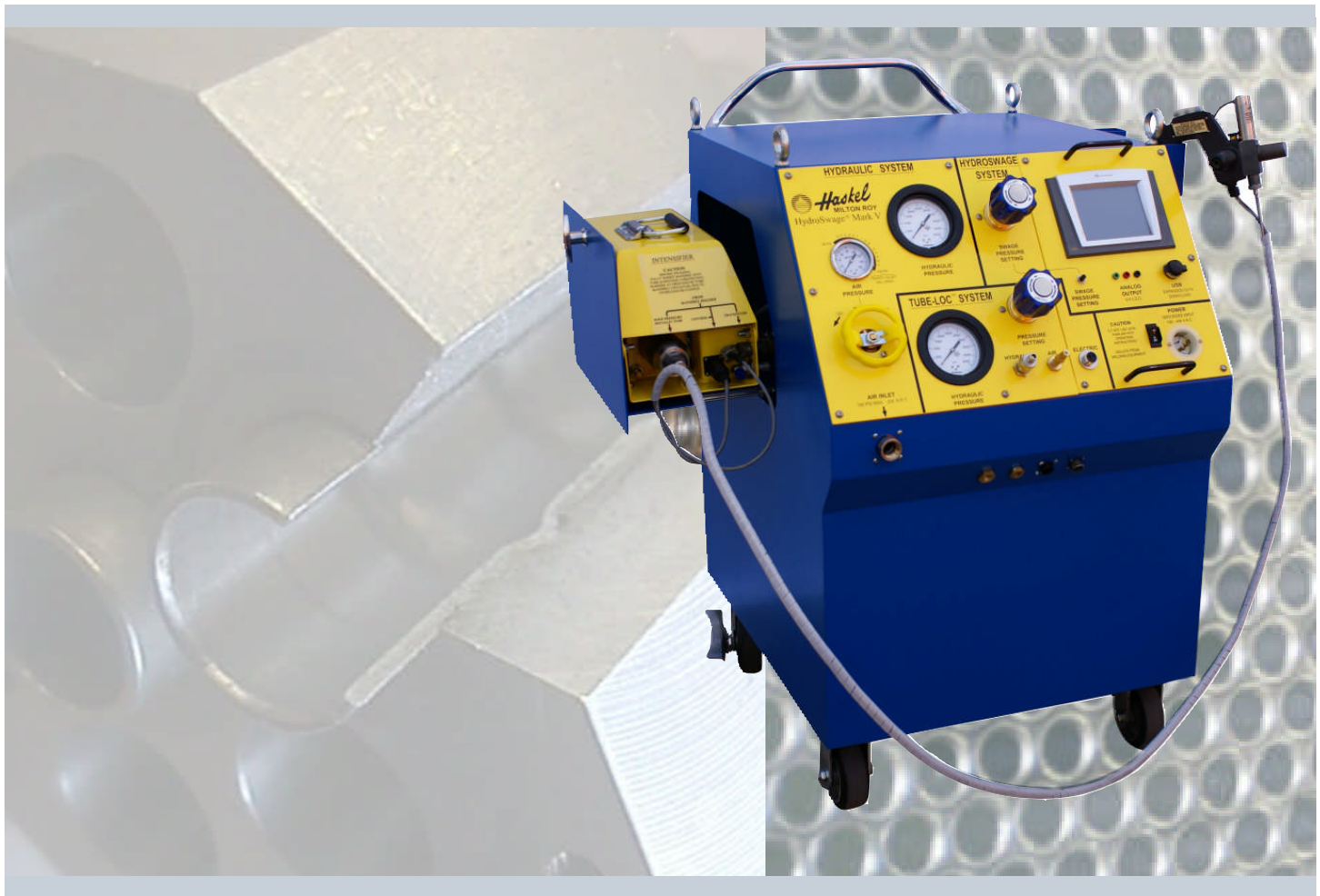




HydroSwage[®] Systems & Tooling

*The Proven Technology for
Hydraulic Expansion of Tubes*



**HASKEL PRODUCTS ARE BACKED BY OUTSTANDING TECHNICAL SUPPORT, AN
EXCELLENT REPUTATION FOR RELIABILITY AND WORLDWIDE DISTRIBUTION**

INTRODUCTION

Haskel International, Inc. has over 60 years of hydraulic and pneumatic engineering experience in the design and manufacture of a wide range of air driven gas boosters, air amplifiers, liquid pumps, valves, fittings and test systems, including 40 years experience with hydraulic tube expansion (HydroSwage®) systems.

