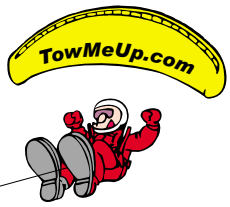

TowMeUp.com
23102 NE 3rd Avenue, Ridgefield, WA, USA 98642
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TowMeUp@iesonline.cc • www.TowMeUp.com

TowMeUp.com is an Internet-based resource for pilots, instructors, and entrepreneurs devoted to providing the best towing equipment and information available in the world. Primarily geared towards Paraglider pilots, our site also provides a wealth of equipment and information usable for Hang Glider pilots as well. Please visit us at: www.TowMeUp.com for the most up to date information, and equipment.

This Document was produced to illustrate the functional operating characteristics of a TowMeUp.com hydraulic Payout / Payin winch for use by our customers. It is the intellectual property of TowMeUp.com and the information contained within was compiled and created entirely in house by Stuart Caruk, our Director of Research and Development. Any specific questions should be directed to him via Email to stucaruk@starband.net

It contains enough information that users of competitve winches may find helpful ideas in improving the performance and safety of their systems. Creative individuals should find enough information to build their own winch should they choose to do so. Our goal is to make towing available to as many people as possible worldwide, using the best, and safest equipment. We would be remiss if we failed to point out, however, that if the average person chooses to make an exact copy of a TowMeUp.com hydraulic winch and they have to buy the components at retail, it will cost significantly more to build one than it costs to buy a completed, functionally tested system. You would also find some of the key components very difficult to obtain or manufacture.

Disclaimer

Any Form of Aviation is potentially dangerous. Paragliding, Hangliding, and in fact many activities we partake in during the course of our daily activities have the potential to injure, maim, disable, or fatally wound the participant or spectators. We assume that those individuals who choose to participate in these sports are aware of the risks involved and are willing to accept the responsibility for their own actions and the results that may occur. If you're willing to accept responsibility for your actions and agree not to sue the owners, designers, suppliers, and pilots who helped design this guide and make the information freely available to all pilots, or to use winches and / or equipment manufactured or supplied by TowMeUp.com please read on and use the information as you see fit.

SuperTow Hydraulic Payout Winch Schematic

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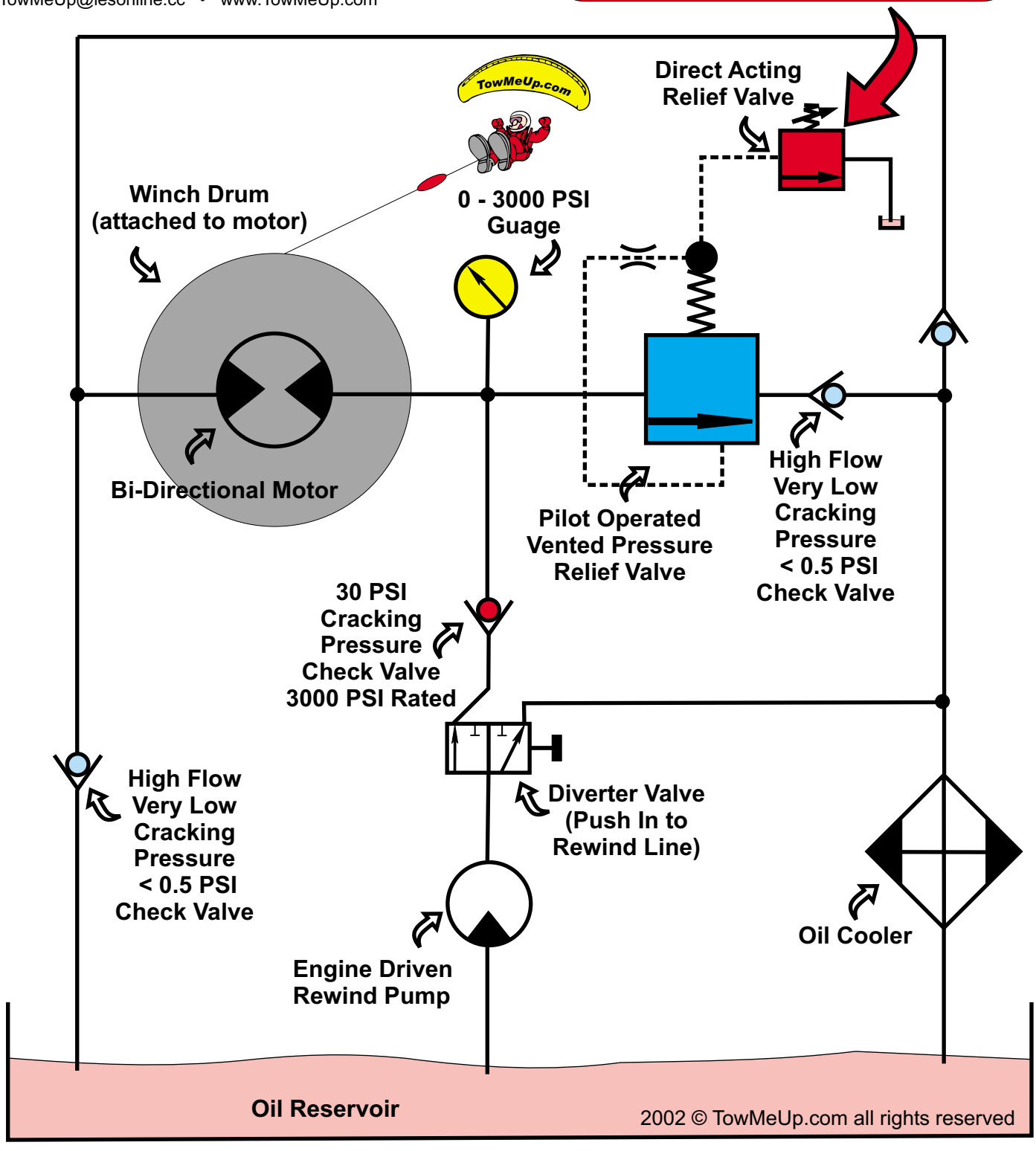
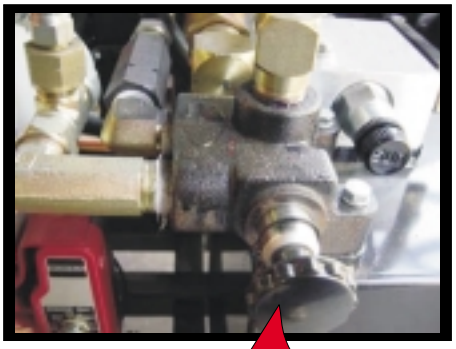
WARNING!
This circuit shows the use of a specially modified fast adjusting 3000 PSI relief valve available **ONLY** from TowMeUp.com **DO NOT** substitute a standard 0 - 3000 PSI 5 turn relief valve for this component, or the winch will be dangerously unsafe!



