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# STEERING GEAR

## SELECTION AND INSTALLATION

Rev 01/2012

“Leaders in Quality Marine Controls, Steering Gear, and Disc Brakes.”



## **NOTES ON WARRANTY**

Kobel Manufacturing provides installation and maintenance instructions for its products. If these guidelines are not followed, the warranty will be voided.

For detailed instructions, please contact our Distributors or go to our website at <http://www.kobel.com>

**If our instructions are followed during installation and maintenance, the performance of our products will prove to be most satisfactory. There is nothing like a satisfied customer.**

## STEERING GEAR SELECTION AND INSTALLATION

Selecting the proper steering gear for a marine vessel is extremely important. If the components that are selected prove to be inadequate, disastrous consequences could arise. Properly selected steering gear will make a tremendous difference in the feel and response of a vessel and will make an enormous difference as far as feeling confident without any major effort in the control of a ship or boat. Kobelt Manufacturing highly recommends that any and all steering gear is sized in accordance with the ship's or boat's rudder, hull design and speed of the vessel. We feel that it is very important to get the proper steering gear components installed the first time around.

After the rudder torque is established, the proper steering cylinder combination can be established. In other words, the diameter of the cylinder and stroke of the cylinder will be sufficient to operate the rudder safely. Once the cylinders have been established the volume of hydraulic fluid to turn the rudder from hardover to hardover is given in our tables. If, for example, a rudder torque is established with 35° to either side, with a torque of 4,000 ft.lbs, a single cylinder model 7080 with 12" stroke can be installed. This cylinder requires 70.1 cu. in. of oil. If, for example, a 7005 helm pump is used at full volume, it will require 12 turns to move the cylinder from extreme to extreme. This may prove to be too many turns for some operators. If a 7012 pump is installed at full volume, this pump produces 12 cu.in. per turn, only six turns at the Helm pump will be required.

Operating a vessel that is highly maneuverable, it might be too much of a physical effort for the operator to use a 12 cu.in. helm pump with six turns hardover to hardover on a continuous basis. One must remember that the higher the volume of a pump the harder it is to turn. Therefore, it might be recommended to install a power driven steering system. One must also install a relatively large steering wheel on a high volume helm pump since with a small wheel the effort will be too strenuous.

If a cylinder is used in a steering gear system, it is extremely important that the cylinder is of a balanced type since there is a limited reservoir in the helm pump. A single unbalanced cylinder will cause the oil to go low with the cylinder all the way extended and may cause the helm pump to overflow with the cylinder all the way contracted. An unbalanced cylinder will also cause unequal turns from side to side. A balanced cylinder has the piston rod coming out on both sides of the cylinder, whereas in an unbalanced cylinder the rod only extends on the rod end side.

If two cylinders are installed in a common steering system the cylinders can be of an unbalanced type. Since one cylinder will be pushing and the other cylinder will be pulling, the volume will be balanced out.

In many a twin or multi rudder steering systems, mechanical tie bars are required. It is of extreme importance that these mechanical tie bars (pipe with rod ends) are designed to withstand the stresses imposed on these tie bars. If the tie bars are quite long, it is also recommended to put a support in one or two locations to support the tie bars from vibrating too severely. The supports should have a nylon or teflon wear pad on top to avoid metal to metal contact when the tie bars are going to the required arc.

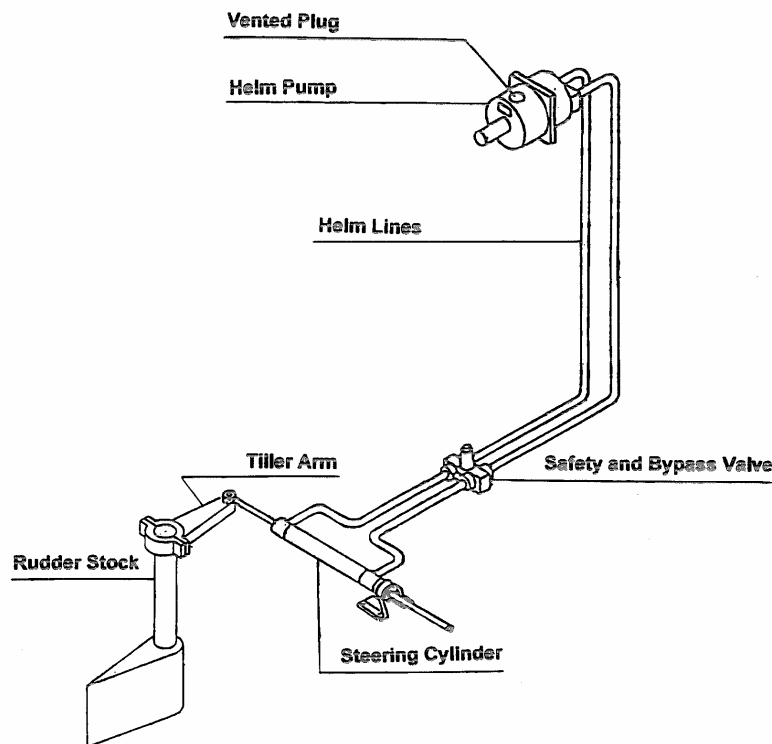
## **STEERING GEAR**

For many years Kobelt Manufacturing has been making hydraulic components for all kinds of devices, mainly steering gear and associated components. We use only the finest seals in order to insure long life without leakage. Any and all hydraulic components are tested in house to insure trouble free operation in the field. If a seal is holding beyond the operating pressure when tested in our shop, which means under normal circumstances it is not likely that it will leak in the field. We have discovered that, over the many years that we have been in business, some people encountered leakages which were seal related and once we received the components that supposedly leaked in the field, we found that most times the system was full of dirty oil. Dirty oil is the biggest enemy to a hydraulic system. Eventually it will destroy everything. So, what we would like to reiterate here is that if a seal is working fine during the original test, it should hold for a long time. Since all the components shipped from Kobelt do not have any damage on the piston tube and rod, it should not cause any problems in the field, but dirty oil will do it every time. A new hydraulic system should be flushed before it is put into service and before the hydraulic fluid is put in the tank.

## INSTALLATION No. 1

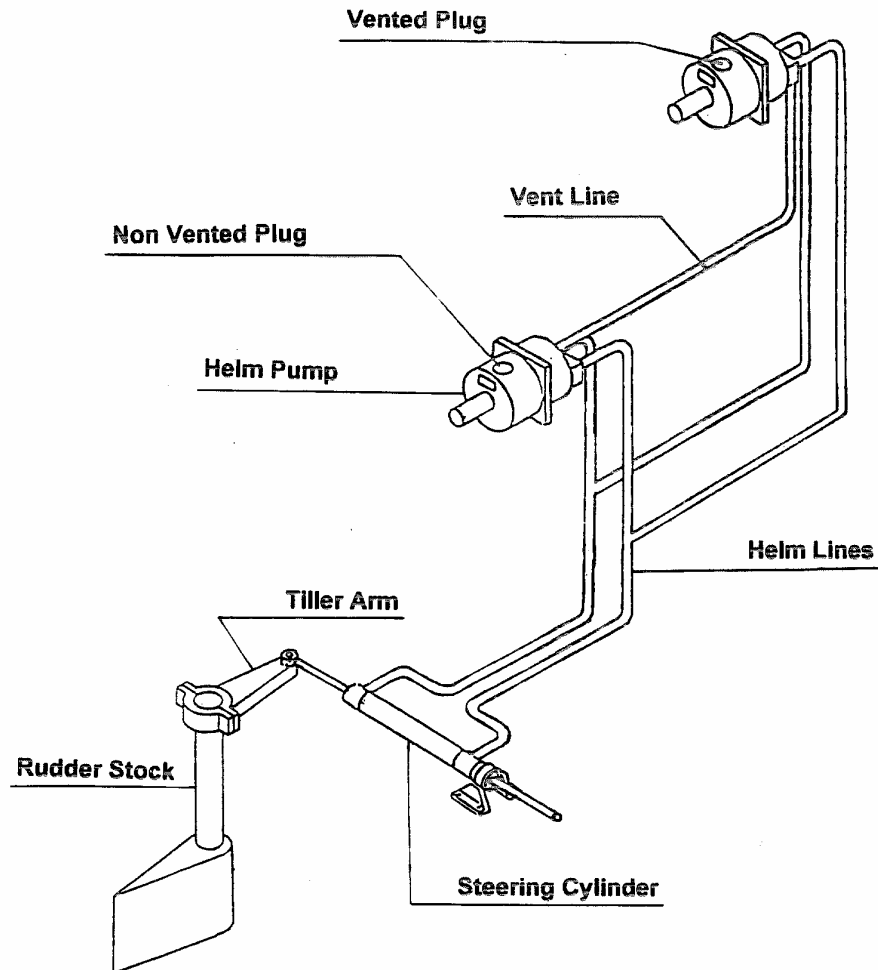
This illustrates a single balanced cylinder operating a single rudder with a one station manual helm pump. A 7020 safety and bypass valve is also installed. The purpose of this valve is to avoid breakage in the steering system, should the rudder bump into some solid object. If the pressure rises in the steering lines above 1400 p.s.i., the oil will bypass in the 7020 valve from the high pressure side of the steering system into the low pressure side of this steering system and will therefore allow the rudder to be moved manually during dry docking. One must, however, remember to close the valve before going to sea.

The helm pump must have a filler vented plug. The system must be left open in order to allow for oil expansion and contraction. Failing to do so will cause damage to the helm pump shaft seal. Please note the size of helm's lines recommended for various pumps and length of the run required. In areas where the weather gets cold, it is recommended to go with the bigger lines since the hydraulic oil can become harder to move.