Haskel is part of United Technologies' Hamilton Sundstrand Corporation. Operating under the ACE (Achieving Competitive Excellence) business model, Haskel has implemented a vision to become the highest quality, lowest cost, most customer focused provider of engineered, liquid and gas handling equipment in the world.

Our quality assurance and control systems have allowed us to achieve critical qualifications in accordance with international standards such as: ISO 9001/2008, ATEX, CE, NACE MR 0175/ISO 151562003, and MIL STD 1330D.

In 1970 Haskel introduced its first system for the high pressure hydraulic expansion of tubes. Using pressures in excess of 100,000 psi, this system is used for expanding aircraft tubing into sleeves. In 1975 the first system was developed for the hydraulic swaging of tubes for nuclear steam generators. 1980 Began with a series of major technical breakthroughs which gave rise to the first successful commercial method for hydraulically expanding tubes, the HydroSwage® system. In 2010 Haskel announces the newest member of the HydroSwage® product line, the Mark V System, with updated electronics, touch screen and PLC, for system control and monitoring in a single portable unit. A continuous investment in the most modern machinery and technology ensures that Haskel remains a leader in hydraulic tube expansion.

HydroSwage® products are designed and manufactured for use in a wide variety of markets including: Power Generation, Petrochemical, Paper Mills, Pharmaceuticals, Heat and Air conditioning, Sanitary Units, Package and Stationary Boilers and Hydroforming.



MAJOR BENEFITS OF USING HYDROSWAGE®

INTENSIFIER

HydroSwage systems utilize an intensifier to achieve swage pressure. This method has strong advantages over systems that depend on a single pump to generate the high pressure needed for tube expansion.

- The dampening effect of the intensifier results in smooth, uniform pressure curves for each expansion cycle.
- Our intensifier contain a valve that senses when the intensified pressure reaches approximately 95% of the swage pressure setting, at which point the swage timer is triggered insuring that the pre-set expansion pressure is maintained throughout each timed swage cycle.
- The intensifier acts as a valve to hold and release the expansion pressure making high pressure cycling more reliable.
- The system pump is not required to supply expansion pressure resulting in longer life to pressure seals.
- The portability of the intensifier, along with the 20 ft umbilical, aids with expanding in limited access conditions such as boilers or mud drums.

ACCURACY

The degree of expansion is directly proportional to the pre-set hydraulic pressure.

REPEATABILITY

Each tube is expanded by the same pressure which is held to within an approximate 2% tolerance of ± 1000 psi {69 bars}.

QUALITY CONTROL

Expansion history can be stored for download to an Excel spreadsheet. Analog connections are also available for strip chart recorders.

SAFETY

No adverse torque reaction on the operator. Swaging pressure is confined within the tube and tube-sheet. Automatic shutoff if tube mandrel seal is lost

EASE OF OPERATION

Go/No-Go lights alert operator as to the swaged condition of each tube. Since success is determined by pressure, not feel, training time is minimized to a great degree compared to mechanical methods.

FAST

Even the thickest tube sheets are swaged in one step in just seconds. As the tool does all the work, no additional operator is needed to pin tubes to prevent its movement.

VERSATILE

One basic system handles all sizes. Interchangeable mandrels accommodate any tube diameter (1/4" to 2") and gauge, and any tube-sheet thickness.

ENDS CHASING LEAKS

Even in partial re-tubing operations. the accuracy of the HydroSwage® process minimizes disturbing the seal of adjacent tubes.

