
AT/B Engineering

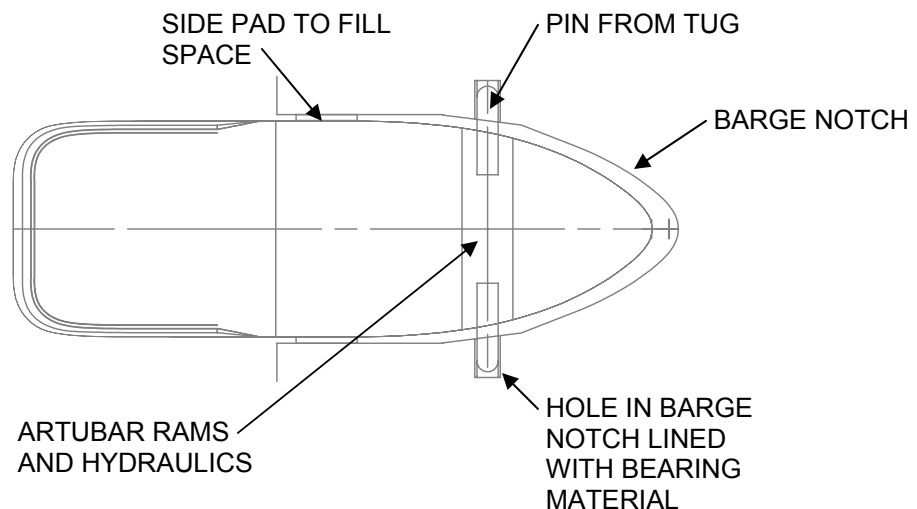
The Systems Available

There are a number of systems available to connect a tug and barge at sea. They vary in experience from many years, to just a few months—from many applications, to just one application. We'd like to introduce you to the most commonly applied systems and some of the newer ones. OT&BE has wide experience with most of these systems, and can assist you in deciding which is best for your application.

ARTUBAR

The ARTUBAR system was the very first “axial” connection system. It is a single-degree-of-freedom system wherein the tug rolls with the barge, heaves with it at the connection point, but pitches independently. ARTUBAR utilizes a port and starboard, large diameter pin which is extended hydraulically from the tug hull. This pin is fixed in rotation, and it engages a pair of holes in the barge notch walls port and starboard. These holes are located approx. 7 feet apart vertically, and tend to be located at the loaded draft of the barge, the light draft, and the ballast draft.. The barge holes are lined with bearing material such as Ultra-Poly or rubber. The large pin then rotates in this bearing material as the tug pitches.

The pin does not bottom-out on the notch wall, and therefore, a space is left between the tug and barge. Experience has shown that this space will allow the tug to slide back and forth and slam into the barge notch. Therefore, a recent modification of the system, includes a set of pads port and starboard, aft of the pins, to fill this space and prevent slamming.