DIVERTER VALVE OPERATION

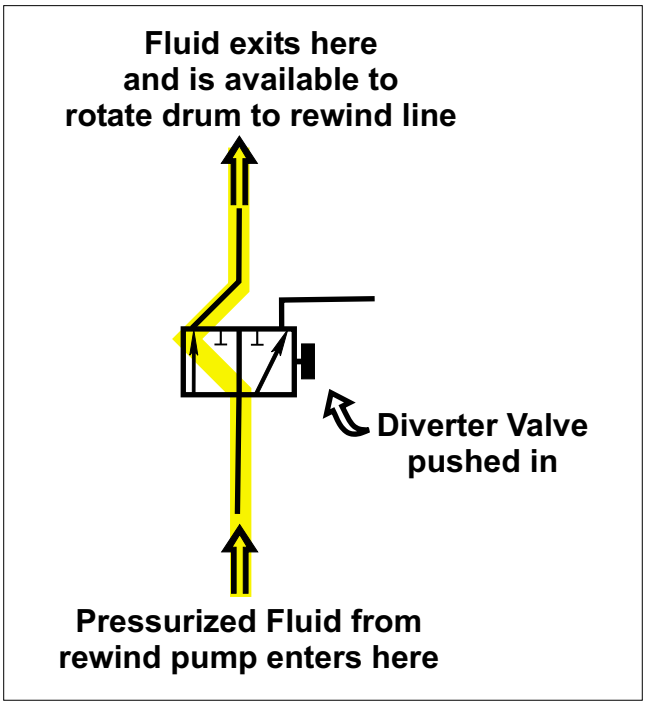


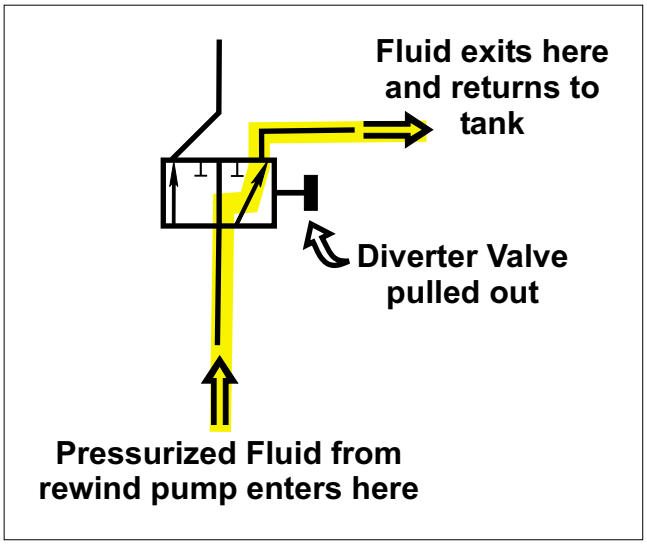
DIVERTER VALVE

A diverter valve is used to make it easy to manually start the gas powered motor that drives the hydraulic pump used to rewind the line.

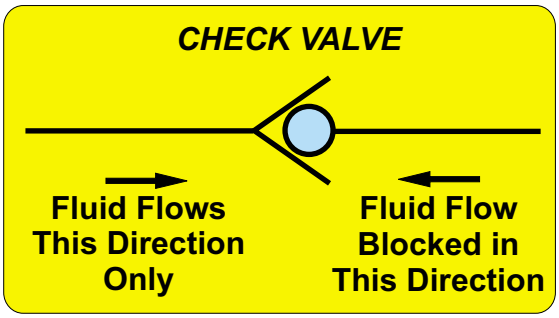
With the diverter valve pulled out (To make it easy to remember just think PAY - OUT) this pump sucks fluid from the tank, goes through the diverter and is pumped back to the tank.

With the diverter valve pushed in (think PAY - IN) this pump supplies pressurized fluid to the rewind circuit and is available to rewind the line.





CHECK VALVE OPERATION



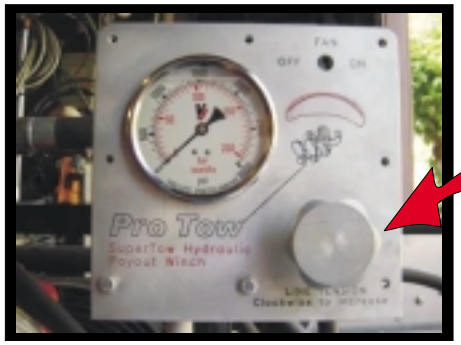
Check Valves are used to force fluid to follow a certain path, or prevent it from flowing where you don't want it to. Fluid can only flow in one direction through the check valve. 4 check valves are used in a standard winch system. The valve from the diverter is a standard hydraulic check that cracks at 30PSI and is rated to 3000 PSI. The remaining 3 check valves are a very special valves because they allow high flow rates at very low system pressures. They must crack at less than 0.5 PSI to function properly.

DIRECT ACTING RELIEF VALVE OPERATION

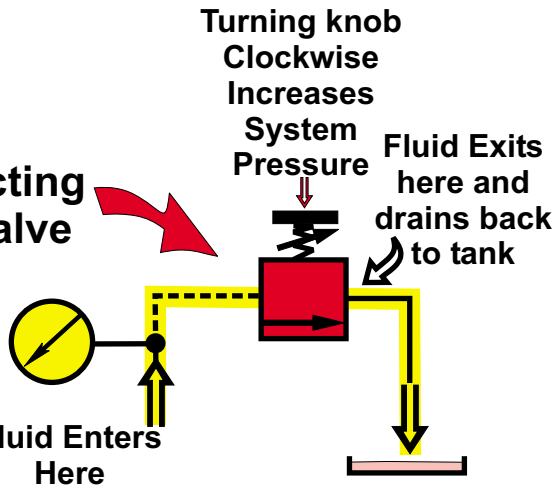
A direct acting relief valve is typically used to control excess pressure in a hydraulic circuit to prevent injury or damage from ruptured hoses, components, etc. This particular type valve is typically controlled by a knob that has a range of 5 turns. Turned all the way out, it allows all fluid to flow freely through the valve and no build up of pressure will occur. As the valve is screwed in, it restricts the flow of fluid through the valve and causes the system pressure to rise.

A direct acting valve should **NEVER** be used as the primary relief, or as the main system valve, because it will only let out enough oil to maintain the pressure it is set to regulate.

In a TowMeUp.com winch, we use this valve as a pilot valve to control the system operating pressure which is regulated by a large, vented, pressure relief valve.



Direct Acting Relief Valve



SAFETY NOTICE!

All winches MUST have a means of rapidly dropping line tension to prevent overtowing the pilot in case of an emergency (pilot trips on launch, etc). At TowMeUp.com we tried several methods. Using a standard 5 turn valve made it impossible to drop the pressure quickly enough since you need 2 1/2 - 3 turns to generate enough system pressure to launch a pilot, and you can't turn it out fast enough to drop the pressure to zero. Adding a circuit with a dump valve to immediately drop pressure, lets the drum freespool and the line goes everywhere. Gearing down a standard valve took the feel out of it and proved mechanically unreliable in wet or sandy environments.