NO TUBE WALL REDUCTION

Wall thickness or tube length does not change after contact is made with tube-sheet. Therefore, the seating of the tube is not disturbed as swage pressure is increased nor are there metallurgical changes.

STRESS CORROSION

Stress corrosion, work hardening and other metallurgical changes are minimized, prolonging tube service life.

REDUCED CREVICE

Reduces crevice corrosion due to accurate control of tube to tube-sheet crevice.

ACCOMODATES DISTORTED HOLES

This is no problem with the HydroSwage process (within allowable tolerances). Uniform hydraulic pressure swages the tube to each hole's configuration.

FULL PRODUCT LINE

In a shop, in the field, aboard a ship, complete or partial re-tubing, new fabrication, tube setting prior to welding or sleeving, there is a HydroSwage' System for every application.

PRINCIPLES OF OPERATION

The HydroSwage® system is an innovative approach to hydraulically expand heat exchanger tubes into tube-sheets through the direct application of high internal hydraulic pressure within an established expansion zone.

A Tube-Loc™ Drawbar quickly positions and sets the tube into the tube-sheet prior to HydroSwage® expansion. It is also used to set tubes prior to welding.

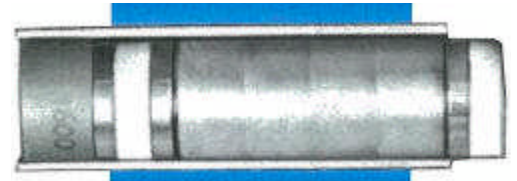
Water pressure from an air driven pumping system is intensified to the desired high pressure. It is transmitted through a small bore, flexible high pressure tube to a lightweight hand-held mandrel holder. A mandrel, which latches into the mandrel holder, directs the pressure to the inside diameter of the tube and is held within an accurately prescribed pressure zone. Pressure is contained within the expanding tube by a soft elastic seal which is supported by a patented elastic backup and an expanding segmented steel ring. Pressure is applied over the full length of the joint in one step. The pressure zone is accurately adjusted which reduces the damaging crevices at the edges of the tube sheet. Stress, crevice corrosion, and metallurgical changes are thus minimized.

Direct Hydraulic expansion with pure water produces clean joints. Lubricant is not forced into the tube surface, and there is no surface flaking or spalling inside the tube.

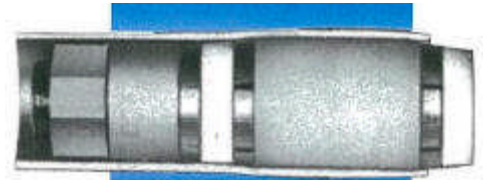
A smooth transition from expanded to unexpanded areas, along with no change in tube material properties, greatly reduces strain hardening, tube fatigue and stress induced corrosion cracking. Tube wall thickness and tube length change is minimal. Before contact is made with the tube sheet, a small reduction in tube wall thickness and length occurs because a constant volume of tube material is expanded to a larger diameter. However, no change occurs during the high pressure swaging, eliminating the shear strain and loss of seal between tube-sheet that is a characteristic of roller expanding.

The HydroSwage® tube expansion cycle is automatic and initiated by the operator button located on the mandrel holder. The tube is filled with distilled water at a low pressure, intensified to the higher setting and held for the time required to accomplish a stable plastic condition of the tube. This dwell time is essential to stabilize exotic tube materials. After the pressure is released, water is drained back into the reservoir. All of this occurs in a period of a few seconds.

Actual expansion pressure at the tube is read on the Mark V touch screen. An adjustable “under” and “over” pressure condition and operating sequence is also shown on the touch screen as well as the operator mandrel holder. To assist with quality control records the Mark V system can store expansion history that can be downloaded to an Excel spreadsheet through the USB port located on the electrical chassis. Analog connections are also provided for strip chart recorders.