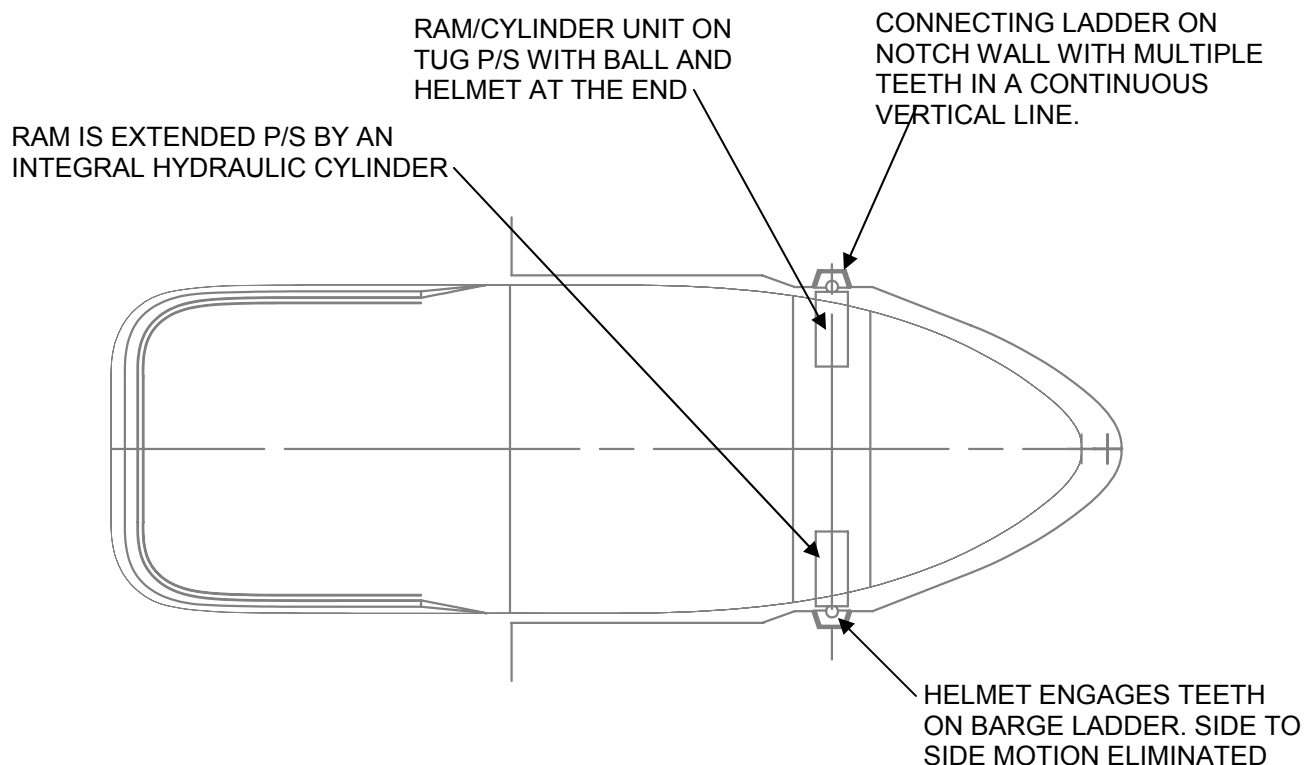


BENEFITS - ARTUBAR is a relatively simple system, machinery-wise. The pins on the tug are extended by hydraulic rams and all the parts are accessible for maintenance and repair. There are some tight tolerances to be dealt with, but overall, you can troubleshoot the system easily. Because the pin does not bear on the notch wall, the internals of the ram assembly and pin are heavy, but simple.

DRAWBACKS - ARTUBAR is an old system which is not supported or sold by any manufacturer. The need to position holes in barge notch wall means that you only have a limited number of places to connect. This makes it necessary to ballast one or both to make the pins line up. It is also very unforgiving of relative heel. The system can be noisy, and the bearings must be cooled constantly in heavy seas. Also, the gap between the tug and barge must be filled, as the noise generated when a tug has even an inch to move back and forth in, can be horrible on the crew.

ARTICOUPLE

This was a Japanese invention designed to solve the shortcomings of ARTUBAR. It came about when a Japanese Artubar unit (the first built), proved so unsuccessful, that a Japanese architect, (Mr. Takeo Yamaguchi) set out to improve the connection design. The result was ARTICOUPLER. The system is similar to ARTUBAR on the tug in that hydraulic rams actuate a pin outward from each side of the tug. However, this pin is in actuality a large ram which has a ball on the end of it. Affixed to this ball is a "helmet" with teeth. These teeth come hard against a vertical row of similar teeth on the barge notch walls. Thus, the tug is prevented from side to side motion allowed by ARTUBAR, and the multiple teeth up and down the notch wall allow connection at virtually any draft of tug or barge. Similar toothless arrangements in another type of ARTICOUPLER, replace the toothed helmet on the tug with a rubber-lined pressing shoe. This system is good for dump scows, or inshore AT/B's.



BENEFITS - The system can engage at any relative draft, and ballasting is not needed to line the tug up with the barge. The ball on the helmet allows a certain amount of angular misalignment as well, in heel. All side to side movement is halted because the helmet lands hard against the barge ladder. The systems allows only relative pitch.

DRAWBACKS - Hydraulics are relied upon to hold the tug in position in the center of the notch. Large side forces put a tremendous load on check valves holding the rams out. The hydraulic system, with accumulators, hold piping, etc., is very complicated and hard to maintain. Failure of a hydraulic hose can lead to unwanted disconnection. Also, ARTICOUPL has very little experience in pushers over 4,000 HP and barges over 15,000 LTDWT. It is primarily a system for smaller AT/B's. There are no US applications, and one Canadian one, using an older Russian tug. The system is not supported here technically or service-wise. The system does not have ABS or USCG certification for dual-mode service.