The solution we chose was to dis-assemble a standard valve with a 24 pitch thread and machine our own valve spindle with a double start 8 pitch thread. We then bore out the valve body to match the threaded spindle, carefully reassemble and test the valve. This process requires that the machinist be capable of setting up and machining to a tolerance within 0.0005" for the component to function properly. **DO NOT EVER substitute any other valve for this application. Doing so will make it impossible to quickly drop the pressure, which is how we drop the towline tension, and it will make the winch dangerously UNSAFE!**

Standard Valve Spindle

TowMeUp.com Custom machined Spindle

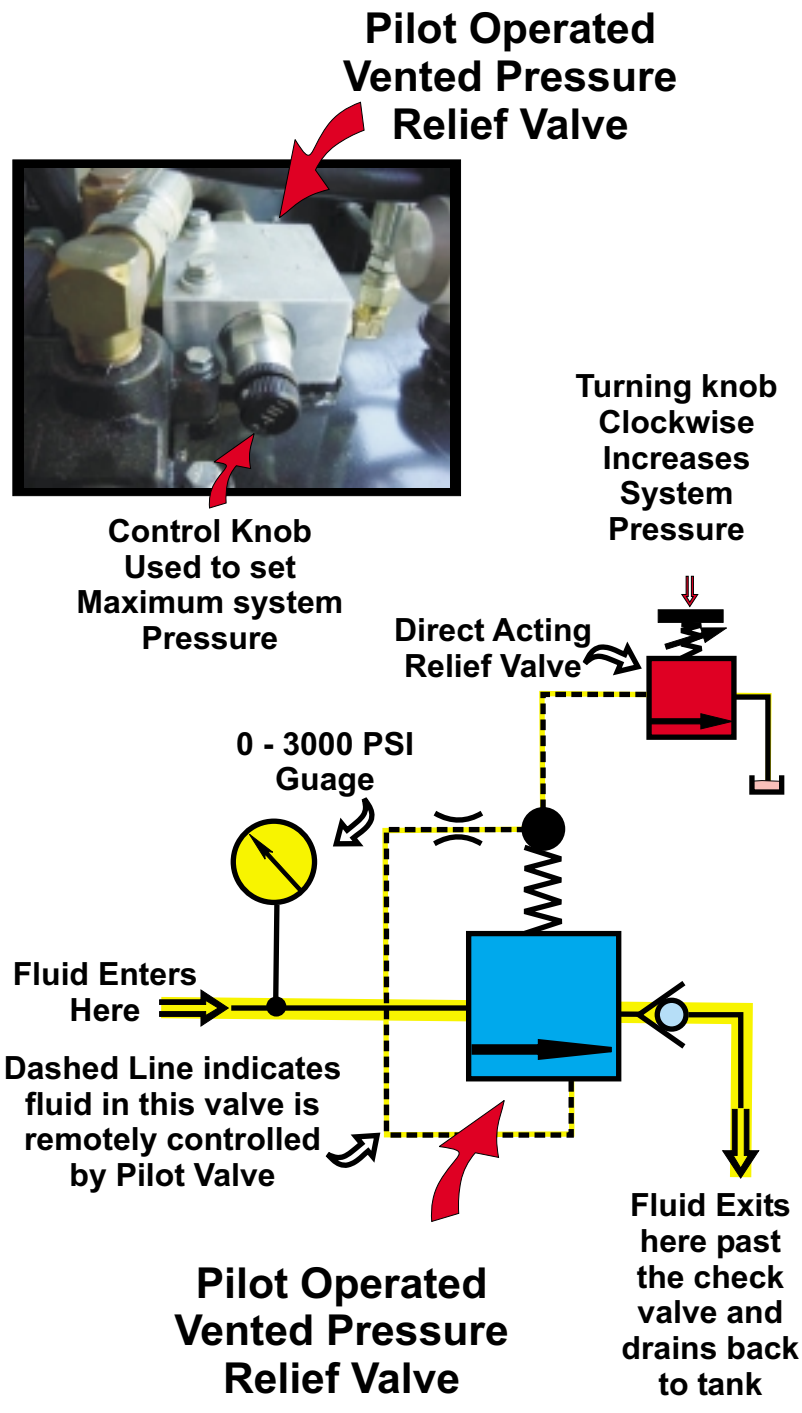
Standard Spindle & Knob

Direct Acting Relief Valve (Pilot Valve) Components shown dis-assembled

TowMeUp.com manufactured Spindle and Knob

PILOT OPERATED - VENTED - RELIEF VALVE OPERATION

Pilot Operated, Vented relief valves are ideal for use when we need to regulate system pressure and allow for high fluid flow rates. To work properly in a hydraulic winch, they must be fast acting, have a low pressure rise vs. flow curve and be easy to adjust. The use of a pilot circuit allows us to use low fluid flow rates (and hence use smaller hoses) to run from the main winch control panel. It allows us to position the control up to 20 feet from the winch, and allows an easy upgrade path. Through the use of electro-proportional control valves the system can be operated from virtually any distance. It can even be operated autonomously by a computer or PLC with a manual over-ride like we use in our premier towboat systems.



The Pilot Operated, Vented relief valve is controlled 2 ways. The main system pressure is regulated by the 5 turn control knob (shown as black in the picture to the left). Ordinarily it is screwed all the way in, so the Pilot valve can control the system pressure through a range from 0 - 3000 PSI. System pressure is then controlled by the Pilot Valve (Direct Acting Relief Valve). Normally the valve is screwed all the way out (counterclockwise) as the tow is started. The valve is screwed in to increase the system pressure, hence increasing the torque, which causes tension to build in the tow line. Increasing the system pressure increases the towline tension and allows the pilot to climb out at a faster rate. In the event that the line tension needs to be dropped suddenly, the control valve can be rapidly backed out due to the special modifications made to this valve by TowMeUp.com

***NOTE* DO NOT SUBSTITUTE ANY OTHER VALVE FOR THIS SPECIALLY MODIFIED VALVE, OR THE WINCH WILL BE DANGEROUSLY UNSAFE!**

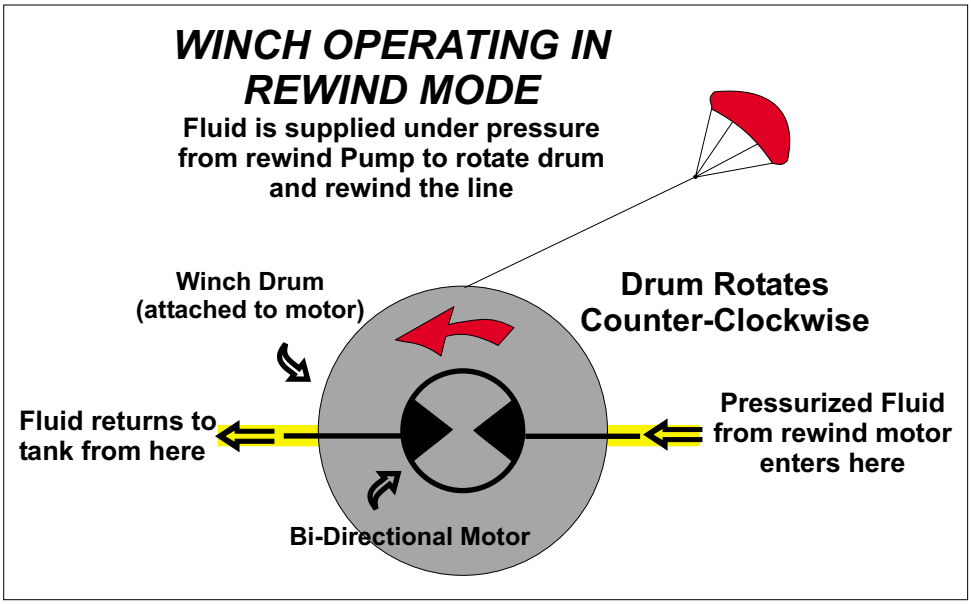
In some applications (particularly when training new winch operators) you may wish to limit the maximum towline tension to a specific value. This is easily done by backing the control knob out so that the system pressure can never exceed that value. For example if the valve is screwed out 2 1/2 turns, the system pressure will be limited to 1500 PSI. This equates to a maximum towline tension of approximately 150 pounds. During the tow the tension is normally controlled by the pilot valve. In the case above, even screwing the pilot valve all the way in, the system pressure will be limited to the 1500 PSI set by the control knob. Pilots who only tow Paragliders may choose to limit the maximum system pressure to 1500 PSI or so to prevent pilots from being over towed.