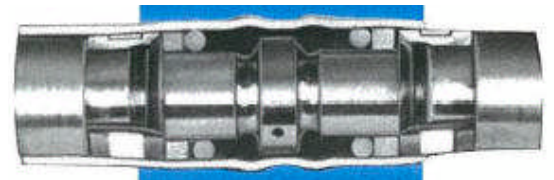
Tube-Loc™ Drawbar in Tube



Drawbar Pulls, Positions and Sets Tube in Place



HydroSwage® Mandrel In Tube



High Pressure Expansion of Tube



Smooth Transition from Expanded to Unexpanded Areas Groove Penetration is Arcuate

MARK V HYDROSWAGE® SYSTEM

The Mark V HydroSwage® System features an electronically controlled, air driven hydraulic system which includes a high pressure intensifier producing pressures to 50,000 psi (3445 bar).

The control panel allows set up and monitoring of all tooling functions through a digital touch screen and is configured to allow Tube-Loc™ and Swage functions to be performed simultaneously by two operators.

The Mark V is housed in a sturdy metal cabinet with heavy duty industrial casters for portability. The touch screen stores expansion history available for download to Excel through a USB port. In addition, analog connections are provided to accommodate chart recorders and computers (optional equipment) for permanent QC records.

Connected to the intensifier by a 20 ft. (6 m) long high pressure flexible tube (other lengths available) the Mark V mandrel holder gives the operator complete control of the swaging cycle. The operator button initiates the sequence of pre-fill, high pressure swage and dwell. The electronic transducer senses the pressure within the tube and displays it on the touch screen. The signal lights (yellow for run, green for completed cycle and red for incomplete cycle), advise the operator of swaging status.

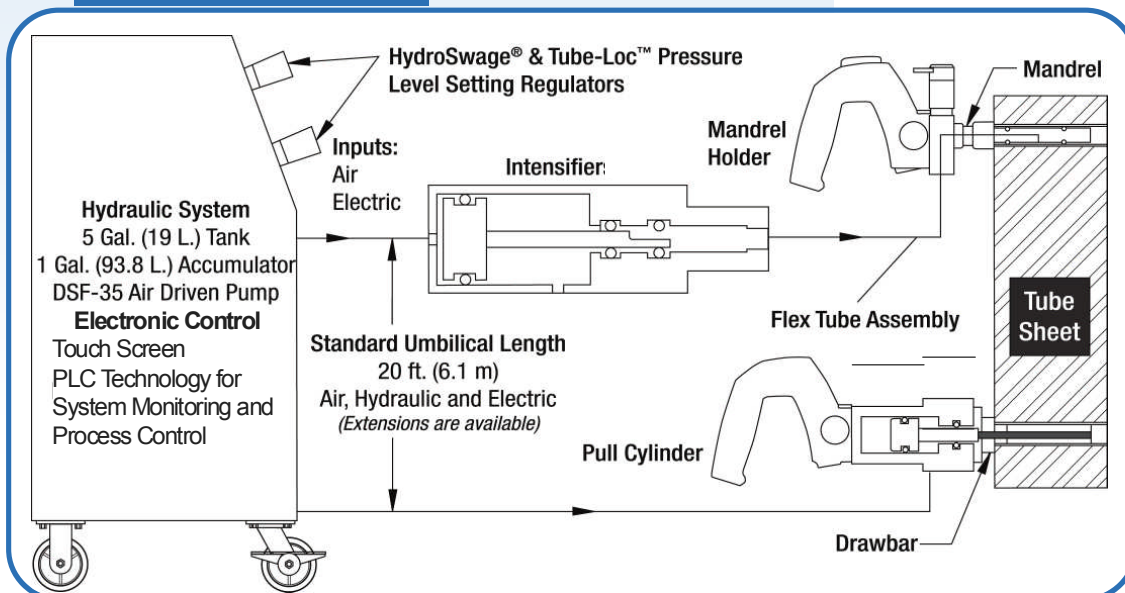
Mark V Hydroswage System 45420



Mandrel Holder 45477 w/ Expansion Mandrel



MARK V DIAGRAM



ES-675 HYDROSWAGE® SYSTEM

The ES-675 HydroSwage System is the most cost effective system of the HydroSwage® line, offering outstanding performance similar to the Mark V at a very economical price.