INTERCON

The INTERCON system was developed to solve many of the problems inherent in ARTUBAR and ARTICOUPL. The operation of the system is straightforward. The system is a single degree of freedom connection that like other systems, establishes a transverse, fixed axis between the tug and barge, around which the vessels are allowed free relative rotation, or pitch. All other movements such as yaw, roll, and heave are restrained. Thus the tug heaves and rolls with the gentler motion of the barge, and unlike systems that allow motions in more than one axis, the system forces are predictable. In the system, the port and starboard sides of the notch wall are fitted with a vertical channel member with the open side facing the barge centerline. Notches, or teeth are incorporated on the fore and aft sides of the channel to eliminate vertical travel. The channel sides are tapered to provide a wider opening to ease connection, and the side taper is flat enough to minimize resultant thrust from higher bow to stern loads imparted on the barge by the tug. The notches lie on the taper of the sides and are of equal angle, peaked to balance forces and to minimize multi-angle planes of contact when engaged by the tug's connecting helmet. The vertical extent of these connection ladders is determined by the relative draft range desired for operation, and they can be supplied in a skeg module, prefabricated at Intercon for installation as a unit into the barge. The machined steel connecting heads of the tug, which are inserted into the channels port and starboard to make the connection, are configured to match the channel tooth pattern. Each head is mounted on a spherical support to allow auto-alignment to the channel while retaining the greatest load carrying capacity in a minimal space. The connecting head of the tug is thus allowed limited movement in all directions except rotation about the horizontal centerline of the connecting points. Horizontal rotation is transmitted to the ram which supports the head by guide locks on the top and bottom of the head. The ram is a heavy fabricated steel cylinder supported on the O.D. by a bronze bushing. The bushings are mounted in the I.D. of a "Load Box" structure which is a stress-relieved steel fabrication designed to transfer all structural loading, shaped to suit the tug and pre-fabricated and outfitted at Intercon with full lighting, access, wiring, piping etc. for insertion into the tug as a module.

To extend or retract the head, the rams are moved along the horizontal axis by a large, male threaded shaft turning in the female boss on the inside of the ram. The threaded shaft is operated by electric motors through gearing mounted to the housing. Two drive motors are provided - one for low-torque high speed operation, the second for high-torque low speed operation. The high speed motor is direct coupled to the gearing. The low speed motor is connected to the gearbox via an air clutch, to protect it from overspeed in high-speed operation. Emergency drives are also connected to the gearboxes, for use in the event of an electrical power failure.

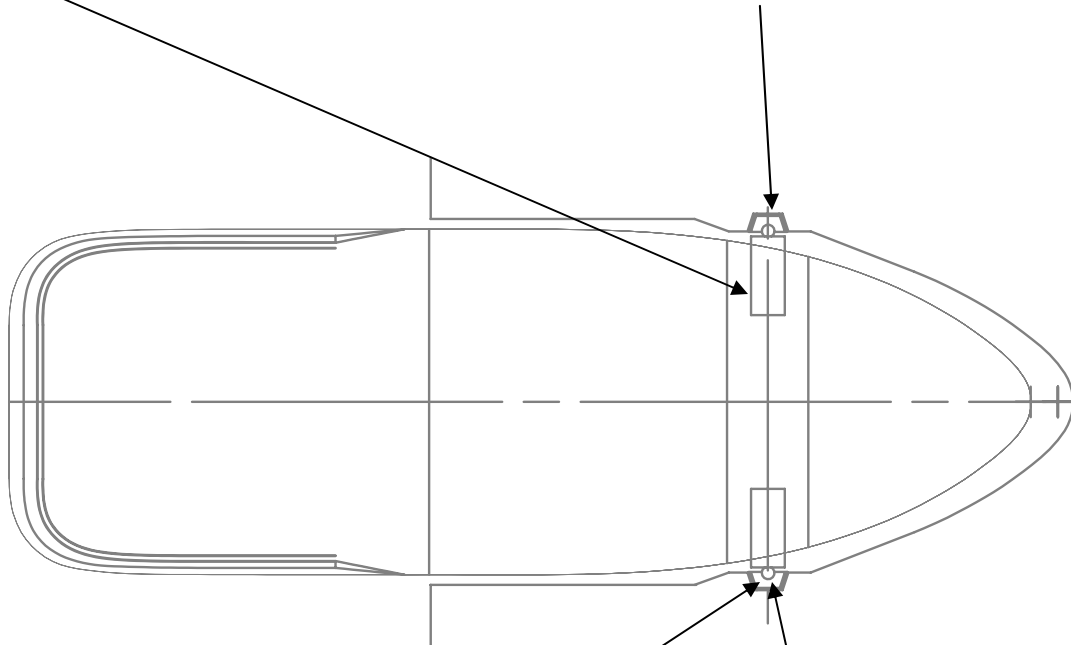
BENEFITS - Like ARTICOUPLER, INTERCON allows connection at multiple drafts. No ballasting is required. The system also is part of a large manufacturers product line, and as such enjoys solid engineering and service support. There is a large population of the units in existence with long experience. The system is built in pre-fabricated hull modules for ease of installation. The system has ABS and USCG approval and certification for dual-mode service. The gear/screw drive, prevents accidental retraction at sea, and allows for finer control of the units. The unit is designed as well, to a very high safety factor.