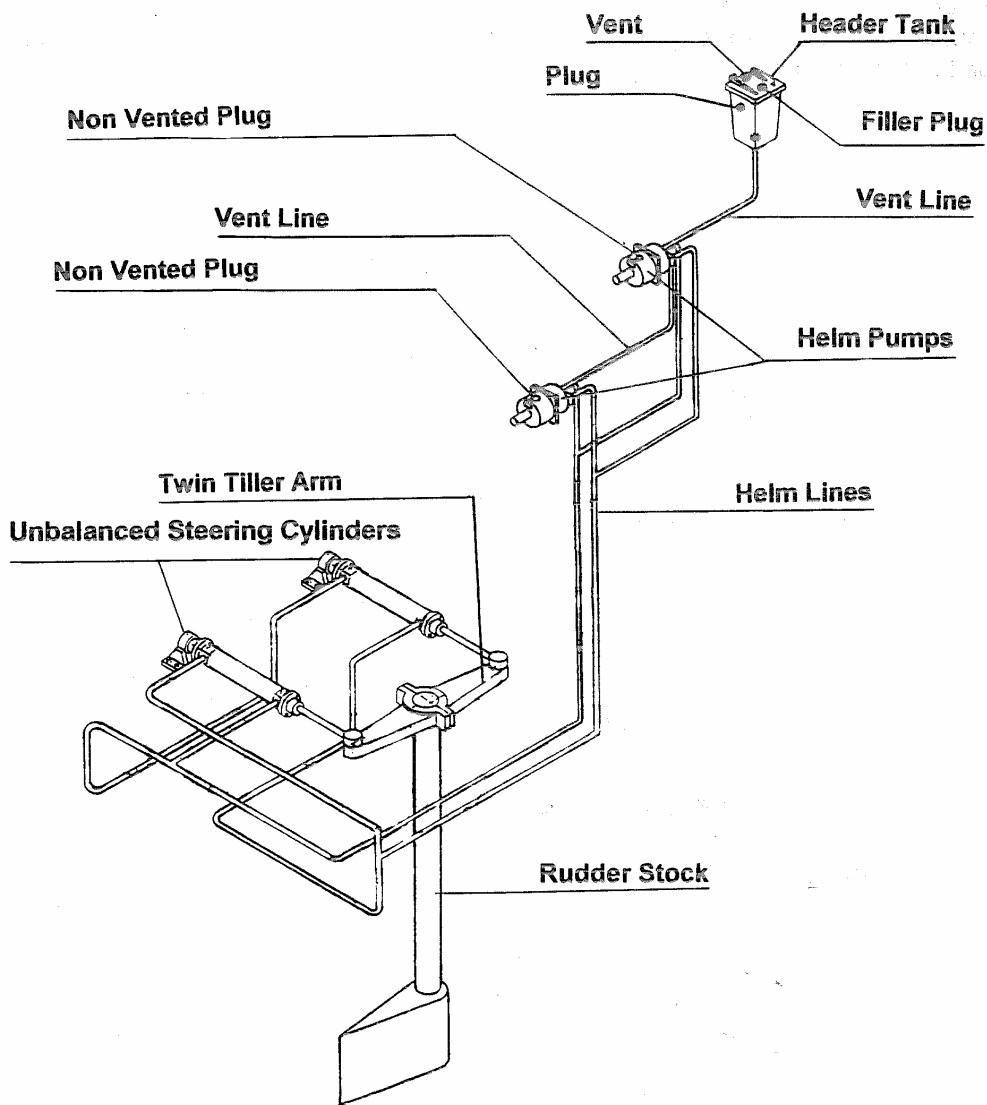
## SYSTEM No. 2

This system illustrates a single rudder single cylinder two station manual helm pump. Please note that the lower station has a non vented filler plug and the upper station must have a vented plug. There is also a 3/8" vent line going from the lower helm pump to the upper helm pump. The purpose of this line is to vent air from the lower helm pump to the upper pump, where the air can escape into atmosphere during the filling process. When installing the tubing between the hydraulic components, it is extremely important to keep this tubing and fittings clean from foreign matter, especially sand. This can cause a tremendous amount of damage to the internal parts of the steering system and could cause the system to leak and fail. We recommend the use of liquid teflon for all pipe fittings.



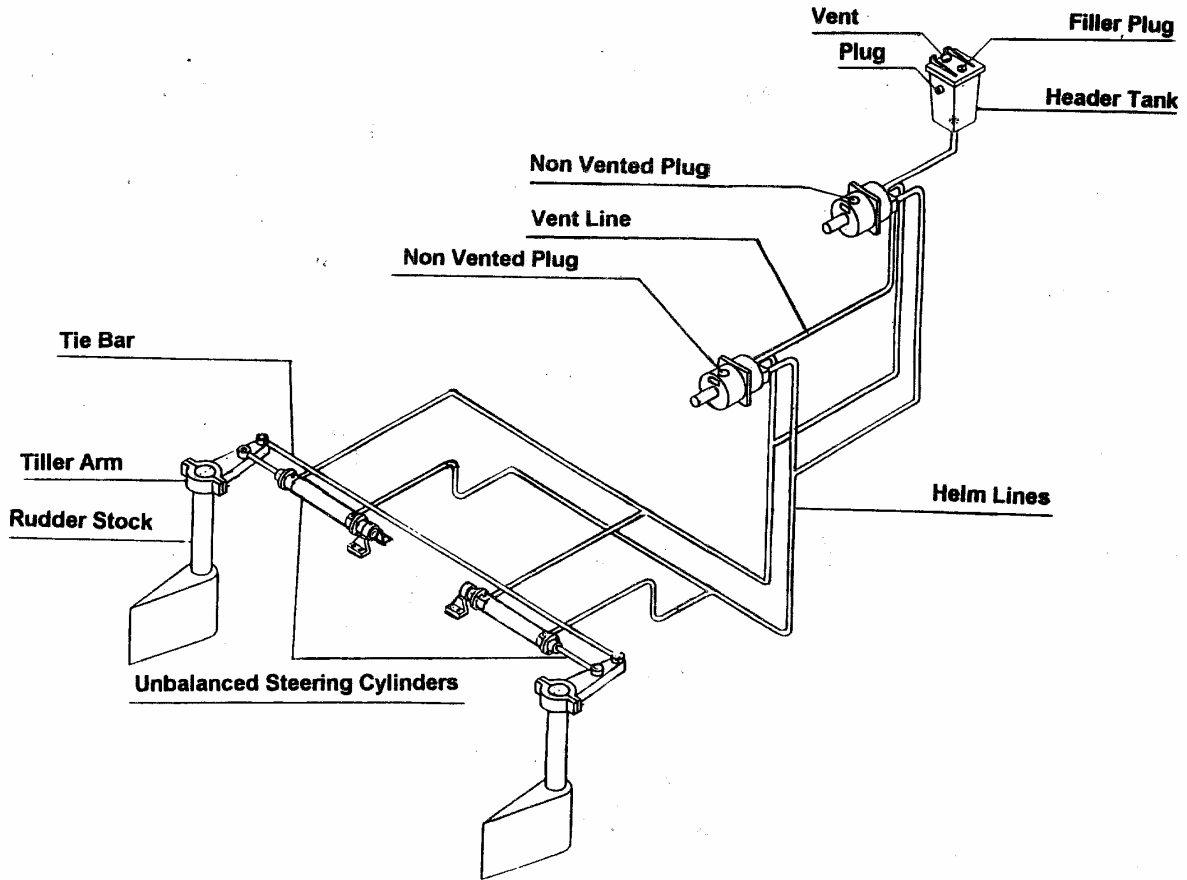
### SYSTEM No. 3

System No.3 illustrates a single rudder steering system with two cylinders attached on a double tiller arm. These cylinders can be of an unbalanced type. Please also note that the two helm pumps are not vented. Again, there is a vent line between the lower and upper helm pump and from the upper helm pump there is a vent line to the header tank. The header tank must have a vent and must be installed above the top helm pump. The extra reservoir in the header tank makes bleeding considerably easier. All Kobelt steering cylinders are also equipped with bleeder valves. The bleeder valves can be opened to let the air escape during the bleeding process.



## SYSTEM No. 4

System No. 4 illustrates a twin rudder manual hydraulic steering. Again, with the two unbalanced cylinders and a mechanical tie bar, this system is basically the same as system No. 3.

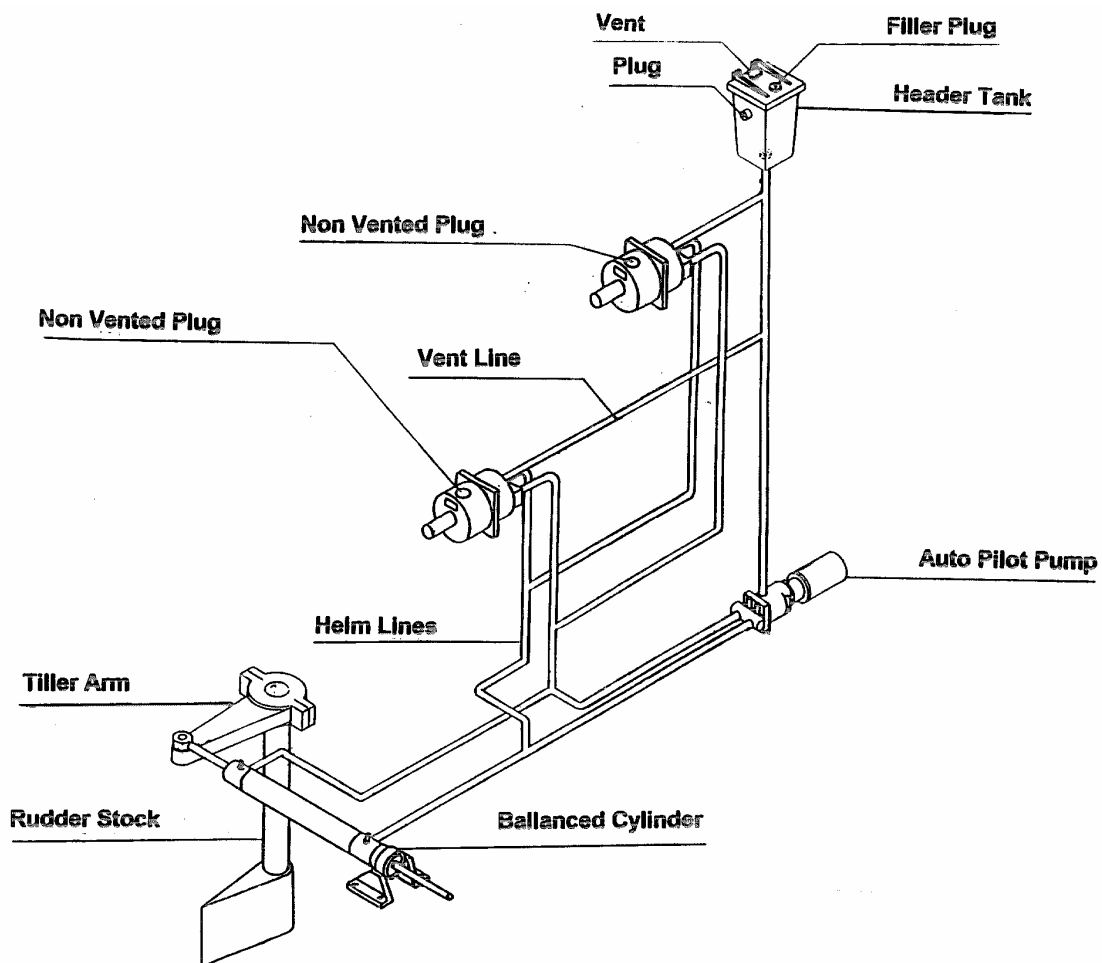


## SYSTEM No. 5

System No. 5 illustrates a two station single rudder manual steering system with a battery operated auto pilot pump, Kobelt part No. 7201. This pump is available in either 12 or 24 Volt DC. The pump is controlled by either an auto pilot or jog lever. Relays (7201-RL-12/24) must be installed between the auto pilot and the pump since the motor can draw up to 40 amps in a 12-Volt system. Safety valves and flow controls are integrated into the pump. A header tank is recommended for this type of system.

### Hydraulic Lines and Fittings

For a manual helm system it is recommended to install hydraulic tubing or lines with a minimum 1,000 psi operating pressure. The tubing must be kept absolutely clean during the installation and all fittings must be of good quality. Since the steering cylinders go through an arc when turning the rudder, a flexible hose must be installed between the tubing and cylinder. This flexible hose must be long enough not to cause any flexing of the tubing and again, the hose must withstand a minimum of 1,000 psi working pressure.