Like the Mark V, the ES-675 HydroSwage® features an air driven hydraulic system which includes a high pressure intensifier producing pressures to 50,000 psi (3445 bar).

The ES-675 uses the same tooling as the Mark V, and offers Tube-Loc™ capability (non-simultaneous use). Unlike the Mark V, the ES-675 features all analog gauges, and is housed in a much smaller cabinet with heavy duty industrial casters for portability.

The ES-675 mandrel Holder (50311) incorporates many of the same features as the Mark V Mandrel Holder, but does not feature an electronic pressure transducer.

Connected to the intensifier by an 8ft (2.4m) long high pressure flexible tube (longer lengths available), the ES-675 Mandrel Holder gives the operator complete control of the swaging cycle. The operating button initiates the sequence of pre-fill, high pressure swage and dwell. A dual colored signal light (green for completed cycle and red for incomplete cycle) advise the operator of swaging status.

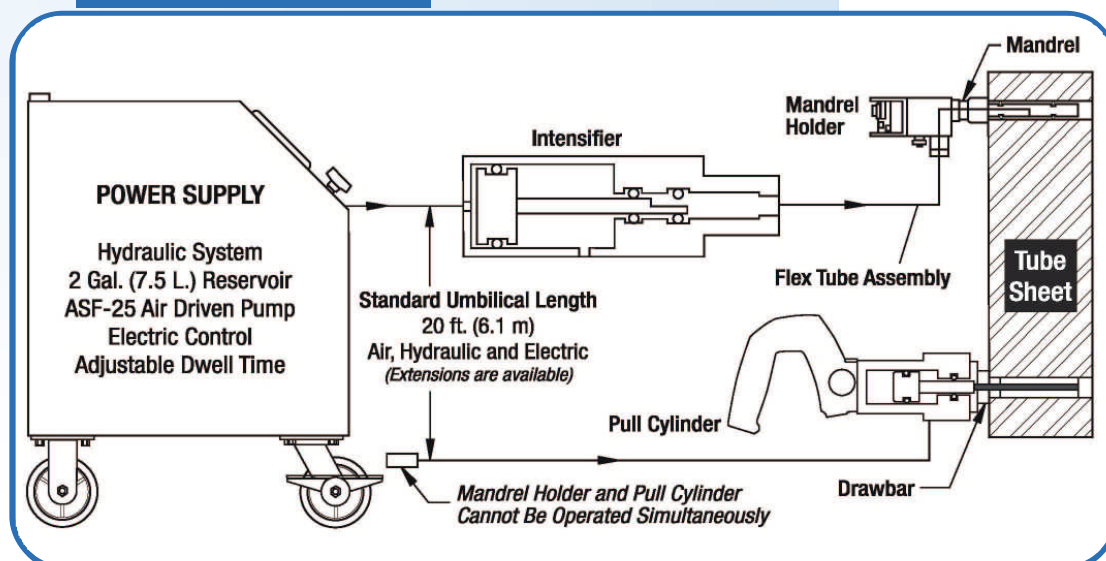
ES-675 Hydroswage System 50307



ES-675 Mandrel Holder 50311 with Expansion Mandrel



ES-675 DIAGRAM



HYDROSWAGE® TOOLS AND ACCESSORIES

Hydroswage® Expanding Mandrels

Designed to provide one step high pressure swage regardless of the tube-sheet thickness, HydroSwage® expanding mandrels feature a patented segmented seal support system which enables the HydroSwage® System to develop and hold high pressures with minimal seal extrusion.

Mandrels are available in .5 mm increments (diameter) and in adjustable lengths which permit exact expansion zone settings. The expansion zone of any mandrel can be tightly controlled assuring full depth tube-sheet expansion thus minimizing crevice exposure.

