Cleco®
Production Tools

Reference Manual
P2224RM
2019-05

Fixtured Spindle

Hardware only

Disclaimer

Apex Tool Group reserves the right to modify, supplement, or improve this document or the product without prior notice.

Trademark

Cleco is a registered trademark of Apex Brands, Inc.

Apex Tool Group GmbH

670 Industrial Drive
Lexington, SC 29072
USA

About this Document

This document provides guidelines of the correct and proper usage of a DC electric fixtured spindle.
The intent is to provide a general overview of item to consider with a spindle is needed for a fixtured application.

Other documents

Number	Name
P1713	System Handbook: Fastening System Serie BB
P1917E	System Handbook: Fastening System Serie BTS
P2077SB	System Handbook: Fastening System Serie BTSE
P2102JH	Cable Management Reference Guide: BB Series / BTS(E) Series

Abbreviations

BTS(E)	Intelligent spindle
BB	Built-in spindle, single calbe version

Cleco Production Tools

EN

Contents

1 Application Considerations

1.1 Review of the Assembly Process

What is begin assembled and how is it intend to be assembled. Will it be in a fully auto station, semi-auto, robotic etc… Each scenario will have its own unique set of challenges.

1.2 Environment

The environment will play a major factor into the selection, design and effective and efficient performance of the spindle assembly. Be mindful of conditions that our spindles my expose to such as liquids, dust, dirt or metal chips. Any one of these in the right condition could have an adverse impact of the spindles performance and life expectancy.

1.3 Duty Cycle

It is highly recommended that a DC electric fixture spindles duty cycle is such that the time on should be equal to less than the idle time. It is important in certain environments that the energy stored in the DC motor is allowing motor to effectively dissipate heat from the fastening cycle before the next cycle.

The duty cycle will have an impact on the preventative maintenance service intervals and the life of the spindle. Our recommendation in other words is 50% on and 50% off.

1.4 Overall Equipment Effectiveness (OEE)

Every assembly system a target for (OEE). IT is important to determine what that target is before a tool is selected. The tool selection will have an impact on the potential OEE of a particular station. If the incorrect tool is selected and the performance of that particular station is less them desirable it will have a negative impact on the OEE[1].

1.5 Fastening Strategy

There are many factors to consider when considering what spindle size and type to use for an application. The following are just a few of the many to consider:

The following are the most problematic conditions that have to be carefully reviewed. Each of these will have an impact on the effective and efficient operation of the spindle as well as an impact to the preventative maintenance service intervals and life of the spindle.

- Prevailing torque
- Long rundown cycles
- Stick slip
- Joint vibration

1.) OEE = (Good Pieces x Ideal Cycle Time) / Planned Production Time Basically OEE= Availability X Performance X Quality. So (Availability= 96.6%) X (Performance=95%) X (Quality=90.4%) = (OEE=82.96%).
The target at Ford powertrain is 85% OEE

Joint conditioning safety must reviewed and considered in the duty cycle because this is consider as addition cycle within the rundown.

Angle control: Sizing is important if there is a thresh hold torque that must be achieved that is significantly less than the final torque could be an issue with the torque transducer resolution if it is below 20% for full scale.
There are many variables that need to be considered when selecting sizing to ensure optimal performance and to avoid overheating and premature damage to the spindle.

- Overall cycle time.
- Time, speed and torque in the 1st stage (pretighten).
- Time, speed, torque and joint (soft/hard) in the 2st stage (final stage).
- Additional stages/sequences that may be required.
- Ambient temperature of the work environment.
- Box or cover around the spindle or cluster of spindles.

1.6 Torque Requirements

In general the recommendation is to size the spindle assembly to only use 75% of the maximum available torque. One of the reasons is to allow for a future additional capacity. In addition, if there is a reject strategy that requires the fastener to be removed by the same spindle there is typically 15% more torque required to remove the fastener as opposed to the rundown torque. It is important to understand class of joint involved and if the tolerance can be repeatability achieved.

1.7 Torque Accuracy

Every joint has a class identification some have tighter torque tolerances than others. The tool and attachments must closely be considered to ensure that the torque tolerance can be achieved. It is important to understand the joint class and it characteristics

Class A	Intermediate, or Class B	Class C and D
Is a joints, that may result in catastrophe or bodily injury. Specific tight torque specification and traceability requirements. Examples are wheels, brakes and steering gear. Impact: manufacturer liability	Is a joints that is reliability-related. Failure of these joints may result in disability of the equipment. Examples are bolted joints in engines and transmissions. Impact: Product cost and warranty	Is a joints related to customer satisfaction. A failure in one of these joints might cause an annoying squeak, leak or rattle. Impact: Future sale loss

The highest attention is given to class A. not only is a higher accuracy required, but also in most cases two tightening parameters are usually controlled (torque and angle). Some important joints from calls B are also treated as class A.