DRAWBACKS - The gear drive system and controls are relatively expensive to manufacture and maintain as compared to cylinders. This also results in a heavier piece of machinery, which is difficult to retrofit to older tugs.

ADDENDUM - INTERCON will shortly release a new, lighter weight connection system. Based on the current design, it features a simpler drive, lighter components, and a lower price. The trade-off comes in durability over longer time periods. This new unit will need shorter overhaul periods, but that is based on operation continually in heavy seas, which most times is not required.

RAM IS EXTENDED P/S BY AN INTERGAL ELECTRIC MOTOR/GEAR/SCREW DRIVE SYSTEM

CONNECTING LADDER ON NOTCH WALL WITH MULTIPLE TEETH IN A CONTINUOUS VERTICAL LINE.



RAM/CYLINDER UNIT ON TUG P/S WITH BALL AND HELMET AT THE END

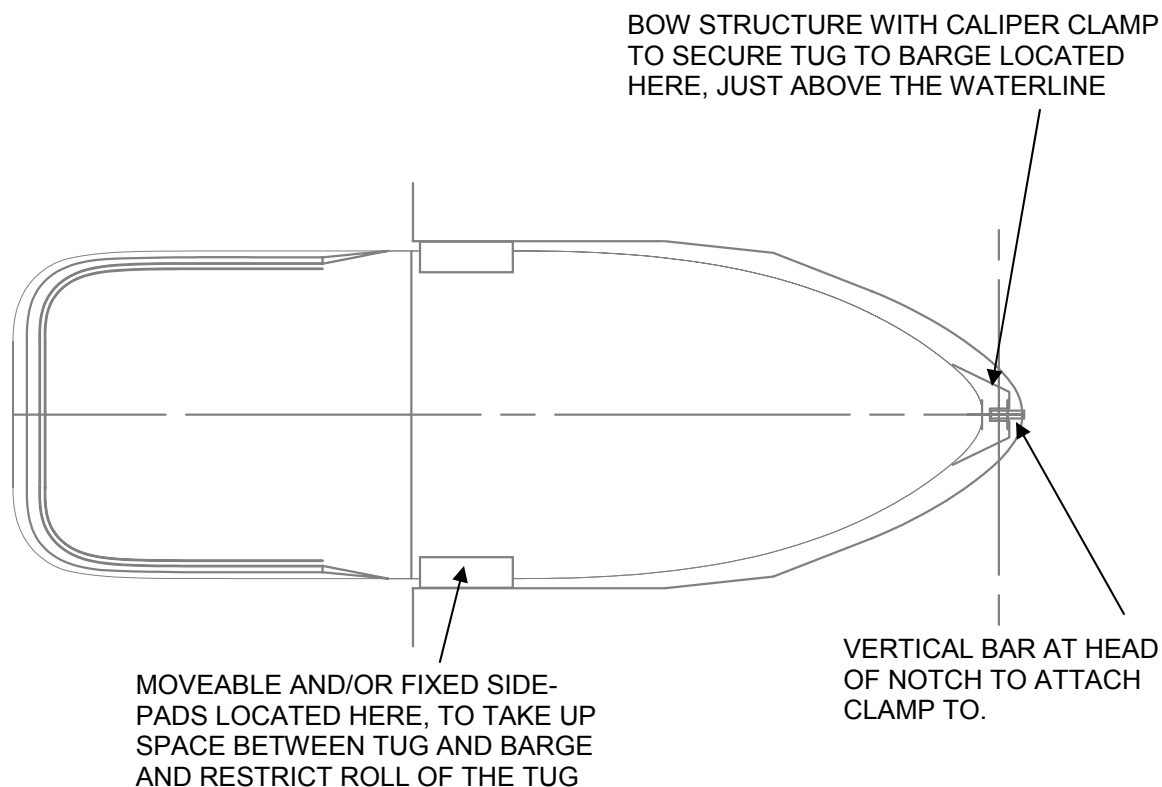
HELMET ENGAGES TEETH ON BARGE LADDER. SIDE TO SIDE MOTION ELIMINATED