Hydrotest Tools; 42330 1", 44183 1-1/2" & 44579 2"

Hydrotest tools with elastic hoses, gauges, and shutoff valves quickly connect and disconnect from 43244 air driven and hand operated Pump Power Supply. They provide a quick and efficient means of hydrotesting boiler tubes from inside the boiler. The hydrotest tool with an o-ring sealing at the tube I.D. is locked into the tube I.D. and a collar-mounted seal is advanced to the drum inner wall. The isolated chamber between drum face and tube O.D. is pressurized with the hand operated/air driven pump. The pressurized volume is locked in the elastic hose and joint leakage evaluated by gauge bleed down characteristics.

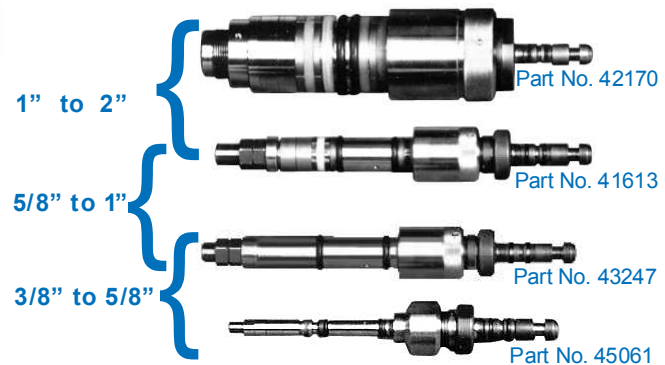
Tube-Loc™ Drawbar Assembly

The Tube-Loc™ Drawbar Assembly quickly positions and sets the tube sheet creating uniform tube end protrusions, and preventing the tube from moving during welding and swage operations.

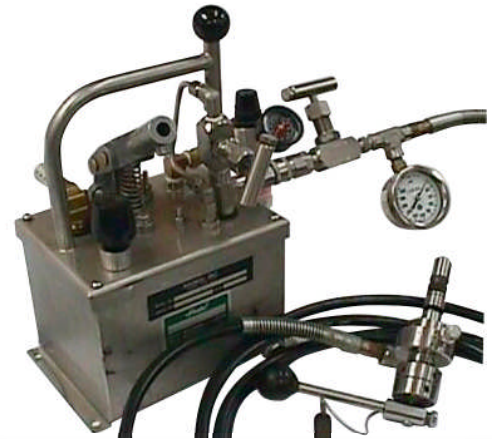
The Tube-Loc™ Drawbar operates from the Mark V and ES-675 Power Consoles or from its own dedicated Tube-Loc™ Power Supply (42380).

Tube-Loc™ Power Supply

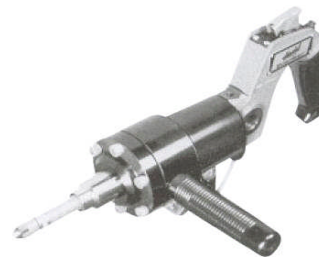
Designed to fit through a 12" x 16" (30 x 40 cm) elliptical marine boiler manway, this system offers the greatest flexibility when using Tube-Loc™ tools. All electrical controls on the power supply are transformed from 115vac and 220vac to 12vac for optimum operator safety. To assure reliable performance, the Tube Loc™ Power Supply uses the same hydraulic pump found in HydroSwage® Power Consoles, and is specifically designed to operate all Tube-Loc™ Pull Cylinders.



Expanding Mandrels



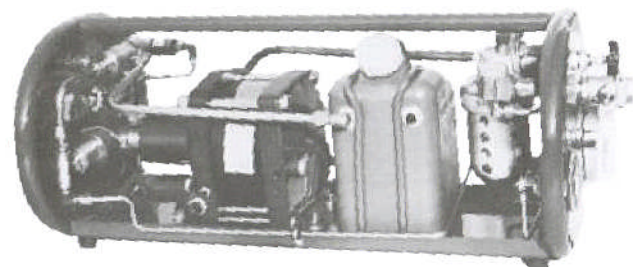
Hydrotest Power Supply 43244 with Hydrotest Tool (1") 42330



Tube-Loc™ Drawbar with Pull Cylinder 41732



Tube-Loc™ Drawbar with Pull Cylinder 42140



Tube-Loc™ Power Supply 42380

STRAIN CONTROL SLEEVING SYSTEM

Most heat exchangers are designed with a certain amount of extra tube capacity to allow a percentage of tubes to be plugged during the life of the exchanger.