## SYSTEM No. 6

### Full Follow-Up Power Assist Steering Models 7147 \*, 7065 and 7085

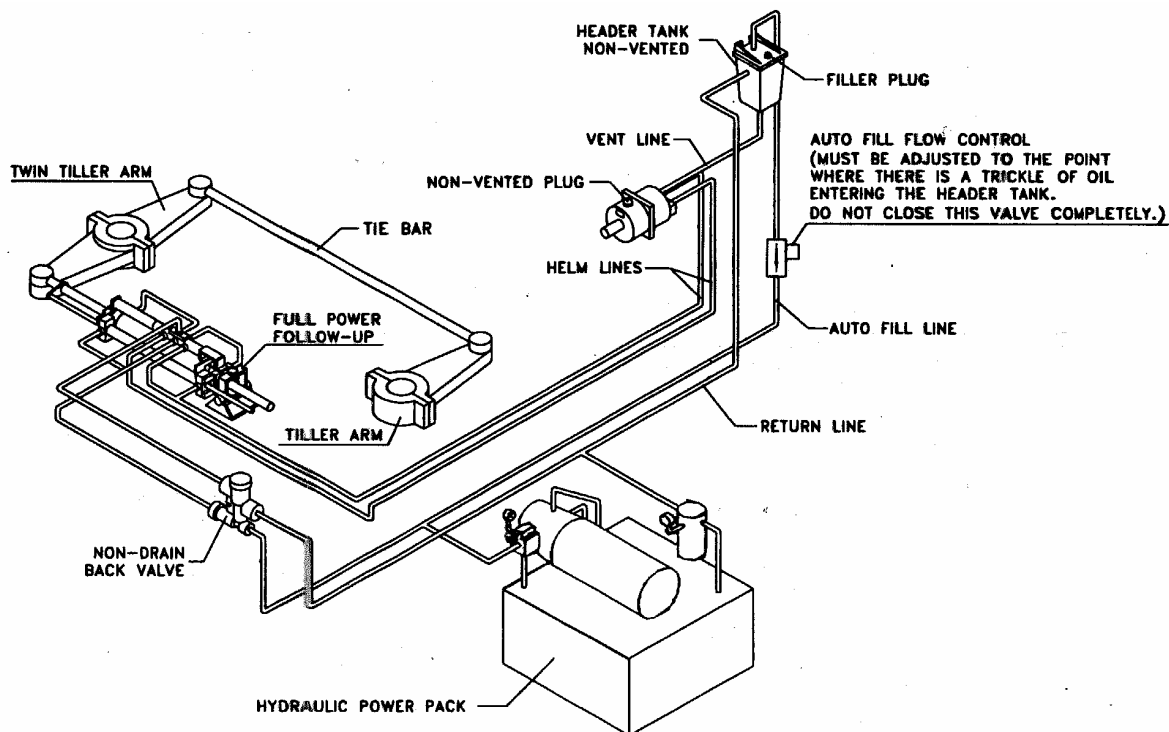
\* (U.S. Patent No. 5,289,756)

The Full Power Follow-up unit is the latest development from Kobelt in the steering gear line. These units are an extremely compact device and provide the ultimate in simplicity as far as installation and maintenance are concerned.

These units are primarily designed for boats from 30 ft. to 150 ft. depending on power and speed. The function is to turn manual steering into power steering which will provide the operator with finger-tip control over the rudder. A source of hydraulic pressure is required to make these units functional. However, should the hydraulic power fail, the valving arrangement will switch this unit automatically to manual steering mode. Additional turns and effort will be required for the manual mode. This provides the ultimate safety. It can be used with a single cylinder or twin cylinder installation (System 7). This is achieved by adding one cylinder and two hoses.

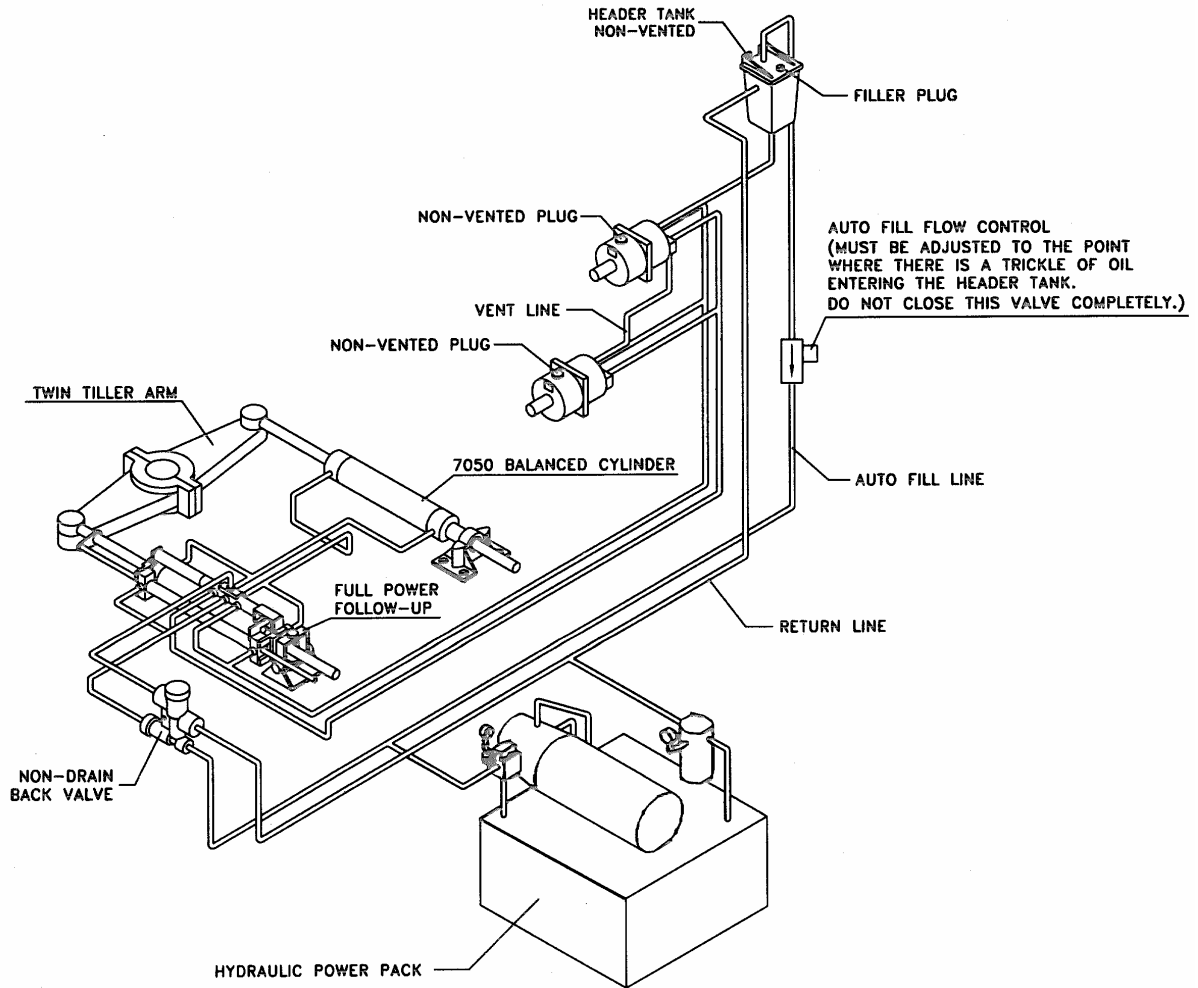
Our 7144 for Auto Pilot Jog Lever Interface can easily be incorporated into the system. It is constructed entirely in bronze and stainless steel. Since a full power follow-up valve and servo cylinder is incorporated on to the main cylinder, no linkage is required to make this unit work.

REFER TO TORQUE CHART FOR CORRECT CYLINDER STROKE



## SYSTEM No. 7

This system is basically identical to system No. 6 but has an auxiliary cylinder. This cylinder must have the same strokes as the servo cylinder. With this arrangement the torque can be doubled. It is also possible to install the same system on a two rudder installation.

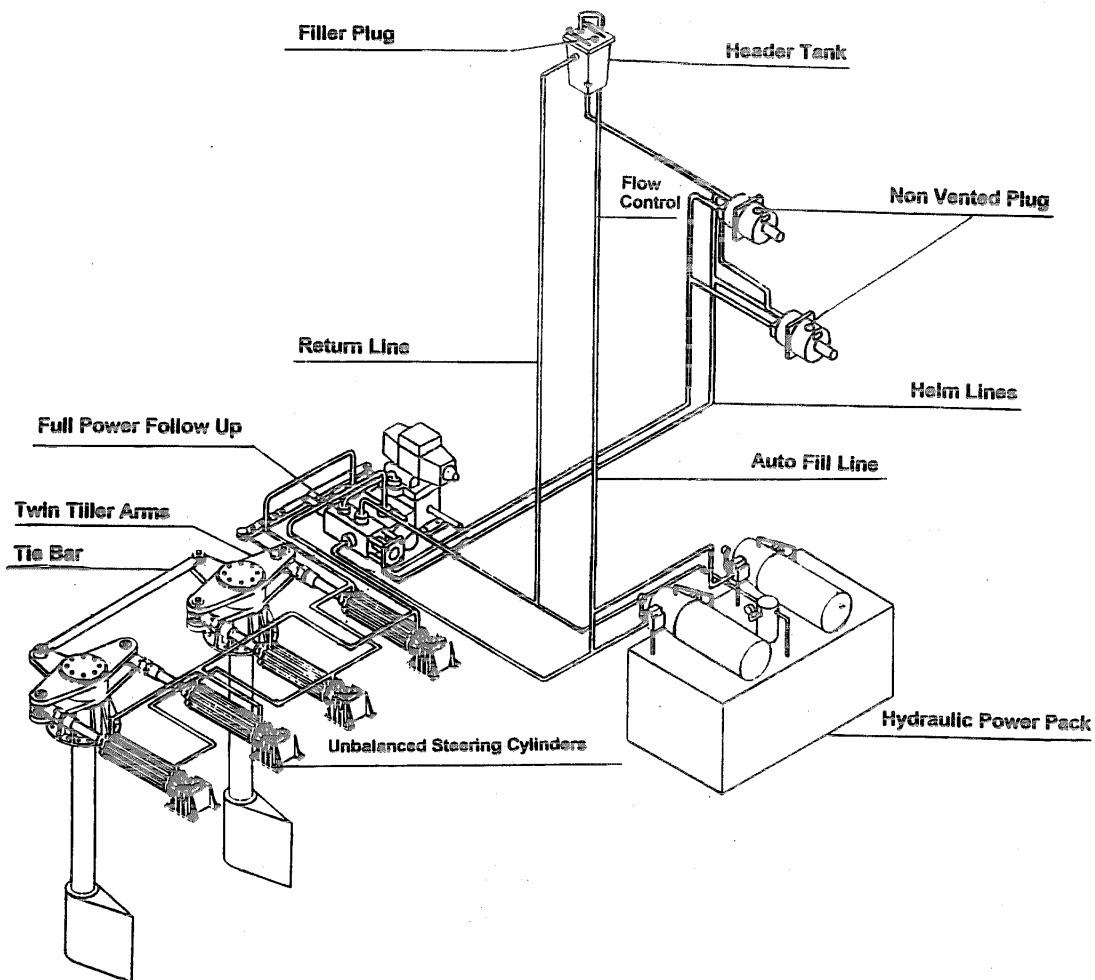


## System No. 8

### Full Follow-up Power Assist Steering Models 7148 \*, 7158

\* (U.S. Patent No. 4,357,771)