BLUDWORTH COOK SYSTEM

This system operates by establishing a pivot, or relative pitch point about the bow of the tug. A clamp or caliper is deployed here, which attaches to a vertical bar at the head of the notch. Once gripped to the bar, the caliper is the pitching point. The tug has two sidepads at about midships, both moveable. The tug enters the notch with one pad retracted. The tug bow clamp is engaged and the pad is extended to fill the notch. The result is that the tug pitches about the bow clamp, with roll restrained by the moveable pads on the tug. The system has been in existence for many years, and BLUDWORTH-COOK is designing a new version that will eliminate many of the shortcomings you'll find in the current design.

BENEFITS - A simple system with light weight and easily retrofittable. The hydraulic components are fairly simple, and take up little space and power. Installation on the tug is straightforward and usually requires little in the way of structural changes. OT&BE's standard tug designs can all take this system. The system is sold and serviced by a reputable organization, and has a long history.

DRAWBACKS - The tug's bow unit holding the caliper can hole a barge easily. The helmsman can't see it in most cases, and it limits the tug to pushing in the notch, as opposed to working alongside, or approaching the barge from a tow in heavy weather. The system does have an 18 degree pitch limit, at which it will automatically disengage. The barge notch in the present system needs to meet very tight tolerances in construction which many yards have a difficult time meeting. The bar at the head of the notch also prevents other tugs from easily pushing the barge, and the longer notch needed as opposed to other systems, adds to barge cost.



OTHER SYSTEMS

HYDRACONN - This system is a mixing of a multiple-tooth engagement such as ARTICOUPE, with the central hydraulic ram idea of the ARTUBAR. The teeth on the barge notch are individual weldments of 3 teeth each,, put in number as required on each notch wall. The main ram assembly is held in the tug with a chocking material such as Chockfast. Rotation of the tug in relative pitch, is via a bearing/axle on which the connection head rides, at the end of the ram. This system needs to be exactly aligned in the tug and barge. While it simplifies installation in some ways, it also marries many of the negative features of other systems. Still, the system has worked extremely well in the Great Lakes, though it has not been used in the open sea on the coast. The systems in use on the Lakes report good reliability and good support from the designer. The system is not manufactured by a large company. Each is custom-built. The system has potential.

ACOMARIN - This system is the newest on the market. It marries some of the ideas of ARTUBAR with a unique approach to connection. In this system, a spring-loaded pin on each side of the tug, self-aligns to a connecting hole as the tug enters the notch. This is done via wedges in the barge notch sidewalls directing the pin to the proper hole. The system is light weight, because the original intent was to not take loading from the tug into the pins, but rather to absorb it at the interface of the tug side and the barge notch. In order to do this, like ARTUBAR, the spring-loaded pin does not bottom out on the receiving hole in the barge. The loads in this case are claimed to be much lower, by the builder. However, there are drawbacks. The free space between tug and barge, like in ARTUBAR, needs to be filled to prevent slamming of the tug back and forth. ACOMARIN's web site reported that very slamming in the maiden voyage of their first application, in light seas.. The effect this will have on pin loads will need to be investigated, though ACOMARIN is said to be pleased with overall performance. Also, the system has only one working application, less than 6 months old, and that system, though it has gone trans-Atlantic, has yet to encounter very heavy seas. However, K-SEA, which owns the unit is planning further conversions to it and is said to be generally happy with the cost and operation. This system has potential, but is very young. If it holds up, it will be a serious contender for retrofits due to it's light weight, and newbuilds due to its' cost.