2 Spindle Selection Considerations

2.1 Spindle Spacing

It is important to review the hole pattern of the part to be assembled as well area in which the spindles will be mounted. You need to ensure that you have access to the fasteners, space for the spindles to be mounted as well as adequate access for serviceability. If space is an issue there are many spindle configurations that are available like offsets, extended spindles, angle heads and U motors.

Application that have tight center to center distances the may be spindle supports required See Spindle Support Section.

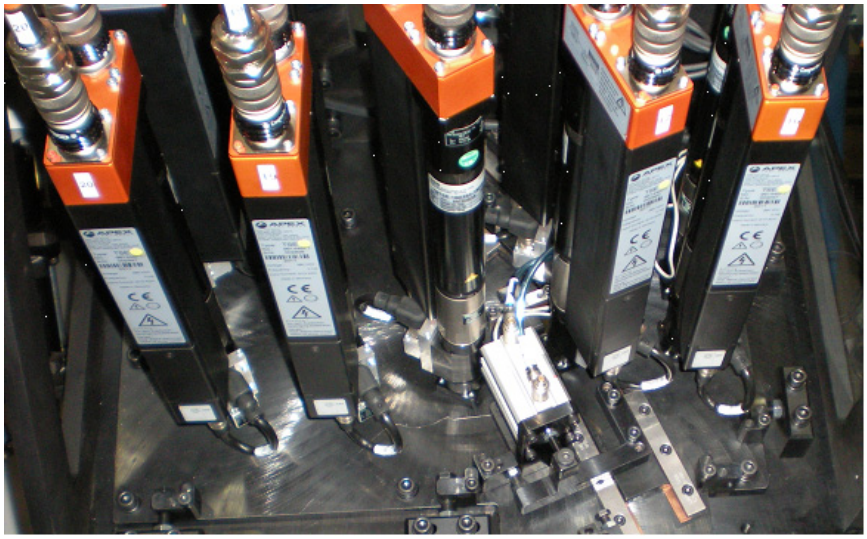


Fig. 2-1:

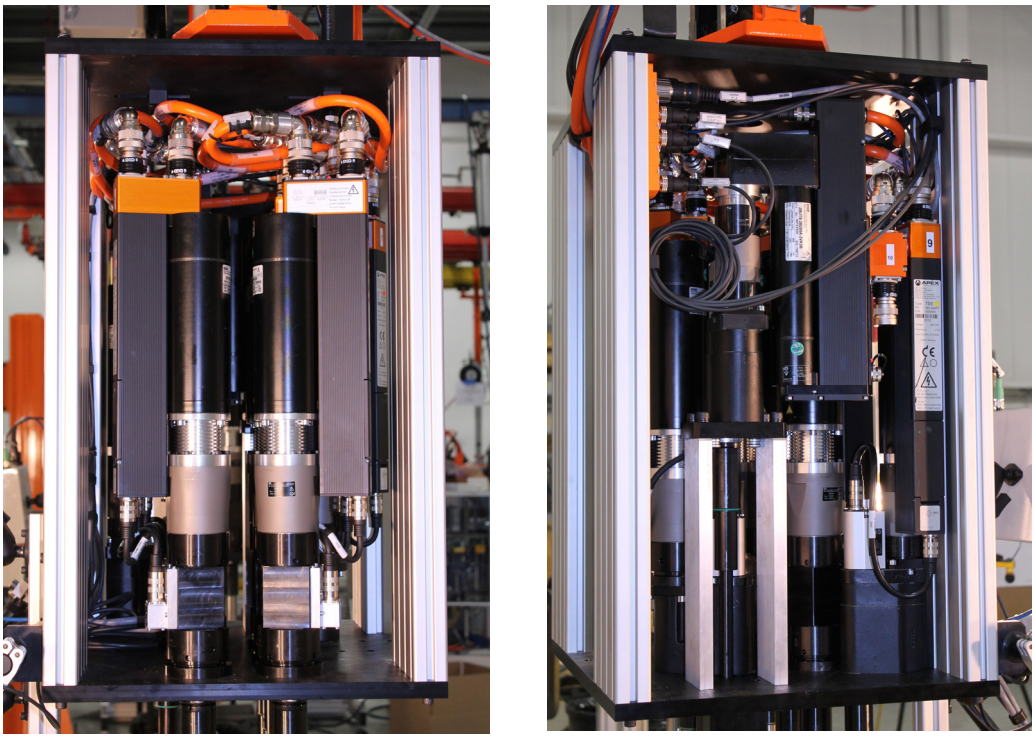
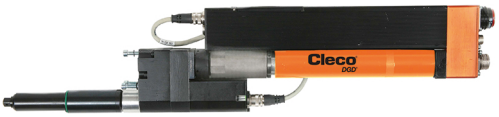