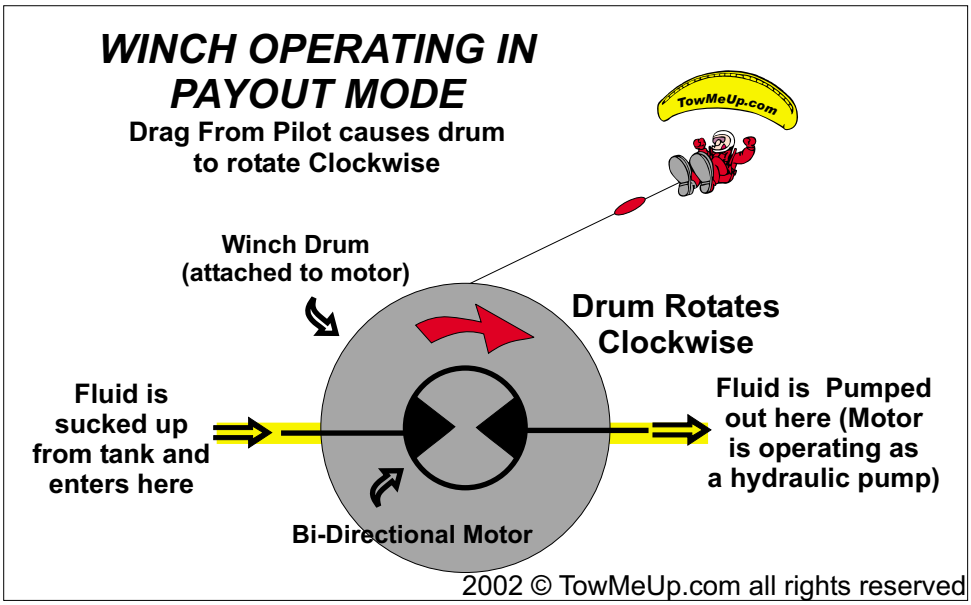
PAYOUT WINCH HYDRAULIC MOTOR OPERATION

A hydraulic motor is the ideal method to be used to control line tension. If set up properly it operates very smoothly, and allows infinite adjustment of towline tension. We prefer this technique of controlling line tension since it allows for back to back solo or tandem tows, with no loss of efficiency. Operators have reported performing over 200 tows in a weekend on a single winch with absolutely no problems or complaints.

Essentially, a hydraulic motor works by forcing pressurized fluid (in our case supplied by an engine driven hydraulic pump) into one port of the motor and forcing it to rotate. The fluid then exits from the remaining port under low pressure and returns back to the tank. All TowMeUp.com hydraulic winches mount the drum that holds the towline directly to the hydraulic motor shaft for exceptional reliability. The speed that the drum rotates is controlled by how much fluid flows through it. The torque that the drum exerts is controlled by the system pressure supplied to the motor.

A cool characteristic of a hydraulic motor that we exploit in our winches, is that if you rotate the motor shaft (or the drum directly connected to it) you can suck fluid into the intake port, pressurize it (the motor works like a hydraulic pump when forced to turn) and then manipulate the pressurized fluid as it returns to the tank. If you allow the fluid to return freely back to the tank, the drum can be spun easily and no tension will build in the line. If you restrict the fluid flow by turning in the pilot valve control wheel, the system pressure will build, which increases the torque on the drum and allows the line tension to increase. If you were to somehow able to completely block the flow of fluid out of the pump, you would find it virtually impossible to turn the drum. This could create an extremely dangerous situation, since it could allow system pressures to exceed the strength of the components used in its construction.





In our case we use a Pilot Operated, Vented Pressure relief Valve to control the system pressure. It is ordinarily used to adjust the system pressure over a range from 0 - 3000 PSI. This allows a typical towline tension adjustment range from 0 - 300 pounds.

Due to the built in safety feature of this relief valve, it will bypass fluid to prevent the system pressure from exceeding 3000 PSI, thus keeping the pressure below the safe working level of all components used in the construction of the system.

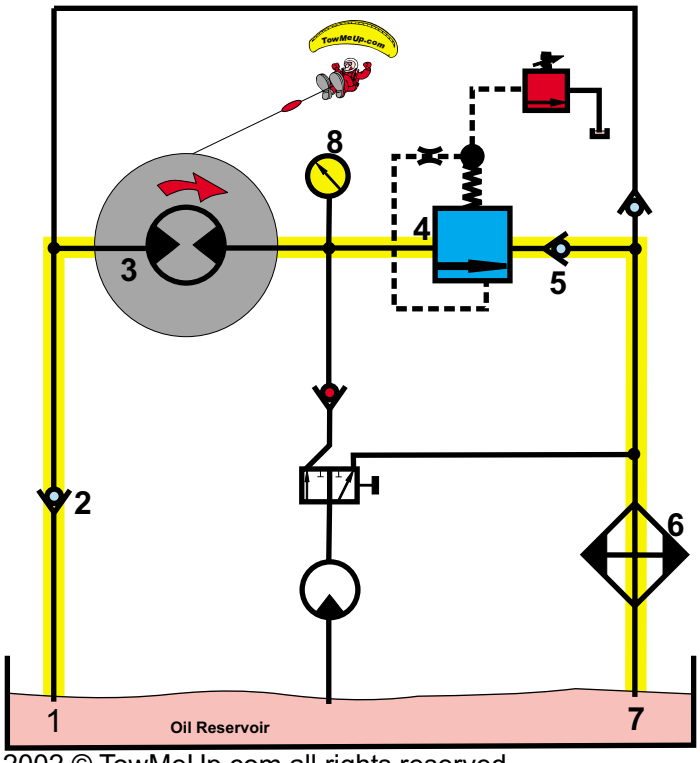
If you require a winch that exceeds 300 pounds of line tension, please contact us at TowMeUp.com and we can custom build you a system designed to safely work at higher pressures.

TowMeUp.com Payout winch operation in PAYOUT mode.

Prior to the start of the tow, ensure that The Direct acting Relief valve (main Control Valve) is turned fully Counter Clockwise (all the way out), The Main pressure relief valve is set to an appropriate position (typically fully in unless you need to set a maximum tow tension at lower value) and the diverter valve (if installed) is pulled out.

When the pilot signals they are ready to launch, the tow vehicle or vessel accelerates away from the pilot heading into the wind. Since the line is attached to the pilot, and the pilot isn't moving; the drum will be forced to rotate towards the pilot. (**WARNING! Do not allow the drum to rotate freely at vehicle speeds above 36 MPH or you will exceed the rotational limits of the Bi-Directional motor, possibly damaging it!)** This sucks fluid from the oil reservoir (see the drawing below at # 1), past a check valve (2), and into the hydraulic motor attached to the drum (3). This fluid is then pumped through the motor where it exits freely through the main system relief valve (4), past a check valve (5), through an oil cooler (6), and is then returned back to the tank (7). The vehicle or vessel continues to accelerate to a speed of around 20 MPH (faster in no wind, a bit slower in stronger winds).