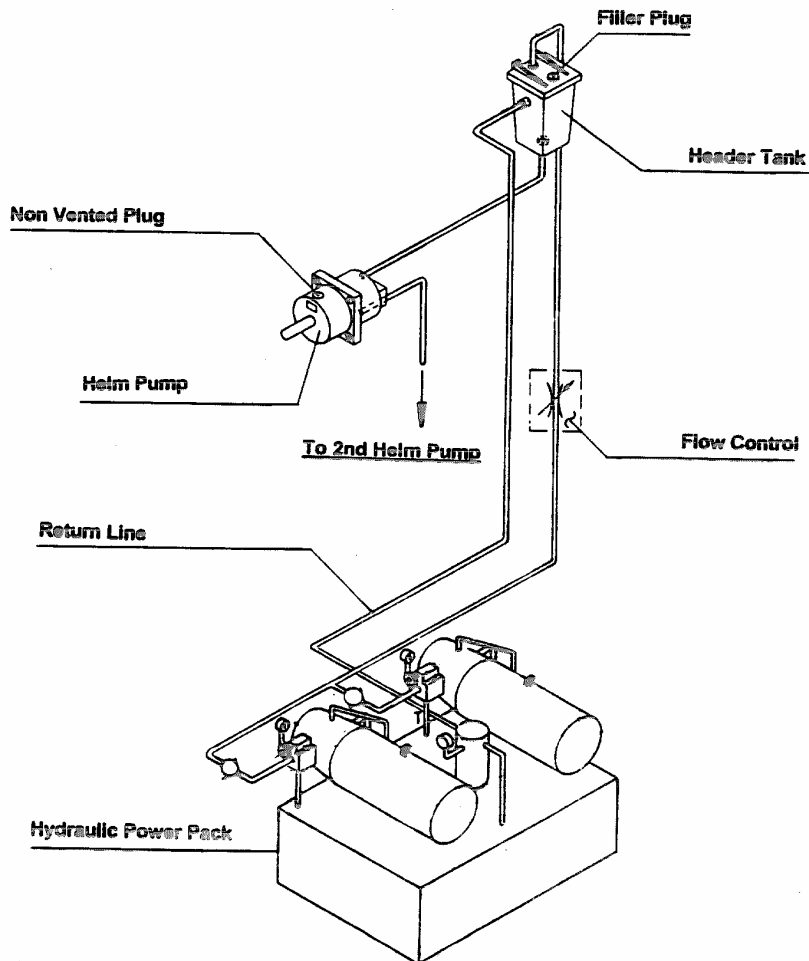
This unit is capable of handling up to 24 gallons per minute with a maximum pressure of 1500 psi. It is designed to give the operator finger tip control over the rudder, with the helm pump. A hydraulic power pack (2 pumping units recommended) is required to make the system operative. If hydraulic pressure is available from the pumping units the 7148 will shift into a power mode whereby the helm pump only operates the servo cylinder which requires very little fluid (13 cu.in.) and also very little pressure. All the oil required to operate the main steering cylinders will then come from the full follow-up four way steering valve. If, however, the pressure source fails, the rudder can still be controlled manually by the helm pump. More turns (of the helm pump) are required to move the rudder hardover to hardover. The 7148 is also equipped with a solenoid valve which can be used for either auto pilot, job lever or full follow-up electronic control.



## SYSTEM No. 9

On medium size boats with power assisted steering gear we recommend to install an auto fill system that fills the steering system automatically. Once the system is completely installed and all pipe connections have been double checked to make sure that all the piping connections are tight, the power system can be turned on. Please insure that there is oil in the tank before doing so and also check that the rotation of the motor is correct. Since from the power system there is a small flow control that will provide a trickle of oil into the header tank and helm pump, the manual part of the steering system will be filled. An overflow line is also provided from the header tank to the main tank. This allows any excess oil in the system to drain back to the main tank. It is recommended to use either the jog lever or follow-up to charge the system rather than using the helm pumps. After the system has been operative in a power mode, the helm pumps and helm lines are relatively easy to bleed.

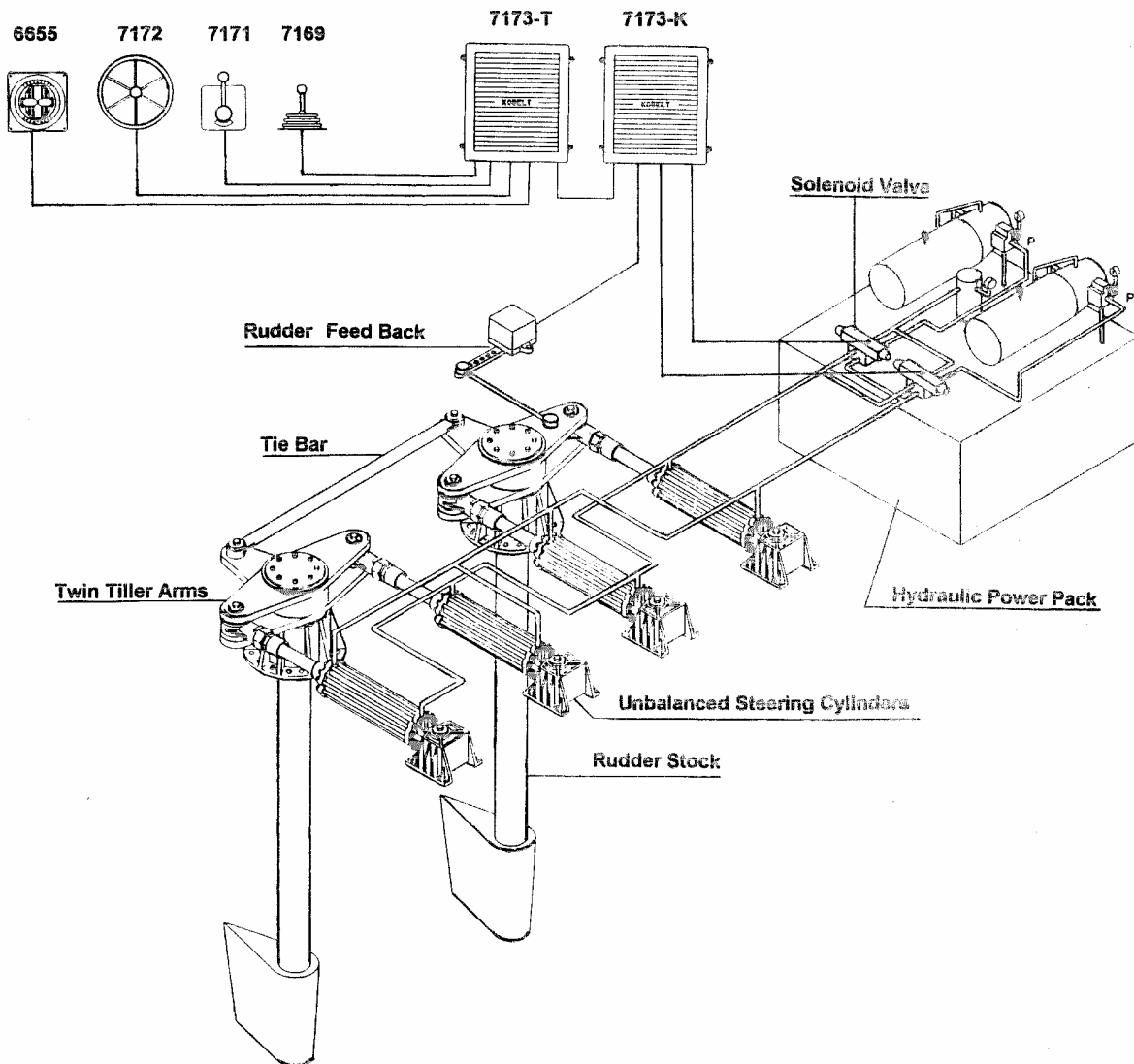
Kobelt Manufacturing provides steering gear requiring power packs from 5 gallon to 100 gallons per minute.



## SYSTEM No. 10

Hydraulic power steering systems, pump power packs, can be arranged in many ways, but it is recommended to have a standby pump in case of motor or pump failure. In most cases, especially on commercial vessels, two independent motor driven pumps are installed mostly on a common tank. On larger vessels, manual helm pumps play a minor role since the volume of oil is just too large for manual operation. If a source of energy steering is required, a DC motor driven pump can be installed as a last source of rudder control. Most of the rudders are then remote controlled electronically. When multiple stations are required, a station select unit

(7173-T) will be required. See the installation instructions) Kobelt Manufacturing makes all the various devices to control large ship steering gear. We will give an example of how these units can be combined.



## KOBELT 180° Steering Gear (U.S. Patent #5,782,195)

We have studied all the various options of 180° steering gear that are presently available. We felt there was room for improvement. It would appear that there is some dissatisfaction with the present chains, linkage and rotary vein steering mechanisms. It is for this reason that we have developed a strictly hydraulic cylinder steering gear apparatus that will provide simple maintenance-free steering gear and deliver the power where it is most needed. It can clearly be seen with the way our cylinders are arranged on the tiller arms, that the most torque is delivered at the point where the rudder is hardest to turn. Experience has shown to us that a twin rudder or multi-rudder installation must consist of single steering units. When two or more are installed they must be electronically synchronized, to make the rudders move harmoniously. This arrangement, however, allows the operator to split the system and he could add a job lever-type of steering mode whereby he can turn one rudder full to port and the other full to starboard or anywhere in between. For an installation of this nature, we would recommend dual rudder angle indicators; one for each rudder. These systems are available from rudder torque of 200 kg-metre, up to 15 tonne-metre, all with standard Kobelt cylinders. The smaller, long stroke cylinder, called the "initiating cylinder" as a rule is approximately 1/2 to 2/3 the piston area on the full torque cylinder(s). If, for example, a single 4" cylinder (7094) is chosen, a 7080 initiating cylinder with the appropriate stroke should be chosen. If, on a larger steering gear a 7098 cylinder is required for the full torque cylinder, a 7094 initiating cylinder with the appropriate stroke should be chosen. Choosing too small an initiating cylinder will cause the system to move too rapidly in mid-rudder position.

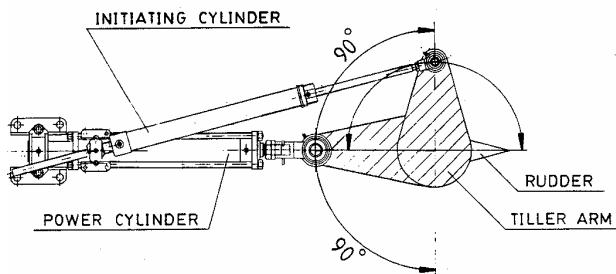


Diagram #1

Diagram #1 shows the rudder in a straight ahead position which means that the initiating cylinder is at 90° to the power cylinder since at this point it takes very little force to move the rudder from a straight ahead position. When the initiating cylinder is energized in either direction, after a few degrees of movement, the power cylinder receives pressure to move the rudder towards the desired position.

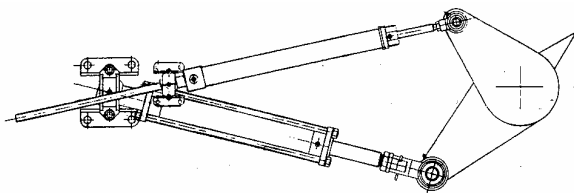


Diagram #2

As can be seen in diagram #2, the further out the tiller arm moves from the straight ahead position, the better the lever relation for the power cylinder becomes.

