine if there is insufficient lubrication. Aggressive and/or frequent machine cleaning will increase the need for such lubrication.

2.3 System inspection (Powered QD only)

Inspect all the hydraulic hoses and their fittings and all electrical cables every **6 months** or 60 runtime hours whichever comes first. Check hoses for leaks and

hoses and cables for signs of chaffing or broken/detached ties. Do not power the Paraflow open or closed if any hydraulic hose or electrical cable shows signs of chaffing deeper than purely surface marks – replace the hose or cable first. Replace any broken or detached ties. Tighten (and reseal if necessary) any hydraulic fittings that are leaking.

2.4 Idler sprockets and shafts

Inspect the idler shafts (4 on QD, 2 on BD) every **6 months** or 60 runtime hours whichever comes first. If any shaft appears dry, add black lithium grease to each shafts through the grease nipples provided. Add grease **annually** to all shafts regardless of condition.

2.5 Drive chains

Inspect the drive chains in the End Support cabinet (5 on QD, 2 on BD) every **6 months** or after 60 hours of runtime, whichever comes first.

Chain lubrication:

If the chains appear dry, apply a light coat of chain oil to each one.

Chain adjustment:

Tie Bar chains (4 on QD, 2 on BD) – check play in middle of longest length. Adjust if necessary to keep play within 3/4" (19mm). For Quad-Drives, make the adjustment with the hex nut labeled with the corresponding tie bar number. For Binary-Drives, adjust the hex nut on the rod closest to the central sprockets. The hex nut at either end of the rod may be turned, whichever is most accessible. Use the supplied M24 ratchet wrench.

Primary chain (1) - (Powered QD only) Adjust if necessary to keep play within 1" (25mm). Make the adjustment by slightly loosening the two M24 hex bolts that hold the hydraulic motor plate and turning the M24 adjuster screw clockwise. Turn adjuster until chain is taught and then back off ¼ turn. When tension is correct, retighten the two M24 hex head bolts. Recheck tension. Use the supplied M24 ratchet wrench.

2.6 Hydraulic oil and filter (Powered QD & BD only)

Check oil level **before powered operation**. Oil level must be between the bold, upper and lower mark on the gauge located on the outside of the End Support Cabinet just below the main door. Add a sufficient quantity of new, A/W32 hydraulic oil if necessary. To fill, unscrew the oil filter cap, remove the filter

cartridge, and add oil. Replace filter and cap when complete. Do not overfill. Clean any oil spills inside or outside the end support enclosure.

If oil becomes dirty (dark), milky (opaque) or otherwise accidentally contaminated, replace oil completely. Remove cap and filter and drain tank thoroughly from the drain point at the bottom of the enclosure (M16 hex head screw). Replace M16 screw and copper washer and refill with 20 US Gallons (75.7 litres) of new, A/W 32 hydraulic oil. Install a new filter cartridge and replace the cap. Clean any oil spills inside or outside the end support enclosure. Change oil and filter every **3 years** regardless of condition.

2.7 Follower slide strips (Quad-Drive) OR Follower guide block (Binary-Drive)

Quad-Drive: Inspect the two follower slide strips, located in the cutout at the bottom of the follower, every **6 months**. Correction will be necessary when excessive side-to-side movement is seen at the lower end of the follower when opening or closing. Restore proper guiding by rotating both pads through 90 degrees. The pads may be rotated three (3) times before needing replacement. Always replace in pairs. Each pad is retained by two M8 button head screws (use a 6mm A/F hex key). The screw heads sit in the counterbored holes in the slide strips.

For long frame sizes (FS 5 & 6) the follower must be moved towards the end support to allow the 1" dia (25.4 mm) access holes in the side of the bottom bar to align with the M8 button head screws. Remove one pair of screws, move the follower another 2" (50 mm) and remove the remaining two screws.

Binary-Drive: Inspect the follower guide block, located on the leading edge of the follower between the bottom bar halves every **6 months**. Correction will be necessary when excessive side-to-side movement is seen at the lower end of the follower when opening or closing. Restore proper guiding by rotating the guide block through 90 degrees. One rotation is possible before needing replacement. The guide block is retained by an M8 x 30 mm long countersunk socket head SS screw (use a 5mm A/F hex key)

2.8 Fasteners

It is prudent to check the tightness of fasteners from time-to-time on any powered equipment. Inspect **annually** and if necessary retighten.

2.9 Flange bearings

Inspect and, if necessary, grease every **12 months** the flange bearings (one or two depending upon model) located inside the end support that support the primary drive shaft. An inspection mirror will aid location of the flange bearing grease nipple on the Quad-Drive.

3 Troubleshooting (Powered QD & BD only)

3.1 TIE BAR NOISE

The tie bars should run 'silently' when opening or closing the machine. If a whine is heard (from the free nuts) or the nuts become too hot to touch, check the following.

POSSIBLE CAUSE	SOLUTION
Tie bars lack lubrication	The grey top cap (when installed) must be removed from the Binary-Drive before performing this operation. Thoroughly clean any contaminated grease from the free nuts and tie bars. (Free nuts are located on the outer surface of the follower and manufactured from Aluminum-Bronze). Apply a light coat of clear food grade grease to the tie bars along the area of follower (free nut) travel.
Drive system has become unsynchronized.	In this case you will need to refer to APV for help. You MUST NOT attempt to open or close the machine.

3.2 EXCESSIVE NOISE FROM END SUPPORT

Under no load conditions (electric motor is running but follower is not moving) the hydraulic system emits an audible mechanical noise. The noise increases in pitch and volume when the machine is opened or closed. Any abnormal sounds may indicate a problem with the drive system.

POSSIBLE CAUSE	SOLUTION
Chains out of adjustment	Adjust chains to give about 2 chain widths of movement at midpoint of longest length. Refer to FRAME ASSEMBLY section for further details.

Chains lubricant.	lack	Lightly oil each chain. Close End Support door to continue automatic operation.
Idler sprocket is running dry.		Lubricate idler shaft with suitable grease. Ensure grease is placed on the shaft at the idler sprocket's working position. We recommend slight slackening of the idler sprocket so that it can be slid along the shaft. Do not slacken the chains such that they can slip around the other two sprockets. Inspect the idler shaft for signs of wear, check the idler sprocket for wobble and apply the grease. If there is excessive wear, replacements should be fitted.
Electric failure.	motor	Contact APV immediately for further assistance. Do not attempt run the system.
Drive clash.	system	Check that chains are not touching each other. Contact APV immediately for further assistance if a problem is found. Do not run the hydraulic system.

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