Two primary causes of tube failure, which often result in tubes being plugged or replaced, are erosion and corrosion. In fact heat exchangers are often completely re-tubed to repair tube failures which occur only at the tube ends.

The HydroSwage® Strain Control Sleeving System 43101 offers an economical method of prolonging the life of aging or failing heat exchanger tubes by installing sleeves (ferrules) to restore lost tube material or as sacrificial barriers to the damaging elements which cause the tube loss.

Strain control is a two stage process which pre-expands a prepared metal sleeve into the damaged or failing section of the tube. The first stage expands the sleeve at a pre-calculated hydraulic pressure beyond the sleeve yield strength, but less than combined yield strength of the sleeve and parent tube.

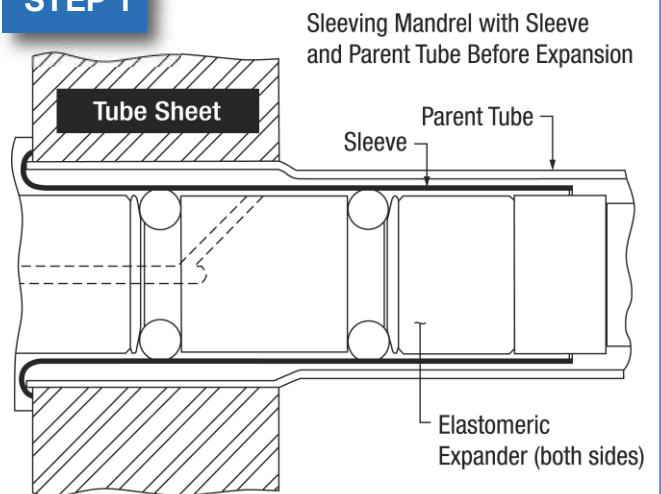
The second stage expansion is controlled by injecting (at a higher pressure) a pre-determined volume of water to control the radial expansion of the sleeve and parent tube to produce a constant interference fit between the sleeve and parent tube.