Once the pilot has cleanly launched their glider, the winch operator turns in the control valve on the Pilot Valve, which increases the main system pressure through the Pilot Operated Pressure Relief Valve; until the slack in the line is taken up. As the pressure increases, it will clearly be shown on the pressure gauge (8). It is important to realize though that during launch THE MOST IMPORTANT PLACE TO BE WATCHING IS THE PILOT. The operator can readily see whether they have to little or to much tension applied, and make an instantaneous adjustment by small movements of the control wheel. It is actually unsafe to allow the operators attention to be distracted by trying to read the pressure gauge. It is used mainly as a reference to set the final line tension. The winch operator then gradually increases the line tension by screwing in the control wheel on the Pilot Valve until the pilot slowly lifts off the ground at a gentle climb rate. Once the pilot has achieved a safe height (it should be at an altitude that allows the pilot to recover from a surge in the event of a weak link break at the minimum) the tension is increased to a value that will allow the desired climb rate for the duration of the tow.



If the pilot were to trip, or need to abort the launch for any reason (badly inflated glider, glider headed towards a lockout, pilot picked up stray dog during launch, etc.) the winch operator needs to simply rotate the Pilot Valve handle all the way Counter Clockwise (all the way out) to reduce the line tension completely. The vehicle or vessel operator will typically stop forward motion at this point to set up for another tow by rewinding the line.

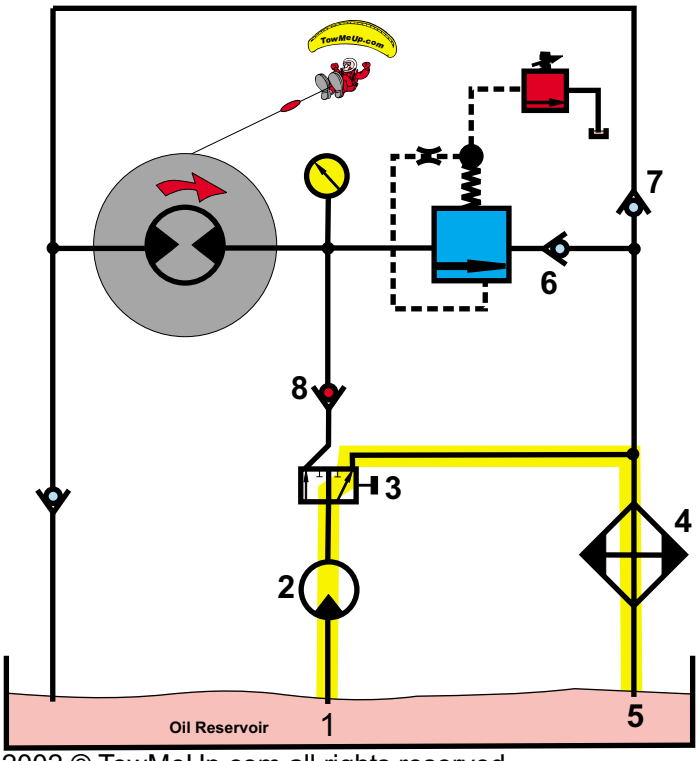
In normal operation, once the winch operator has set the desired towline tension, it is typically not adjusted for the rest of the tow. Since we use a skinny drum, the scientifically or mathematically inclined might wonder what effect the decreasing line diameter has on the system torque, or doesn't it increase the force on the towline, and require the operator to reduce the pressure to maintain the ideal climb rate for the pilot? In theory yes, in

practicality, no. At TowMeUp.com we conducted extensive testing and engineering to size the Spectra Towline and the drum width and diameter so the torque increase exactly matches the increased drag caused by the air loads and bow in the towline as altitude is gained. This makes a TowMeUp.com winch one of the easiest to operate winches that you will find available anywhere in the world.

Once the line tension is adjusted, the only thing the operator needs to do is to adjust the speed of the tow vehicle or vessel so that the drum rotates at a continuous rate. If the vehicle drives to slowly, the drum will stop rotating. This causes the flow of fluid to stop, and hydraulic pressure will become erratic or uncontrollable. If the vehicle drives to quickly the drum will rotate at an excessive speed, and the available distance to tow the pilot to altitude will be wasted. If in doubt, It is better to be slightly fast than too slow.

At TowMeUp.com we have our line custom manufactured for us, and we color code it for a very specific reason. Our hydraulic winches are normally supplied with 5500 feet of 1100 pound test urethane coated towline. 500 feet at either end of the towline is colored bright red so you can readily determine when you are about to run out of towline. During the tow the winch operator monitors the line color and when it turns to red, it means it's time to get set to end the tow. To make it easier to plan the rewind, we have added a diverter valve to all our winches than can be manually started. If the diverter valve is pulled out, as in the illustration below, the fluid is sucked from the oil reservoir (shown at # 1), through the check valve (2), through the diverter valve (3), where is routed over the oil cooler (4), and back to the tank (5). Note that the check valves (6 & 7) prevent any fluid from flowing to other areas of the circuit. All the fluid is forced through the oil cooler so that you can essentially run the rewind pump for as long as you want. In fact, you can start it up and run it through the entire tow if it proves to be necessary or convenient to do so.

The main reason for the diverter valve is to make it easier to manually start the rewind pump motor. One of the principles of hydraulics is that a pump will only generate enough pressure to overcome the load placed upon it. By diverting all the fluid from this pump back to the tank, very little pressure builds up in the rewind circuit, so the gas powered motor has little work to do and spins up freely. If the operator forgets, and leaves the diverter valve in, it doesn't affect the operation of the winch. This side of the circuit is isolated from the normal payout circuit by the check valve shown at 8. It does make it difficult to start the gas powered motor though, since as soon as the operator pulls the recoil handle to spin the motor over, the pump attached to it starts to build up enough pressure to crack the check valve (8) and then it must build up enough pressure to match whatever pressure is operating in the payout circuit. This can make it difficult or impossible to start the gas powered rewind motor.



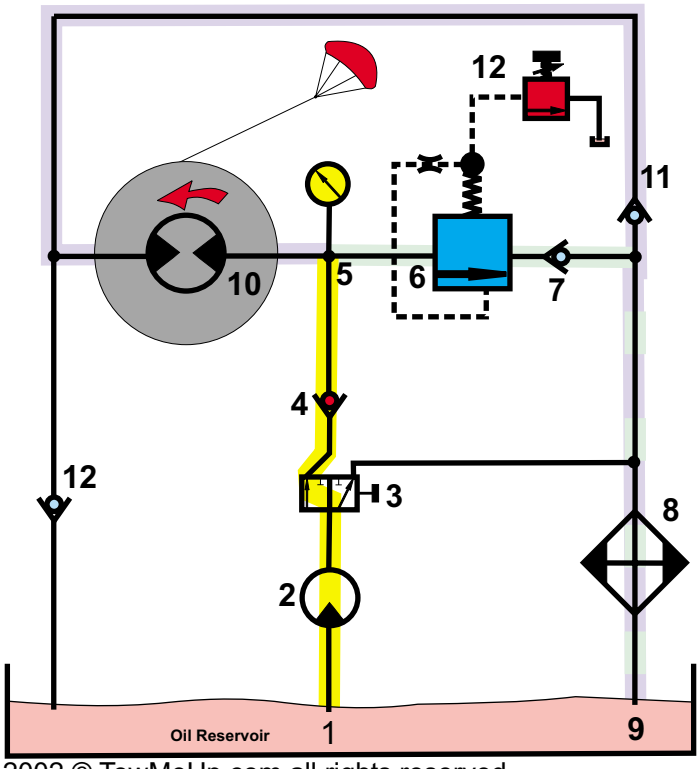
If you are fortunate enough to be using a larger gas motor (Say the 13 HP version) and you are using the electric starter, you can leave this valve in or out as desired. The starter can easily start the gas motor even with a pretty good load applied to it. If you are using an electrically controlled clutch operating an engine driven hydraulic pump, the vehicle engine has way more than enough power to overcome the loads placed on it, and flipping an electrical switch is all it takes to supply fluid to rewind the line.