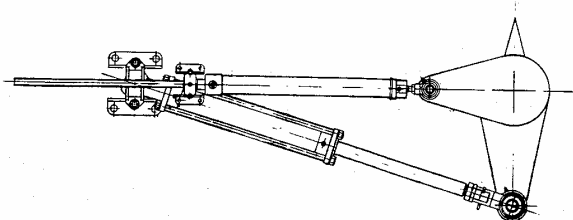


Diagram #3

Diagram #3 illustrates very clearly that at the hard over position the cylinder will produce maximum force when maximum torque is required. This arrangement makes it an ideal solution for 180° steering gear application,

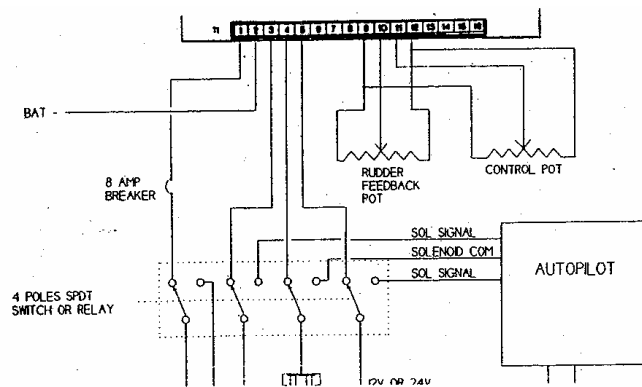
*For further information, please consult Kobelt Manufacturing*

## FULL FOLLOW UP ELECTRONIC STEERING

Kobelt Manufacturing has engineered an electronic control Model 7173-K which is the heart of our electronic steering. A potentiometer signal is sent from our control device and fed into our 7173-K. The rudder position is also fed into our 7173-K from our rudder feed back device such as model 7168 or 7174. The purpose of the 7173-K full follow-up amplifier is to process these signals and send an electric signal out to the solenoid valve which will disperse oil to the steering cylinders in the desired direction. The 7173-K can be used in various functions the most common being a single hydraulic steering system for single or multi rudder. The second purpose would be to use it as a 2-speed hydraulic steering control for single and multi rudders in a 2-speed configuration. The 7173-K will make big corrections very rapidly and small corrections slowly. In order to make the two speed steering system function, a double solenoid is required. The solenoid should be equipped with flow controls so that the high speed can be adjusted for rapid flow and slow speed can be adjusted for lesser flow. A valve such as the 7145 is ideally suited for systems up to 15 gallons per minute. Larger valves are available on request. The third function that the 7173-K is ideally suited for is catamaran applications where it is impossible to install a mechanical tie bar. A single potentiometer can be used for a rudder demand position. A separate steering system can be installed onto each rudder with a common hydraulic power pack. Two rudder angle feed back units, one on each rudder that will in turn feed the rudder position into the 7173-K. The 7173-K will then keep the rudders electronically synchronized. This has proven to be extremely successful. It is a very simple and inexpensive solution. (See next page). Instruction manual for the 7173-K is available.

An electronic full follow up system can have as many steering stations as desired. It is, however, most important that a station transfer (7173-T) system be installed, that will allow only one steering station to be in command at any one time. If there is an auto pilot aboard the vessel, it must be treated as a separate control. All other devices must not be operational when the auto pilot is in command. The wiring (as shown below) for the hydraulic solenoid valve should be connected in such a manner that will not allow any feed back to our 7173-K.

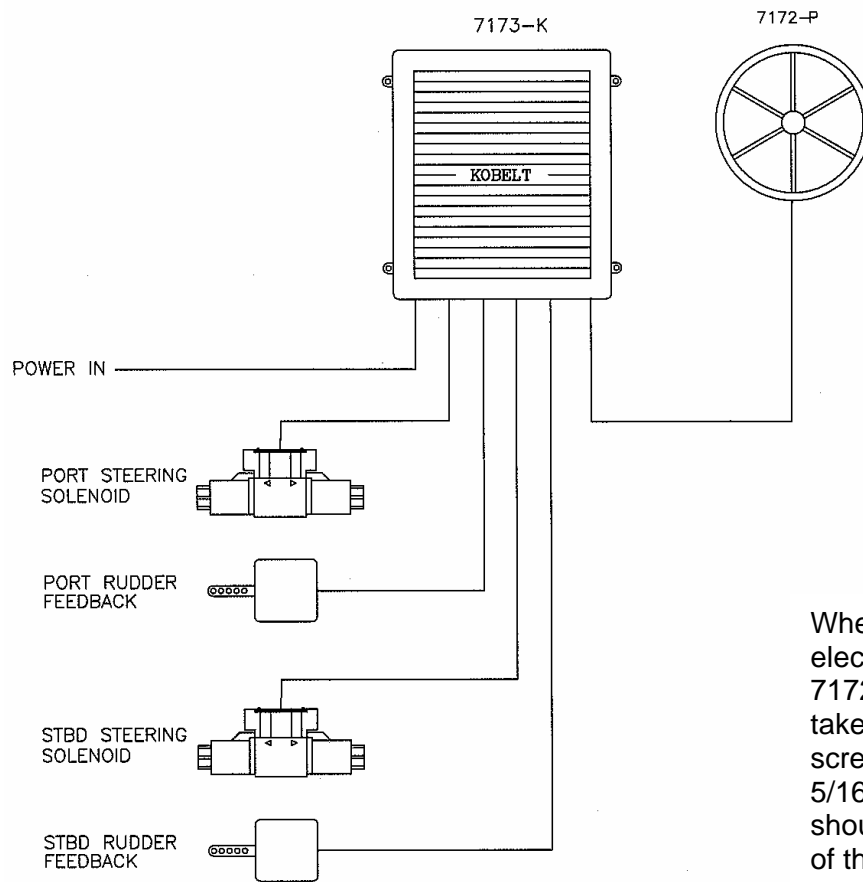
This is best achieved by switching the power input and output from the 7173 to the auto pilot therefore rendering the other inoperative.



## ELECTRONIC RUDDER SYNCHRONIZATION

In some of the dual rudder installations it is not possible to have a mechanical tie bar between the tiller arms. This holds especially true on catamaran type vessels. Kobelt Manufacturing has developed a system whereby the rudders are electronically synchronized at all times. The system is rather inexpensive, not complicated, very reliable and accurate. Our model 7173 amplifier plus our standard rudder feed back units 7168 and 7174 should be installed on each rudder. A large variety of controls such as models 7171 and 7172 can be used. Even our control heads model 6657, 6580R which will possess combined engine and rudder control, can also be used to provide complete control over the rudders.

Refer to separate 7173-K manual for details.



When installing the electronic helm 7172, care must be taken with mounting screw length - 5/16nc. This screw should be the length of the mounting panel plus a 1/2 in. Installing long screws will damage the internal gears.

## MOUNTING THE HELM PUMP

The helm pumps are supplied with a short shaft or with a long shaft. Either of these pumps can be mounted through the console or behind the console, although the short shaft version would normally be mounted in the thru-console mode.

There are currently five models in the helm pump series.

Model 7031, a fixed displacement type, is available with either 2 cu. in. or 2.6 cu. in. per turn. Model 7004, a larger version of 7031, will provide with a capacity of either 3.4 cu. in. or 4.5 cu. in. per turn.

Kobelt Manufacturing also produces three pumps which are capacity adjustable. Model 7003 can be adjusted from 1 to 3 cu. in. per turn. Model 7005 is adjustable between 2 and 6 cu. in. per turn while Model 7012 is adjustable from 4 to 12 cu. in. per turn.

When installing these helm pumps, you should allow sufficient space for the installation of the steering wheel. The bigger the volume of the pump, the bigger the steering wheel should be. For our smaller pump models like 7031 and 7004, we recommend the minimum wheel diameter of approximately 12 to 14 inches. Bigger wheels can be used without causing any harm to the pump. With our models 7004 and 7005, we recommend a 24" diameter or bigger wheel be installed. On the model 7012, a 30" – 36" diameter or larger wheel are better suited for the job. The reason for these large wheels is that a person must produce a torque on the helm pump sufficient to operate the rudder. With a small wheel it is very difficult to produce the necessary pressure for the steering actuator. Kobelt Manufacturing does not recommend operating cylinders larger than our Model 7080 with a manual system since the human effort required is too much to operate such cylinders on a continuous manual basis.

When deciding which way to mount the pump, attention must be paid to the method of filling the system. When mounted thru-console, the filler plug is accessible, but may not be the case for the behind-the-console mode. In the behind-the-console mode, you should either arrange for access to the filler plug or design for some form of remote filling system. The remote filling system can either be a small tank or a tube run up from the pump to a position convenient for topping up with oil.

Kobelt helm pump models 7031 and 7004 can be installed at any angle. A complete pump with tilting mechanism (Model 7035) is available for these pumps. The variable capacity pumps, models 7003, 7005 and 7012, are best installed with the shaft on a horizontal plane.

### Thru-Console

A template is provided for the cut-out to allow the front half of the pump to protrude through the console with the flange butting up against the back or front face of the console. The pump should be secured to the console by four bolts through the bolt holes at the four corners of the pump flange. The mounting surface for the pump must be flat. An uneven surface could distort the pump causing it to leak.

### Behind-Console

A template is provided for the cut-out to allow the pump shaft getting through the console and for the bolts used to secure the pump to the back face of the console. Four bolts and washers are required to screw into the tapped holes in the face of the pump. If the variable flow facility of the helm pump is to be used, a small access hole is needed for access to the adjusting screw at the front of the pump.

### Installation with adaptor plate

An adaptor plate is optionally available to greatly simplify mounting of the pump. This plate can be installed on either side of the console. A template is provided to drill the necessary holes. Two bolts with washers are required in this case to secure the pump to the bulkhead.

The standard helm pump has a lock valve mounted directly on the back. The ports are for O-ring fittings only. In dual station installations, the vent line ports must also be used. These ports are 1/4" NPT on all pumps.

TABLE 1

	Lock Valve Ports	Rear Top Port	Rear Bottom Port	Filler Cap
7003	1/2"-20 O-ring fitting	1/4" N.P.T.	1/4" N.P.T.	1/2" UNF
7004	9/16"-18 O-ring fitting	1/4" N.P.T.	1/4" N.P.T.	1/2" UNF
7005	9/16"-18 O-ring fitting	1/4" N.P.T.	1/4" N.P.T.	5/8" UNF
7012	7/8"-14 O-ring fitting	1/4" N.P.T.	1/4" N.P.T.	5/8" UNF
7031	1/2"-20 O-ring fitting	1/4" N.P.T.	1/4" N.P.T.	1/2" UNF

### Adjusting the output (Applicable to 7003, 7005, 7012)

Increasing the output of the pump decreases the number of turns hard over to hard over. The lower the number of turns, the stiffer the steering will feel. Larger diameter wheels may be necessary at full pump output, depending on cylinder size. Consult our distributor or dealer.

Decreasing the output of the pump increases the number of turns hard over to hard over. The steering will become lighter on the wheels and this allows the use of smaller wheels.

To increase output, turn the adjustment screw clockwise.

To decrease output, turn the screw counterclockwise.

### Tubing

Depending on the number of stations, the length of runs and the size of the helm pump, the piping must be chosen accordingly. We recommend the minimum diameter of 1/2" tubing. But on long runs and larger pumps, the 3/4" tubing is recommended.

TABLE 2 Tubing Sizes for Main Steering Lines

Helm pump model	Length of tubing between pump and cylinder up to					
	50 ft (15 m)		65 ft (20 m)		100 ft (30 m)	
	Inch	mm	inch	mm	Inch	Mm
7003	1/2	12	5/8	16	--	--
7004	5/8	16	3/4	20	3/4	20
7005	1/2	12	5/8	16	5/8	16
7012	5/8	16	3/4	20	3/4	20
7031	1/2	12	5/8	16	5/8	16

- Tubing size is specified by outside diameter.
- The use of tubing larger than specified will have no adverse effect on steering performance.
- For interconnecting (balance lines) use 3/8" (10 mm) OD tubing.

#### Fittings

Pipe fittings should not be over-torqued since the tapered thread can cause splitting of the control components. The table below is a guideline indicating the torque required for tightening tapered fittings and liquid Teflon should be used on all pipe joints.

1/8" N.P.T.	10 ft-lb
1/4" N.P.T.	20 ft-lb
3/8" N.P.T.	30 ft-lb
1/2" N.P.T.	40 ft-lb.

#### **Hydraulic Lines and Fittings**

For a manual Helm system it is recommended to install hydraulic tubing or lines with a minimum 1,000 psi operating pressure. The tubing must be kept absolutely clean during the installation and all fittings must be of good quality. Since the steering cylinders go through an arc when turning the rudder, a flexible hose must be installed between the tubing and cylinder. This flexible hose should be long enough not to cause any flexing of the tubing and again the hose must withstand a minimum of 1,000 psi or the system maximum working pressure, whichever is higher.