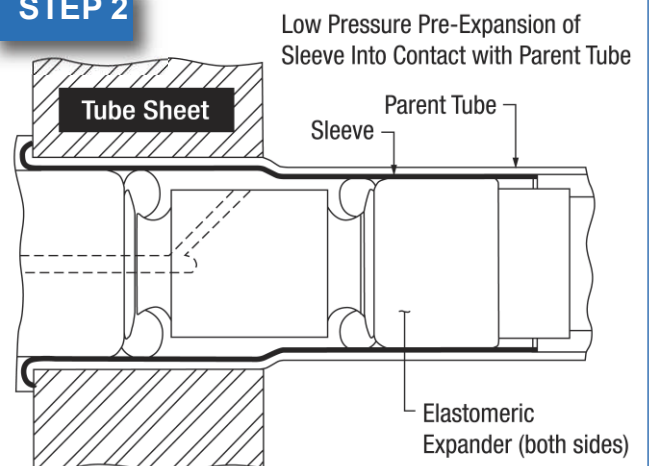
Strain Control Sleeving System 43101

PRINCIPLES OF OPERATION

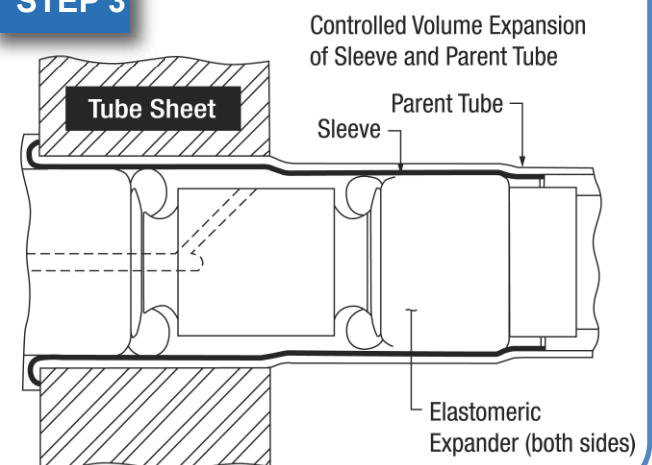
STEP 1



STEP 2



STEP 3



PART NUMBERS AND SPECIFICATIONS

Part Number	Description	Approximate Overall Dimensions Inches (cm)			Approximate Weights lbs (kg)	
		Height	Length	Width	Operator*	Shipping
Mark V HydroSwage® System						
45420	Power System (Includes 45437 Intensifier)	35 (89)	25-3/5 (67)	30 (76)	N/A	368 (167)
45477	Mandrel Holder	6-1/2 (17)	7-3/4 (20)	1-3/4 (4-1/2)	4 (2)	9 (4)
ES-675 HydroSwage® System						
50306**	Power Supply	31 (79)	23 (58)	18 (46)	N/A	143 (65)
50309	Intensifier	9 (23)	17-3/4 (45)	10-1/2 (27)	N/A	60 (27)
50311	Mandrel Holder	3-1/2 (9)	10-1/2 (27)	1-3/4 (4-1/2)	3 (8)	4 (10)
Tube-Loc™ Systems						
	Drawbar Thread	Effective Area IN ² (CM ²)				
42380	Power Supply	11-1/4 (20)	25 (65)	14-1/4 (36)	N/A	59 (27)
41915**	1/4" - 28	1.35 (8.71)	2-1/2 (6)	6 (15)	3-1/2 (2)*	5-1/2 (3)
41732**	9/16" - 18	2.70 (17.42)	7 (18)	12 (30)	8 (4)	11 (5)
42140**	7/8" - 24	11.46 (73.94)	7-3/4 (20)	11 (28)	14 (6)	17-3/4 (8)
Hydrotest Systems						
43244	Power Supply	Haskel 36:1 ratio water service pump. Air or hand operated pump in 3 liter (183 cu. in.) tank. Weight 18-1/2 lbs (8.4)				
42330**	Hydrotest Tool	1" x .085" & .095" Flared tube joints. Weight 7-1/2 lbs. (3)				
44579**	Hydrotest Tool	2" x .134" & .165" Flared tube joints. Weight 8-1/2 lbs. (4)				

Notes: * Actual weight imposed on operator for hand-held equipment

** Hydrotest tools supplied with 20 ft elastic hose with plumbing and gage that connect to 43244 Power Supply

HYDROSWAGE^(R) SYSTEM - AVAILABLE INFORMATION

- Mark V & ES-675 Systems
- ASME 82-JPGC-PWR-1 "Hydroexpanding The Current State of the Art."
- Central Test Laboratories Test Report MET 341E181 "Hydroswage - Roller Comparison as to Stress Corrosion Cracking,"
- Truesdail Laboratories, Inc- Report 3799 1 ASTM G35 "Stress Corrosion Cracking of Tubes (Hydroswage vs. Rollers)" Haskell Application Reports
- ASME Code Acceptance for Hydraulic Expansion BC-80.529
- Chemical Engineering Reprint "Heat Exchanger Tube to Tube-Sheet Connections."
- "Tube Expansion Issues and Methods" White Paper
- User's List



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SPECIALTY TOOL SERVICES

A Division of Specialty Tool & Supply, Inc.

2330 N. FM 3083 RD. E. CONROE, TX 77303

PH: 936-760-1100 FAX: 936-760-3100

TOLL FREE 800-360-TOOL (8665)

www.SpecTool.com