TowMeUp.com Payout winch operation in REWIND (or Stationary Tow) Mode.

As the pilot is topping out on tow, the winch operator is getting ready to signal the pilot to end the tow. The best solution is to make sure the rewind pump's gas motor is running with the diverter valve pulled out ready to supply fluid to the rewind circuit. Occasionally, operators have difficulty starting up the gas engine that powers the rewind motor. Make sure the Key (See the photos below) is in the run position, or start if you have an electric start engine. Also be sure to check that the fuel shutoff is open, and the choke is in an appropriate position. You typically need to choke it to get the engine to start when it is cold. Once warmed up you don't need to choke it. You should always warm up the motor (and ensure that the tank is full of fuel) before launching the pilot for the first flight of the day. In manual start applications, the recoil handle may be positioned to a more appropriate position by removing the bolts that hold the recoil housing to the engine, rotating it so the recoil handle faces an appropriate position, then inserting and tightening the bolts back down.

When the winch operator is ready for the pilot to get off tow, you can either call them on the radio, or we prefer to make a distinct 90 degree turn to the left and stop. The pilot will be flying towards the winch and this will give enough slack in the line for them to release without any big surges. At this point the winch operator should push the diverter valve in, which will supply power to the rewind circuit (If you are using a large electric start motor to run the rewind pump, or a big engine driven clutch pump, you can typically just leave the diverter pushed in all the time (it won't even exist on engine driven clutch pump systems) and flipping the start switch or clutch energize switch supplies fluid to the rewind circuit.

Look at the circuit below to see the beauty and simplicity of operation of a TowMeUp.com winch. The fluid is sucked up from the oil reservoir (shown as #1), where it is pumped through the system by the rewind pump (2), it then goes into the diverter valve (3) where it will be directed to the rewind circuit once the diverter valve is pushed in. It passes through a high pressure check valve (4), and then it goes to point 5 where the fluid has to make a choice. It has the option of going through the main hydraulic motor (10), which will rewind the line, or, it can go over the relief valve (6), and back to the tank. The hydraulic fluid will always take the path of least resistance, so the direction it goes is controlled by the control wheel on the pilot valve (12).



Typically we leave the gas motor that powers the rewind pump running wide open, and control the line rewind speed with the pilot valve. At TowMeUp.com we use a large 5' vented, stabilized drogue chute to provide tension on the line for the rewind. It is held collapsed during the tow by tension on the apex where the leader line attaches, and then runs to the pilot via a weak link and the tow bridle connection. This drogue generates about 80 pounds of line

tension at normal rewind speeds (Those with larger rewind motors can easily see up to 200 pounds tension... a sign that you are rewinding a bit aggressively).

Essentially, if you back the control wheel all the way out, no pressure will be built up in the system. The fluid will go from the branch T at point 5, through the Relief Valve (6), past a check valve (7), through the oil cooler (8), and back to the oil reservoir (9). As you screw the Pilot valve in, the pressure will build in the system and the fluid flow through the relief valve (6) will reduce. As the pressure builds in the system, it becomes easier for the fluid to flow through the Bi-directional motor (10), which naturally spins the drum, and the line will rewind. As you increase the system pressure by screwing in the Pilot Valve (12), more pressure builds in the system. This creates more torque, which overcomes the drag produced by the drogue, and provides a faster rewind speed. The fluid at this point is flowing from the branch T (5), through the Bi-Directional motor (10), past a relief valve (11), over the oil cooler (8), and back to the tank (9).

The winch operator continues to rewind the line until it gets close to the vehicle or vessel. To slow the line down, all you need to do is reduce the system pressure by unscrewing the Pilot Valve (12), and less and less fluid will flow through the motor as it becomes easier to go over the relief valve (6), and back to the tank.

Now that you understand the concept, you should be able to realize one of the key principles of a TowMeUp.com hydraulic winch. The same Pilot Valve (12) that controls tension during a Payout tow, controls tension exactly the same way during the rewind. If you supply enough power to the rewind pump, you can easily stationary tow with any version of a TowMeUp.com winch. In fact most winch operators have found them to be the easiest to operate winch that they have ever used. One of the key benefits to this is the towing areas this type of winch opens up to the operator. All TowMeUp.com winches will switch seamlessly from Payin or stationary towing to Payout towing. The limiting factor on a Payin tow is the amount of power supplied to the rewind motor. For example the 6 ½ HP Honda motor is adequate to rewind the drogue in virtually all conditions, but it doesn't have enough fluid flow to launch a paraglider pilot in no wind (unless they are really light). Pick a day with a slight breeze though, and it will Stationary tow with ease. The larger motors say the 13 HP Honda, with a larger pump, can supply enough fluid and pressure to stationary tow a tandem paraglider in most conditions. If you use an engine driven pump, you can stationary tow most anything you would like, and you don't have to listen to the rewind pump engine droning on and on. Most of the operators who tow full time eventually gravitate to this type of rewind pump. We have lots of experience in this area, so feel free to contact us for advice.

Lets say you have a great tow road that runs East / West, but the prevailing winds are from the North, and there is a barbed wire fence along the South side of the road that would make launching to the East very sketchy with a Brand X Payout winch. Typically the Brand X winch operator wouldn't even attempt to tow. So now you, as a proud TowMeUp.com winch owner scope out the 500 foot long field at one end of the road that lies just South of your Tow Road. No problems for you. You can park your tow vehicle on the road, and run out 500 feet of line into the field. The pilot will be launched towards the vehicle, into the wind using the rewind circuit and a standard Payin launch technique. Once the pilot gains a safe altitude, the tow vehicle starts to drive off down the road. If you look to the previous page and the Rewind circuit Schematic, the rewind (or the Stationary tow in this case) tension is controlled by the Pilot Valve (12). As the truck accelerates the drag created by the paraglider will increase and the drum will slow down as this drag causes the pressure to rise. Once the vehicle goes fast enough, the drum will stop winding the line in and start to Payout line. All the operator needs to do at this time is shut off the rewind pump and continue with the Payout tow, while the pilot flies the line clear of any obstructions.

Another benefit becomes especially clear to boat tow operators. Don't you just hate it when you circle to bring the pilot back to launch and the pilot cuts the corner and you have 3000- 4000 feet of line going slack dipping towards the water threatening to decapitate waterskiers, jetskiers and such? With most Brand X winches the only choice you had was to mash the throttle and try to outrun the pilot and take up the slack. With a TowMeUp.com winch you simply fire up the rewind pump and supply fluid to the system. Since the line is slack, the drum will rotate freely to rewind the line. As the turn is completed and the line goes tight, the drum will stop rotating, and switch seamlessly to Payout mode again. If you're a really nice operator and the pilot can't stay on the towline so they don't achieve maximum altitude, you can easily slow down towards the end of the tow, engage the rewind circuit and top them off by finishing the tow as a Payin tow.