## INSTALLATION INSTRUCTION FOR STEERING CYLINDERS

Before installing a steering cylinder, it is important that the proper cylinder is selected to provide enough force and stroke distance to turn the rudder hard over to hard over in extreme conditions. A steering cylinder is a linear motion device and its function is to convert this linear motion into a rotary motion off the rudder stock via the action of a tiller. It is important to remember that the cylinder must be installed to provide equal travel in both directions. The information needed for all cylinder installations are given in Kobelt steering gear brochures. To arrive at the proper geometry the tiller arm must be at 90° in mid-position in accordance with our installation instructions. If this is not accomplished, unequal travel from straight ahead will result.

The following two sketches indicate: Figure 1 shows the proper angle and positioning of steering cylinders, rudder stock and related components. Figure 2 shows an incorrect installation where it can clearly be seen that even though the rudder turns 35° in either direction, the stroke is unequal and therefore, the rudder would not be in mid-ship position. In such case, all indications and feedback signals, as well as the amount of fluid required to turn the rudder hardover to either side would not be the same.

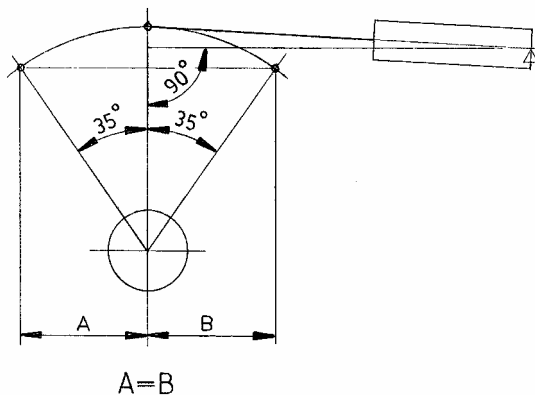


Fig. 1 **Correct** Cylinder Positioning with dimensions A and B being equal.

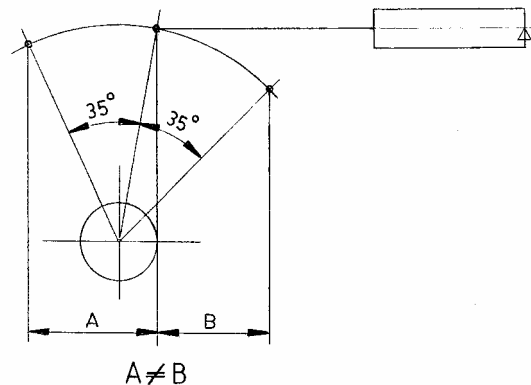


Fig. 2 **Incorrect** Cylinder Positioning with dimensions A and B being unequal

The feedback linkage for rudder angle indicators and electronic steering devices must also be installed on the same mechanical principles, as once again, a rudder angle indicator could be reading more degrees of rotation to one side than the other, if these steps are not followed. It should also be noted that the piston rod on a balanced cylinder will protrude past the mounting foot when the cylinder is in its retracted position and so during the installation, adequate room must be allowed for the piston rod's range of movement.

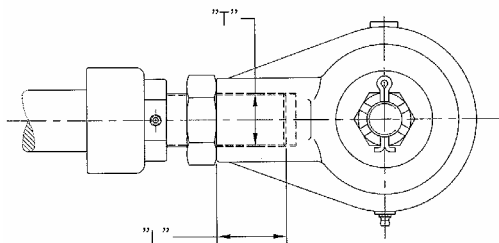
In heavy duty steering gear applications, it is also important that welded stock blocks be put on either side of the cylinder mounting foot to prevent it from moving in heavy seas.

It must also be remembered that a piston rod goes through a slight arc as the cylinder is moved from hardover to hardover. Allowance must be made so that there is no physical interference with any other objects. Failing to do so could result in bending the piston rod.

Another very important fact is that the piston rod itself is made of chrome-plated steel, machine-ground, hard-chromed and polished and is therefore a relatively expensive item. The rod should be protected during installation from mechanical or welding damage. If the piston rod, in fact, is damaged, the hydraulic seals will become damaged and ineffective and external leakage is unavoidable. This would mean that the piston rod itself and the seals will have to be replaced. Painting the piston rod or servo devices such as those in 7085-S, 7065-S, 7147 and 7148 models could also bring damage to the seals causing the units to stick or jam. These units must be safeguarded from paint during any painting procedure.

The cylinder must be installed on a flat and even surface to avoid stressing of the mounting foot. If this is not followed, the mount foot could get cracked. Since the cylinder moves through an arc in operation, a solid pipe or tubing connection to the cylinder is not acceptable. A flexible hose must be installed. All piping and hoses must be of sufficient diameter and pressure rating to comply with the general system specifications. It is of extreme importance to keep all lines and hoses as well as all other hydraulic components spotlessly clean during the installation since any foreign matter inside the components and transmission lines could cause great damage to the hydraulic system.

It is of extreme importance that the spherical bearings and rod ball ends be screwed sufficiently onto the threaded portion of the hydraulic piston rod to avoid the threads being stretched or worn. This is accomplished by screwing the rod ball end or the spherical bearing housing onto the piston rod at least 75% of its diameter. In other words, if the threaded portion of the piston rod is 1", the clevis should be screwed onto the rod a minimum of 3/4". If the threaded portion of the piston rod happens to be 2" around, the rod ball and/or spherical bearing housing must be screwed on a minimum of 1 1/2".



Thread engagement "L" is to be at least  $\frac{3}{4}$  of diameter "T"

It is also of extreme importance that the lock nut must be tightened securely against the spherical bearing or rod ball end.

Failing to do this could cause damage to the threading portion or loss of steering.

## Other Considerations

Power Pack setting - If a pressure compensated pump is used in conjunction with a safety valve, it is of the utmost importance that the safety valve be set 10-25% (minimum 200 psi) higher than the maximum pump pressure. Failing to do this may cause the pump to operate at the safety valve pressure and maximum volume, inadvertently dumping the oil back to the tank. This would create high oil temperature, excessive consumption of energy and unwanted wear and tear.

Emergency Steering – It is recommended that the builder/installer provides a method of emergency steering. In the event of a hydraulic failure, a bypass line with isolating valves from one side of the cylinder to the other side will allow the rudder stock to be moved with a mechanical tiller. Systems with hydraulic power pack could also be fitted with a manual helm pump as a back up to the hydraulic power supply.

***Failure to install Emergency steering may result in vessel becoming stranded.***

The tiller arm and mounting pad for the foot must be designed to absorb a minimum of double the stress imposed by the hydraulic cylinder(s). All bolts and nuts should be of superior quality and should be tightened securely.

### Recommended Bolt Size for Kobelt Cylinders

Cylinder Model	Size of Mounting Bolt (SAE Grade 5 or better)
7040	5/16" UNC
7050	3/8" - UNC
7065	1/2" UNC
7065S	7/16" UNC
7067	5/8" UNC
7080	5/8" UNC
7085	3/4" UNC
7087	5/8" UNC
7090	3/4" UNC
7093	3/4" UNC
7094D	3/4" UNC
7095	7/8" UNC
7096D	1 1/8" UNC
7097	1" UNC
7098	1" UNC
7100	1 1/4" UNC
7147	3/8" UNC

## NOTE

Kobelt Manufacturing recommends that a form of locking device on all cylinder hold down bolts be used. Loose lock-washers, fasteners with metallic distorting threads or adhesive are prohibited. The locking device must be detectable by visual inspection

## **Filling and Bleeding a Steering System (General)**

### Filling a Manual Steering System

A single helm pump must have a vented filler plug. If more than one pump is installed in the system, the uppermost pump must have a vented plug or connected to a header tank which is to be sitting at the highest point in the steering system. Any helm pump below the uppermost unit must have a non-vented plug.

The tubing and piping in a manual hydraulic system should not have any rises and falls in the plumbing. As the helm pump produces a relatively small volume so that purging the air from the elevated pipes would be extremely difficult if not impossible. It is very important that the piping from the cylinder to the helm pump be of a continual rise or straight up arrangement.

ISO #10 hydraulic oil is recommended to be used for manual system due to its ease of flow property although the oil has little lubricating quality. The oil should be new and clear of all foreign matter.

### Purging the system:

In order to fill the system, the uppermost helm pump, or better, a header tank is to be filled up using a funnel while the helm is to be turned slowly in either direction until some resistance is felt at the steering wheel. For variable displacement pumps, it is best to set the volume to its maximum for effective priming.

Apply further pressure to the wheel to break the lock then reverse the direction.

Continue to turn the wheel hardover to hardover until all the air escapes through the uppermost point at the funnel or filling tube. During the process the oil level must be maintained in the helm pump or header tank by adding oil to the system.

Our cylinders are also equipped with bleeder screws to help vent the trapped air.

Allow a period of several hours for any air bubbles in the system to group together and then repeat the hardover to hardover procedure.

Light tapping on the pipes could help release the air bubbles adhered to the pipe surface.

While there is still air in the system, the pump may be quite stiff to turn and on reversing the wheel, there is quite a distinct noise as the lock valve moves across. Once air is out of the system, the pump should turn smoothly and the lock valve will move quietly from one side to the other on reversing the rotation of the wheel.

### Filling a Servo Steering System

A servo steering consists of a manual pump system and an engine or motor driven pumping system. Clean hydraulic oil grade ISO #32 is recommended for a power driven pumping system.

In order to fill this system it is best to start the hydraulic power unit first to fill the main cylinders and also have a flow of oil from the auto fill line into the header tank or the uppermost helm pump.

When starting the power pack it is of importance that the oil can flow to the system and back to the tank in order to scavenge the air out of the power driven pump. Make sure the power driven pump receives oil for self lubrication. Caution: Running a dry power driven pump for a short period of time could do severe damage to the pump.

Same would be true for the manual pumps. As mentioned in our other literatures, a model 7143 Non Drain Back valve could be installed to prevent the helm pump from running dry after sitting idle for some time.

If the main cylinders are full of oil, one must wait until the oil shows up in the uppermost helm pump or header tank. Once the oil is apparent, you can turn the helm pump to port or starboard to fill this part of the system.

The same procedure applies to the manual portion of a servo steering system, as in a strict manual system.

#### Filling an Electronic Remote Control Hydraulic Steering System

A system of this nature normally does not require bleeding of any kind.

Once the power packs are setup properly as described in the previous section, they can be started up and the electronic control system operating the solenoids will look after the filling of the main cylinders which in turn bleed themselves.

If, however, this is not accomplished automatically, bleeder screws provided on the cylinders could assist in the process.

In some cases a manual helm pump must be installed as a backup in order to comply with the classification requirement.

Depending on the location of this helm pump, bleeding the helm pump is basically the same as the manual or servo system.

After any kind of hydraulic steering system is installed and operative, check for leaks to ensure that there is no loss of oil. Check the oil level in the tank after all the cylinders are filled and insure that all fasteners are tightened properly.