If you have ever struggled with a scooter tow as a stationary winch, you will love using your TowMeUp.com

hydraulic winch for stationary towing. Remember how hectic things got when your low time pilot hit a booming thermal on tow, and you didn't get off the throttle quite quick enough? With a TowMeUp.com winch life is much simpler. You launch the pilot using the Pilot Valve to increase the tension. Once the pilot is up and climbing you set the tension, and pretty much forget about it for the rest of the tow. If the pilot hits a booming thermal, the line will slow down rewinding, even stopping and paying out if it needs to. Once the pilot flies through the thermal (unless they wisely choose to release and go somewhere) the line will continue rewinding as before.

O/K so you ask, why don't all the other hydraulic winches work this easily? There are a lot of reasons. The primary one is that a good winch costs a decent amount of money to build, and you can't skimp on important areas. A lot of individuals see a hydraulic winch, realize the price and figure they can do better on their own. Trust me, you can't unless you have a lot of equipment and experience. Hydraulic engineers often get it wrong. Typical hydraulic systems are designed to use high pressures, at relatively low fluid flows. This works well for the rewind circuit, but in the most important mode, Payout, we need to move great volumes of fluid, at very low system pressures. This is something few hydraulics engineers have experience designing.

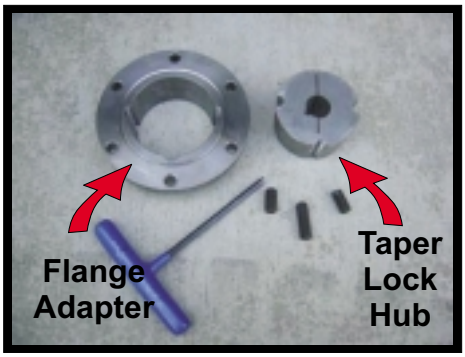
Many systems lack key components. For example, look at the Rewind circuit on the previous page. If you skip the check valve shown at item 11, the fluid will come out of the relief valve and be sucked back through the Bi-Directional motor rather than be forced over the oil cooler. This makes the fluid excessively hot, and causes a serious problem. Many systems also lack a simple check valve in the suction line to the Bi-Directional motor. This allows the fluid to fall back into the tank and introduces air bubbles in the suction line.

Probably the single greatest problem we see with the Brand X winches is that they simply don't have enough fluid volume. It seems that a lot of people are on an eternal quest to achieve the absolute lightest system. Of course they want it to be cheap as well. Unfortunately, light and cheap don't come together. Sure you can make a winch lighter. You'll save 20 or 30 pounds by building the frame out of aluminum rather than mild steel tubing. It will, however, cost about 10 times as much to build the frame because of the extra cost of the materials, and the fabrication techniques required to assemble them together. One of the quickest (and worst) ways to shave off the pounds is to reduce the volume of hydraulic fluid used in the system. We use a minimum of 86 pounds of hydraulic fluid in our winches. Some competitors use as little as 7 pounds of fluid! They skimp on the fluid because it costs money, and makes the system weigh more. The problem is that when you tow a pilot on Payin or Payout, the fluid in the system becomes aerated as it exits the Bi-Directional motor or the relief valve. This aerated fluid then returns to the tank. In a properly designed TowMeUp.com system, we have enough fluid in the reservoir that the bubbles float to the surface and we can pull clean non-aerated fluid into the suction lines of our pumps and motors (we even add a very high flow 5 micron screen in the tank outlet to prevent debris from working through the system). In a Brand X system the limited fluid supply means that the bubbles never have a chance to settle out, and this aerated fluid is then pulled into the suction lines. The big problem is that these bubbles expand when they enter the suction line because of the reduced pressure. When they hit the Bi-Directional motor (which in Payout functions like a pump, remember) they are compressed and detonate. The motor will sing and squeal and will get very hot. The bubbles detonate as they compress and the system pressure becomes erratic at best. Control of the winch is virtually impossible as the pressure will fluctuate and line surges become common.

To compound the problem, most of the hoses on the Brand X winches are far to small. This creates excess drag and creates turbulent fluid flow, which helps to further compound the problems. These winches often perform adequately for isolated tows or maybe the odd tandem tow, but they rarely stand up to constant use. TowMeUp.com winches are used in comparison by commercial operators who tow every day, do back to back solo and tandem tows, and want the most bombproof, reliable winch available. At TowMeUp.com, we have conducted extensive tests and fluid flow analysis to determine the minimum fluid volumes and hose sizes that can reliably be used in a properly functioning winch. There is a very specific reason we use 1 1/4" hoses in key areas of our winch, and 3/8" hoses in other areas. Simply connecting an assortment of components with 1/2" hoses and hoping it will work, typically yields poor results.

Another very important area where some Brand X manufactures skimp is on the winch drum. The drum is a very critical component in the design of the system. Obviously it must be large enough to hold all the line you should need, and it should be capable of holding it when wound with very low line tension in the event of an irregularity in the towing operation. (It can take twice the storage area on the drum to wind on 5500 feet of line at no line tension, vs. the same line wound with 70 pounds of tension). If the drum is to wide, the line won't stack well, and a level wind system will be required. The diameter is critical as well, unless you feel like

constantly fiddling with the line tension during the tow. At TowMeUp.com, we conducted extensive tests both in computer simulations and practical tests to determine the optimum minimum and maximum drum diameters. Some Brand X manufactures try to shave weight on this critical component. We're very aware of the incredible forces exerted by the line on the core of the drum, and outwards on the sides of the drum. Skimping in these areas yields a drum that is simply crushed by the forces on the line, or the drum sides are skewed outwards after just a few rewinds. The drum operates like a big flywheel and damps the surges and pulses that are otherwise introduced into the system. This is one of the reason tow pilots comment on how smooth the tows are on a TowMeUp.com winch vs. those experienced on some brand X winches. It's also another reason where trying to shave weight by making the drum (and the flywheel) lighter yields negative results.



Securing the winch drum to the motor output shaft is critical to ensure the system runs in balance, free of wobbles. At TowMeUp.com we use a taper lock hub as the core of our winch drums. (See photos at left) It consists of a split bushing with a broached key-way slot and a tapered outer diameter. This mates to a internally tapered flange. The key-way is used to ensure the drum can't rotate on the shaft, and tightening the two 1/2" x 13 TPI allen screws pulls both components tightly together so the hub grips the shaft very tightly and runs concentrically. Should you need to remover the drum from the motor for any reason you need to remove both tightening screws, and insert one screw into the threaded hole at the base of the split in the central hub. Tightening this screw pushes the taper apart and makes it easy to remove the drum from the shaft.

To install the drum on the shaft we find it easiest to insert a spare setscrew into this hole to keep the taper pushed just slightly apart. Slide the drum onto the shaft (don't forget the woodruff key for the key-way), insert both tightening setscrews, then remove the first screw and tighten the 2 setscrews securely. You need to be sure these screws are tightened equally to keep the drum rotating true. As simple as a drum seems at first glance, this is actually a critical component and is fairly difficult to manufacture. Since our winches inevitably find themselves running in wet or sandy environments, we designed them to be ventilated to aid in drying the line, and easy to disassemble should they require cleaning. Our winches consist of the taper lock hub, 2 @ 1/4" thick 6061 T6 Aluminum drum sides, cut out from alloy plate with a CNC waterjet cutting machine to a tolerance of -0.000 / + 0.015," one CNC machined hub spacer, 24 @ CNC machined drum spacers (with tapped threaded holes in each end and all being identical lengths +/- 0.0002" to make the drum run as true as possible), all these components are held together with 60 stainless steel button head cap screws.