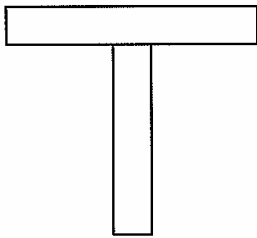
## **ADJUSTMENT INSTRUCTION FOR HYDRAULIC STEERING GEAR CYLINDERS EQUIPPED WITH STOP NUTS**

The Kobelt 4" to 10" cylinders normally come equipped with stop nuts attached to the piston rod. On special custom-orders, it is possible to shorten the piston rod by eliminating the stop nuts. The purpose of the stop nut is to adjust the stroke of the cylinder: the more the stop nut is turned towards the cylinder end cap, the shorter the stroke becomes and vice versa with limitation on the piston being bottom out on the foot end of the cylinder. Since all of these cylinders are unbalanced, it is necessary to have two cylinders in the same steering system. When two cylinders are installed on a common tiller arm, it is of extreme importance that the strokes are balanced. In other words, when one cylinder is extended to the maximum and the opposite cylinder is retracted to the maximum, they must both come to a mechanical stop which is – either the totally retracted cylinder hitting the stop nut or the opposite cylinder which is totally extended with the piston contacting the cylinder end cap. The way this is accomplished is by turning the clevis on the rod end in and out and adjusting the stop nut in and out until both cylinders simultaneously hit the mechanical stops. If mechanical tie rods are installed between two rudders, it is even more important that the cylinder or cylinders operating one rudder are in absolute synchronization with the second rudder that is connected to the tie bar. If the two cylinder travel is unequal, the tie bar can be damaged.

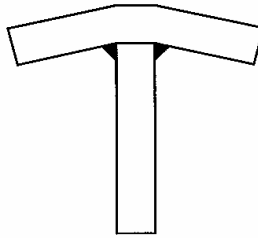
The rod end must be attached to the piston rod with a sufficient amount of thread without causing the threads to strip. In other words, if the threaded diameter part of the piston rod is 1", there should be a minimum of 1" of thread in the rod end. It is also important that the lock nut is securely tightened against the rod end.

## Mounting Plate Fabrication

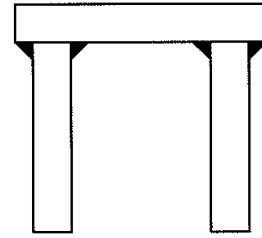
When fabricating mounting foundations for either steering gear or disc brakes, it is extremely important that these items be installed on a flat and even surface. Failing to observe these instructions will cause a failure in the castings. When making a "T" section foundation, the fabricator will install a flat piece of steel, as shown in figure 1. However, when the items are welded together it will cause the mounting plate to be deformed as shown in figure 2, because when the weld cools, it will pull the mounting plate downwards causing the top surface to become uneven and is not acceptable for the installation of any Kobelt equipment. Even by placing mounting shims on the outside corners will not eliminate the problem since the shims would have to be tapered to fit underneath precisely between the mounting foundation and the item to be installed. It is, therefore, recommended to make foundations as per figure 3 and even in this case, welding can deform and twist the foundation plate at times. Please be careful to make this plate straight and square in order to provide a firm base for installation. Any fabrication selected must be strong enough to withstand any and all forces imposed by the steering gear or disc brake. The mounting bolts must be at least of SAE grade 5 or better.



**FIGURE 1**



**FIGURE 2**

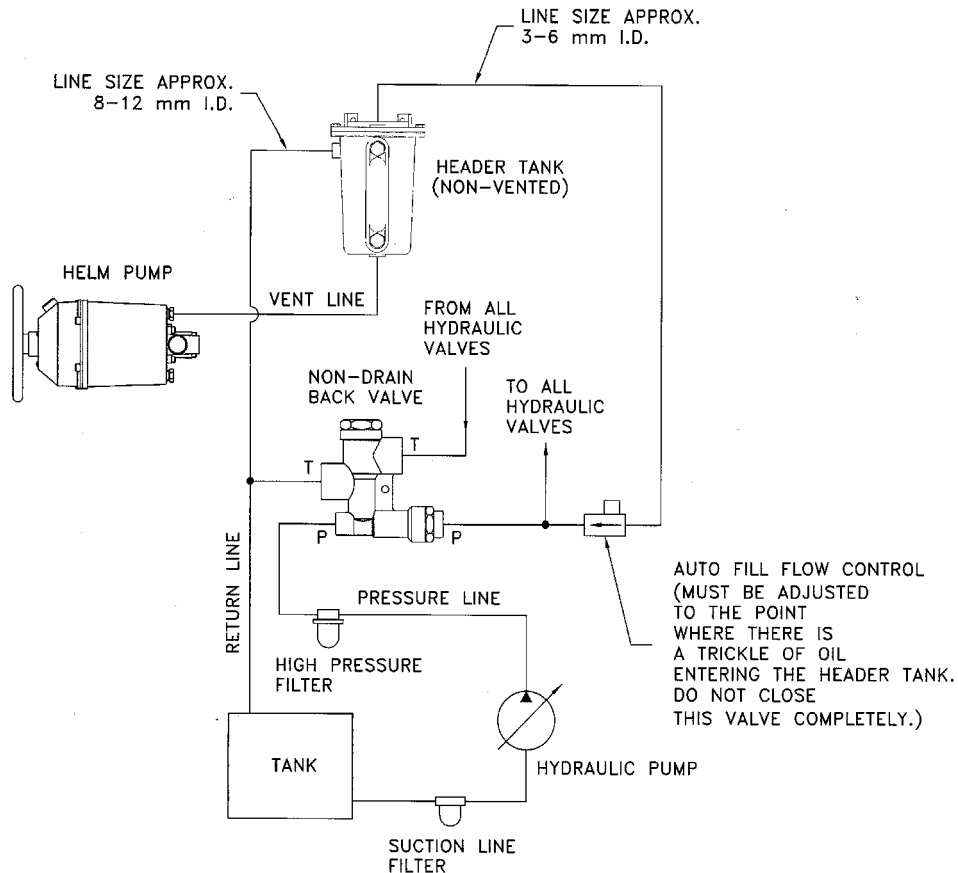


**FIGURE 3**

## Non-Drain Back Valve

Kobel Manufacturing also developed a non-drain back valve, our model 7143 and 7153. This valve serves an extremely useful purpose in the servo steering systems where a hydraulic power pack provides normally all the power to operate the rudder and helm pumps are used for manual steering. All hydraulic solenoid valves are designed on a spool type principle which is a sliding fit and all spool valves have a tendency to leak internally after a vessel is tied up for any length of time. Oil will drain back from the highest point to the lowest point (the tank) and this would cause the hydraulic helm pump to run dry and in an emergency situation, the pump would be empty and not functional, therefore making steering impossible. The 7143 and 7153 valves, if properly installed, will retain all the oil in the system and will, therefore, not cause any problems in a steering system.

If the 7148 is installed on the servo steering system, all helm pumps must have a non-vented plug. The header tank must also be sealed (non-vented). The return line from the header tank must go directly to the main tank. The flow controls supplying oil to the header tank must be open far enough to allow all the pressure from the hydraulic system to vent via the header tank back to the main tank. If flow control is too widely open, the header tank will be pressurized and could cause possible damage to side glass and cause leakage between the tank and the cover. A minimum of oil should pass through the flow controls, but sufficient enough to allow the pressure not to drop off in the system.



## HYDRAULIC POWER PACKS

A hydraulic power pack basically consists of a tank which should have a minimum five times the flow capacity of the pump or pumps. The power pack must be equipped with a filter or strainer on the suction side, filter on the high pressure side, a pressure gauge on the output side, a sight glass or dip stick to indicate the oil level. If the steering gear is tied onto an alarm system, a pressure switch for each pump should be installed, a device indicating pumps in operation or not in operation to interconnect with the pressure switch. Also indication of oil level and oil differential should be installed. After the selection of the proper size power pack is made, one must also remember that the appropriate size hydraulic lines and valves must be installed to handle the oil flow. The table below indicates the minimum tubing size.

### Power Pack Hydraulic Line Sizes

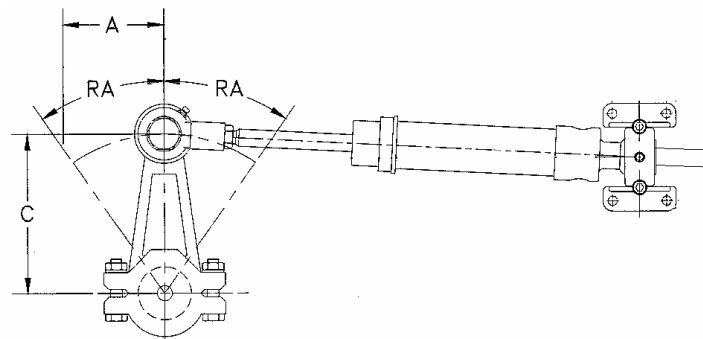
Flow Capacity GPM	Pressure Line Pipe I.D. inch (mm) minimum	Return Line Pipe I.D. inch (mm) minimum
5	1/2 (13)	3/4 (19)
10	3/4 (19)	1 (25)
20	1 (25)	1 1/4 (32)
30	1 1/8 (29)	1 1/2 (38)
40	1 1/4 (32)	1 1/2 (38)
50	1 3/8 (35)	1 1/2 (38)
60	1 1/2 (38)	1 3/4 (44)
70	1 1/2 (38)	1 3/4 (44)
80	1 3/4 (44)	2 (51)
90	2 (51)	2 1/4 (57)
100	2 1/4 (57)	2 1/2 (64)

Hydraulic lines shall be supported by clips, straps or other means to prevent chafing or vibration damage. The clips, straps or other devices shall be corrosion-resistant and shall be designed to prevent cutting, abrading or damage to the lines and shall be compatible with hydraulic line materials.

## TILLER ARMS

Kobelc Manufacturing produces a variety of tiller arms. These are stock items. In order, however, to select the proper tiller arm, you must know the stroke of the cylinder and the degrees of rotation of the rudder. Larger tiller arms for model 7094 up to 7100 are custom made. In most cases, these tiller arms are cast in steel and machined to suit custom requirements. Before the machining the tiller arm can begin, a drawing is required with precise measurements of the rudder stock also showing the desired key way.

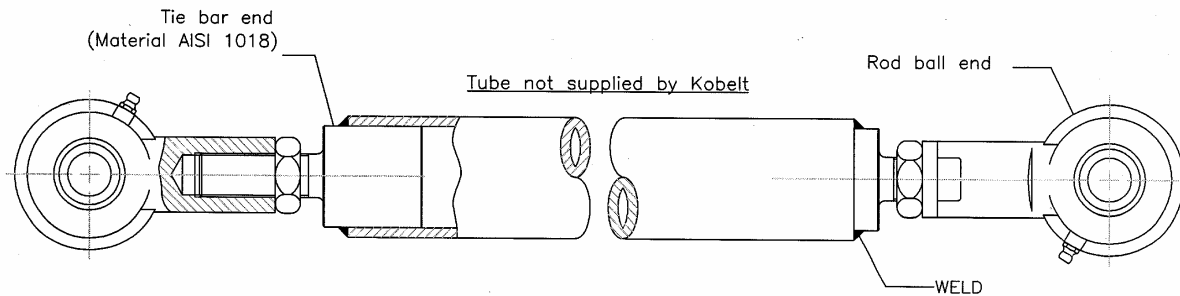
On vessels that are to be refitted with Kobelc steering cylinders it is quite possible to utilize the existing tiller arm and make special adjustments for our cylinders to be fitted. The responsibility for this would mostly fall onto the shipyards. The table below shows the arm dimension for the standard tiller arms.