Once assembled, the completed drum is then trued up by mounting it in a horizontal boring machine with a lathe tool mounted to the moving table, and the sides are radiused to prevent snagging or damaging the towline, or operators fingers. (This is a neat non-traditional application of this type of tool which is typically used to bore large concentric holes in big parts). You can see Anita in the photo at left carefully machining the drum outer diameter to the desired specification. She is also the lady responsible for the excellent sewing of our TowMeUp.com tow bridles.

Another key component is our unique tracking head. The line is routed off the winch drum, over a guide pulley, then up a protective, shock absorbing tube to the freely rotating tracking head. This head automatically swivels to keep the line pointed directly at the pilot, regardless of the heading of the tow vehicle. It is free to swivel, or rotate continuously in any direction. This makes it particularly attractive to boat towing operators, or any operator who needs to operate in a payout mode while turning, or circle towing.

Because of the typically wet, dirty and corrosive environments our winches are subjected to we make all the key components of our tracking head from 316L stainless steel for unsurpassed corrosion resistance. The

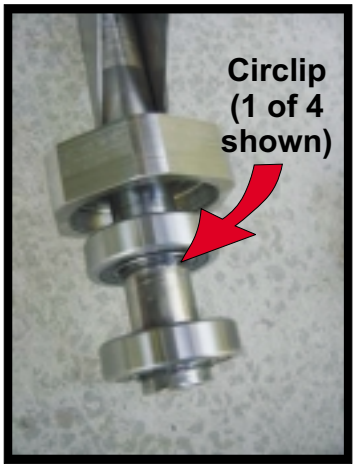
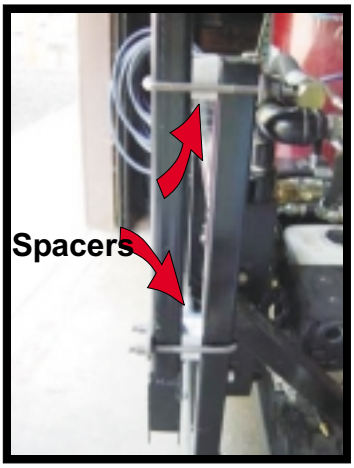


photo above left shows the CNC machined bearing pocket which is welded to the top of the tracking head tube. 2 replaceable sealed bearings are installed on the shaft using circlips so they can be easily replaced if you manage to wear them out, or damage them. On top of the machined nut is a seal to help keep water out of the bearings if your winch is exposed to wet environments. It is a good idea to check the bearings every few months. The greatest wear comes from allowing moisture to accumulate on top of the bearings if it leaks past the upper seal. You can prevent most of this water infiltration and wear by packing the area between the upper bearing and the nut full of grease. When you tighten the nut, the grease will be forced out of the seal, lubricating it, and keeping the water away from the bearings. Don't worry about excess grease getting on your towline. It won't work it's way down below the lower bearing, where it would need to go to come into contact with the line. The pulley is an oversized nylon guide pulley cast around a pair of sealed roller bearings for long life, high speed operation. It is easily replaced if damaged. The same pulley is used at the base of the tracking head tube as well. Keeping a spare pulley is always a good idea.



A couple key things to note are the spacers that are required to be installed between the winch frame and the tracking head tube. These spacers ensure that the line exits the pulley exactly in the center of the winch drum, which is important to ensure even stacking of the line on the drum. You can adjust the height of the guide tube wherever it is most convenient to you. Be certain to ensure that the line doesn't rub on the top of the front line guide.

Also important is to ensure that the line that comes down the center of the tracking head tube passes between the two guide bars located above the lower pulley. In all current versions of the TowMeUp.com winch, we added a cutout above the pulley to make this an easy item to check. It also makes dropping the line down and threading it over the lower pulley a breeze. If you happen to have a tracking head that lacks this improvement, the slot can be easily machined at any competent shop. If you happen to be in the area, give us a call and swing by, we'll perform this modification for free while you wait. You might also want to add a small piece of foam to be inserted between the lower pulley and the guide assembly. It can be made from any rigid foam, with a slot gouged out the center to just clear the pulley. This virtually eliminates the chance that the line can jump the lower pulley in extreme towing situations.

Troubleshooting Winch Operational Problems.
Below is a list of common problems and their solution. If this doesn't solve the problem, please contact us at TowMeUp.com for assistance.

Winch won't build enough Pressure.
Make sure there is fluid in the tank, with no fluid, there is nothing to build up system pressure.
Make sure Pilot Operated, Vented Pressure relief valve knob (Black Knob) is screwed in all the way.
Drum must be rotating to pump fluid and build fluid flow in Payout mode. The system will not work if the drum is stationary or moving to slowly during payout operations.
Direct acting relief valve turns in (clockwise) to build pressure. Are you turning it the right way?

Rewind Gas motor is very hard to start.
Make sure their is gas in the tank, fuel valve is turned on, and the choke is set appropriately. (Choke should be on to start engine, you can reduce the setting as the engine warms up, and take choke completely off once engine is warmed up). The throttle is typically set just above idle during the start. If the engine is flooded (You used to much choke), open the throttle fully and crank until the engine fires, then adjust throttle. If the engine fails to start, remove the spark plug and ensure it isn't fouled.
If the engine is hard to crank over, make sure the diverter valve is pulled all the way out until engine is started and warmed up. The diverter valve **MUST** be pulled out to manually start the gas engine.

Paraglider pilot can be launched on Payin tow, but can't climb out.
The rewind gas motor / pump combination is to small. This is an issue with the standard 6 1/2HP rewind system. It uses an 8 GPM 2 stage hydraulic pump driven by the gas motor. This pump generates 8 GPM fluid flow at system pressures up to 800 PSI. Once the system pressure exceeds this, the pump switches to the second stage and the fluid flow drops to around 2 GPM. This reduces the line speed to the point where the pilot can't fly fast enough to sustain flight. This is why the system will work on windy days, but perhaps not on calm days, since you can wind the line in slower on a windy day. The solution is to use a higher volume hydraulic pump, which of course requires a larger gas engine to power it. The ultimate solution is a vehicle operated clutch pump. Virtually any single stage hydraulic pump that produces no more than 16 GPM at 3000 PSI can be used. Exceeding 16GPM fluid flow will cause the Bi-Directional motor to exceed the rotational limits, which will damage or destroy it. We strongly recommend that those who choose to use high volume pumps install flow controllers to prevent exceeding the limits of this motor.

Weak Links are Breaking when launching Paraglider pilots.
Typically this is an operator problem, rather than a winch problem. It occurs mostly during light or no wind launches when the winch operator tries to "assist" the pilot in launching their glider by tugging them into the air. What happens is the glider never comes cleanly overhead, and the pilot launches in a semi - constant stalled configuration which greatly increases the tow force, and the weaklink breaks. The solution is to not increase the line tension until the pilot has cleanly brought their glider overhead. Using a tow bridle with a Tow Assist device (TowMeUp.com produces and ideal version) makes it far easier to ensure the glider comes cleanly overhead on launch. In fact we rarely launch new tow pilots without such a device.

Weak Links are Breaking when launching hang Glider pilots.
This usually happens when the pilot pops the nose of their glider up on launch, which increases the drag and tow force until the weak link breaks. If the pilot uses a single towline that attaches to their body, the towline pulls down on the base bar as the tow progresses to steeper line angles. Some pilots choose to route this line under the bar, and tension on launch pops the bar out, causing the problem. TowMeUp.com manufactures a special bridle for foot launched hang glider pilots that uses 2 separate releases to solve this problem.