Cylinder Stroke (= 2A)		"C" (RA = 35°)		"C" (RA = 45°)	
in.	mm	in.	mm	in.	mm
10	254	8.72	221	7.07	180
12	305	10.46	266	8.48	216
14	356	12.20	310	9.90	251
16	406	13.95	354	11.31	287
18	457	15.69	399	12.73	323
20	508	17.43	443	14.14	359
22	559	19.18	487	15.56	395
24	610	20.92	531	16.97	431

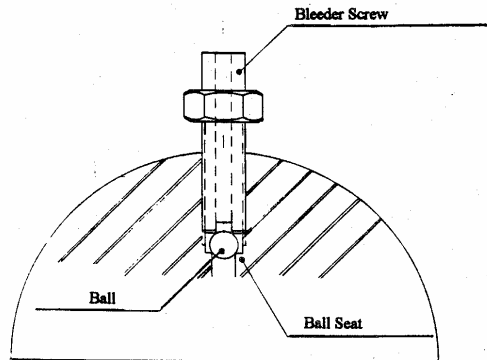
## MECHANICAL TIE BARS

On multiple rudder installations where the rudders are connected with mechanical tie bars, Kobelt Manufacturing normally does not supply the tie bars. We do, however, make tie bar ends that can be readily welded into a piece of steel pipe that is normally supplied by the shipyard. In most cases, these tie bars are quite long and it is not economical to ship a pipe halfway around the world when it is readily available from a local supplier. A mechanical tie bar should, however, have a thread on one end so that the tie bar rod end can be adjusted to give precise alignment between the rudders.



## CYLINDER BLEEDER SCREWS

The Kobelt steering cylinders for inboard applications are equipped with bleeder screws. When installing the cylinder, it is recommended to have the bleeder screws facing up. This will allow the installers to bleed the air out of the cylinder during startup. It is best to move the cylinder hardover to hardover when doing so.



The bleeder screw itself is basically just a threaded stainless steel hex (as above) with a ball seat in the cylinder end cap and a ball being compressed against the seat. This makes an ideal one-way check valve. The fluid and air can escape from the cylinder, but with the bleeder screw facing up, air cannot enter the cylinder. Moving the cylinder hardover in either direction will pressurize the cylinder at that end and air will escape through the bleeder screw. Continue the operation until a solid flow of hydraulic fluid is available.

To prevent oil spills, a plastic hose can be attached to the outer part of the bleeder screw and any oil can be collected with a container and recycled, provided it is clean.

If the bleeder screw is removed totally, the possibility of losing the ball does exist since hydraulic fluid will wash it out of the port and without the ball, the steering system is inoperative. It is therefore recommended not to remove the bleeder screw and only loosen it about one turn to let the air escape. Care must be taken not to over-tighten the bleeder screw. Over-tightening could cause the expansion of the bottom part of the bleeder screw and therefore make it seized in the end cap and possibly break the screw. We recommend a torque of approximately 4 ft-lb for the small cylinders and up to 10 ft-lb for the larger cylinders.

***CAUTION:*** When centering the steering gear components, one must be extremely cautious to avoid any moving steering gear components since high pressure hydraulics exerts tremendous force that could shear off a human limb easily.

After the installation is completed ensure all fasteners are securely tightened.

Note:

**CAUTION** denotes a reminder of safety practices or direct attentions to unsafe practices which could result in personal injury or damage to the craft or components.

## Installation and Adjustment Instructions for Model 7145 – 2 Speed Solenoid Unit

The purpose of this model is to provide 2 or 3 speed hydraulic steering operation. The high speed provides rapid speed off the rudder to close to the desired rudder angle and the low speed valve will gently bring it to the exact final location. This makes for a very smooth rudder operation. In separate operations, the low speed solenoid valve is being used for autopilot functions whereas the high speed valve can be used for jog lever applications. It is, however, most important that the electrical signals from various components be separated. In other words, a station transfer system is required to avoid interference of various electronic or electrical components. It must only receive one signal from any one of the control components at any one time.

The unit is equipped with a pressure port marked 'P'. This is where the oil pressure from the pressure source enters and port 'T' is for the return line to tank. Ports 'A' and 'B' are connected to the steering system (cylinders).

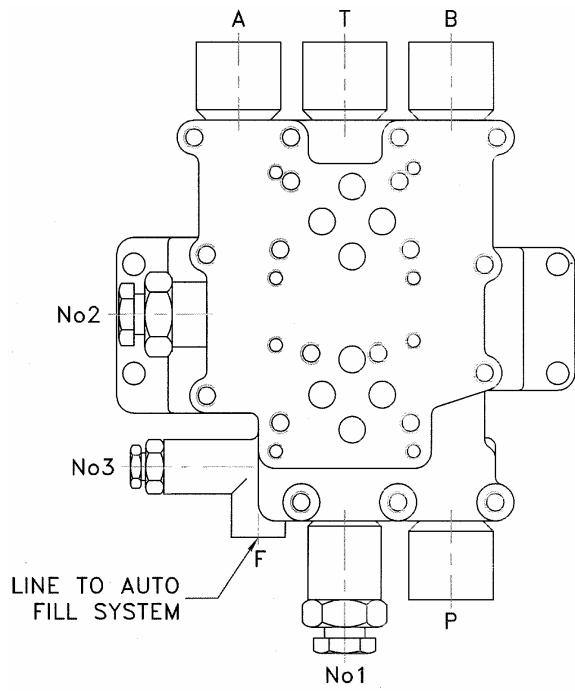
The unit is equipped with three flow controls:

- #1 flow control – regulates the amount of oil that goes to the high speed valve. (This valve will give the high speed flow required to turn the rudder when a big correction is required).
- #2 flow control regulates the flow of oil going to the low speed valve. (The volume is much reduced to give a nice soft shift).
- #3 flow control provides a trickle of oil to the auto fill system and the pipe connection 'F' shows the line going to the header tank for the auto fill system.

The solenoid valves must be of the "soft shift type" and the proper voltage (in AC or DC) must be selected in conjunction with the control system.

Our model 7173, which controls the high and low speed valves, also has some adjustments. The appropriate adjustments are found in the Instruction manual for the 7173.





# BASIC SELECTION GUIDE FOR KOBELT HYDRAULIC STEERING

- A. Manual hydraulic steering (M) or Power (P)
- B. Manual: No. of turns required HardOver to HardOver
- C. Number of steering stations (Hydraulic)
- D. Header tank (P/N 7002)
- E. Rudder angle indicators required (P/N 7175, 7180)
- F. Panoramic rudder angle indicator (P/N 7178)
- G. Auto-Pilot hydraulic pump (P/N 7201)
- H. Auto-Pilot interface  
If yes, indicate speed
- I. Number of jog levers
- J. Full Power Follow Up servo hydraulic steering (P/N 7147, 7148)
- K. Full Power Follow Up electronic steering (P/N 7173)
- L. Electronic tie bar (P/N 7173)
- M. Station transfer
- N. Number of stations (electronic)
- P. Tiller arms
- Q. Type of electronic controls (please specify, e.g 7171, 7172, etc)

M	<input type="checkbox"/>	P	<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
Single	<input type="checkbox"/>	Dual	<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
			<input type="checkbox"/>
Single	<input type="checkbox"/>	Twin	<input type="checkbox"/>

## Rudder Information Required

- Number of Rudders
- Number of cylinders per rudder
- Tie bar fitting required
- Degree of rudder rotation (e.g. 35°, 45°)
- Rudder torque \*\*
- Speed HardOver to HardOver in seconds

1	<input type="checkbox"/>	2	<input type="checkbox"/>	Others	<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
35°	<input type="checkbox"/>	45°	<input type="checkbox"/>	Others	<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

## Power Information Required

- Specify electrical power available for power pack
- Specify electrical power (DC) available for electronic controls
- Engine driven pumps

V.	<input type="checkbox"/>	Phase	<input type="checkbox"/>
12V	<input type="checkbox"/>	24V	<input type="checkbox"/>
			<input type="checkbox"/>

\*\* if rudder torque is not available please complete hydraulic steering technical data sheet

For further information, please consult Kobelt Manufacturing

## Hydraulic Steering Technical Data Sheet

To properly size the steering system required for your vessels please complete the following accurately.

Customer Name: \_\_\_\_\_ Date: \_\_\_\_\_

Address \_\_\_\_\_ Phone: \_\_\_\_\_

\_\_\_\_\_ Fax: \_\_\_\_\_

Vessel Name \_\_\_\_\_

Vessel Length \_\_\_\_\_ Vessel Type \_\_\_\_\_

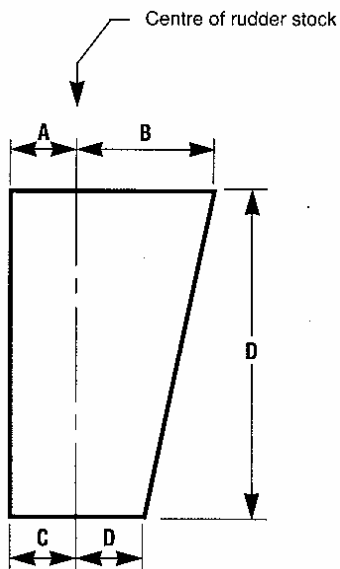
Hull Type: Planing \_\_\_\_\_ Displacement \_\_\_\_\_ Sail \_\_\_\_\_

Maximum Speed \_\_\_\_\_ knot Number of Rudders \_\_\_\_\_

Maximum degree of rudder angle \_\_\_\_\_

Please specify other details (nozzle, tunnel, etc.)  
\_\_\_\_\_

Dimensions and counter balance of rudder, provide sketch as per sample



Unit of measure      mm       inch

## CLASSIFICATION

*Classification* is a well-recognized form of certification of a vessel, marine structure or system. It is a representation to the structural and mechanical fitness for a particular use for service in accordance with Rules and standards.

*Certification* is a review of individual materials, components and systems for compliance with recognized standards. It is a “one-time” process including technical review on the products and surveys during manufacture for compliance with the Rules and specifications.

Not all steering gear components need approval from the classification societies. The ones that do and manufactured by Kobelt Manufacturing are Type Approved.

*Type Approval* means that the product is designed and manufactured to be functional and seaworthy for its intended purpose. The product is built to a specific standard or specification and with consistent quality. The Type Approval is granted by individual classification body.

For example, if a vessel is built to the marine shipbuilding rules but not certified, all components can be readily used without further paper work. However if a vessel is to be certified, special documents on all of the items installed have to be prepared and submitted to the relevant certification agent for approval.

There are several classification groups such as LRS, ABS, BV, DNV, RINA, NKK and a few others who are doing the certification work for the marine industry. Their rules and specifications are very similar and once type approval is granted by one of these authorities, there is a very good chance that the others will accept it as well.

Most of the steering gear components supplied by Kobelt are society approved. The shipbuilder still needs to get the installation approved. Kobelt's certification provided by the Society only relates to the components supplied by us. Getting the system approved remains to be the responsibility of the shipbuilder. The certification process can sometimes be lengthy and also expensive. The closer the cooperation between the customer and Kobelt and the more information made readily available to us at the very beginning, the more the expense can be reduced since the rates charged by the inspection authorities are high.

To properly identify the steering system, the Installer is requested to fill out the following Designation Information form in accordance with the requirement of ISO10592. The completed information should be kept as part of the Owner's Manual.

### Designation of Hydraulic Steering System

- (a) Name of Vessel: \_\_\_\_\_
- (b) Speed of Craft: \_\_\_\_\_ knots
- (c) Length of Hull: \_\_\_\_\_ m.
- (d) Type of Hull: \_\_\_\_\_ P – Planing; D – Displacement
- (e) Number of Engine: \_\_\_\_\_
- (f) Type of Engine: \_\_\_\_\_ I – Inboard motor;  
I/O – Inboard/Outboard motor;  
O – Outboard motor.
- (g) Number of Control Stations: \_\_\_\_\_
- (h) Number of Cylinders: \_\_\_\_\_
- (i) Maximum Torque to be applied to the Steering Axle: \_\_\_\_\_ N-m.
- (j) Maximum Working Pressure: \_\_\_\_\_ MPa

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

Note: For other information regarding the components, please also refer to the technical manuals or consult the manufacturers for details.

It is the responsibility of the installer to build the steering system to conform to EN ISO-10592 and to issue a Declaration of Conformity.