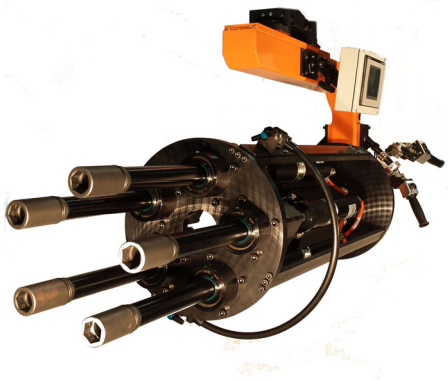
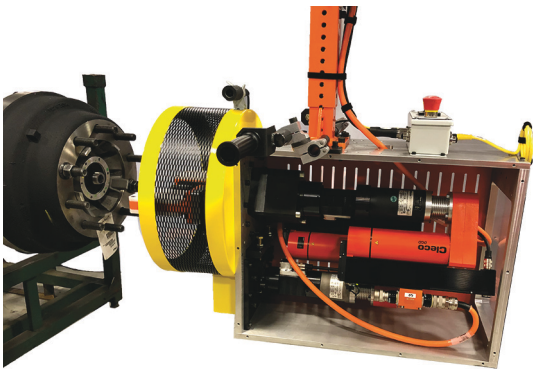
Fig. 2-2:

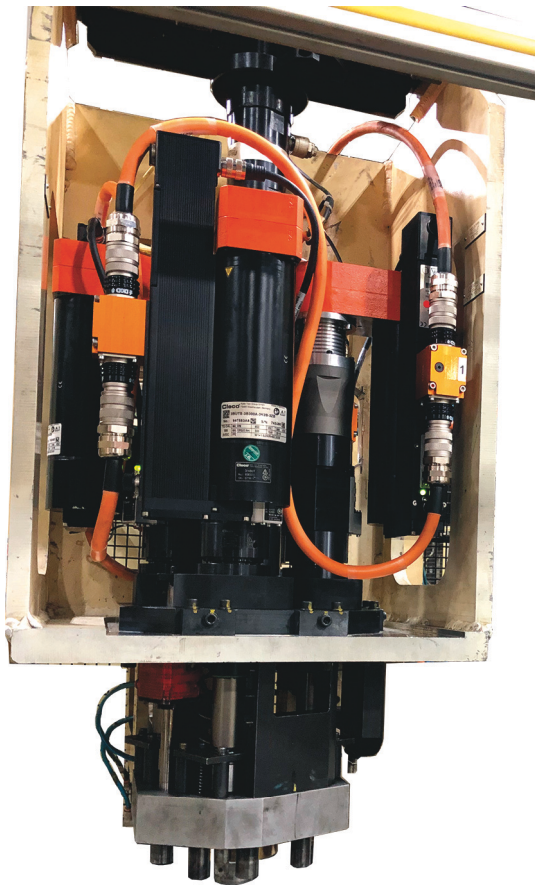
2.2 Various configurations of the intelligent spindles

Should a compact multiple be necessary we offer both in-line of offsets and reversible gearing.

 In-line spindle	 U-Spindles: In-line spindle
 Spindle with Angle Head	 U-Spindles: Spindle with Angle Head
 Spindle with Offset Attachment	 U-Spindles: Offset spindle

2.2.1 Spindles on site



U-Spindles Inline

2.3 Torque Reaction

In general, the typical fixtured spindle has built in mounting provisions for ease of mounting. However, each application has to be reviewed to ensure that standard mounting plates will be effective. It is critical that the adjoining mounting plate is engineered to withstand the forces being applied.

You must consider the operators safety to reasonably ensure that the torque being applied to the application is absorb by the equipment and not transferred to the operator.

2.4 Drive Spindle Adaptor Spring Travel

The standard travel is 50 mm compression of the square drive adaptor. It is recommended to only use 75% of the available travel. The amount of spring travel used will impact the life of the internal spring. The more travel used the shorter the life expectance will be on the spring. If full travel is used there is a potential of damaging the drive adaptor because the forces are being transfer into the drive.

Other considerations is increasing or decreasing standard spring force.
Increasing spring force: If larger dia. wire gauge is used be cautious to ensure that *coil bind* will not be a problem before the full travel can be realized. In semi-automatic (operator run) multiples are used be careful to not design the springs to be too stiff that will not allow the operator to overcome and compress the spindles, if necessary.

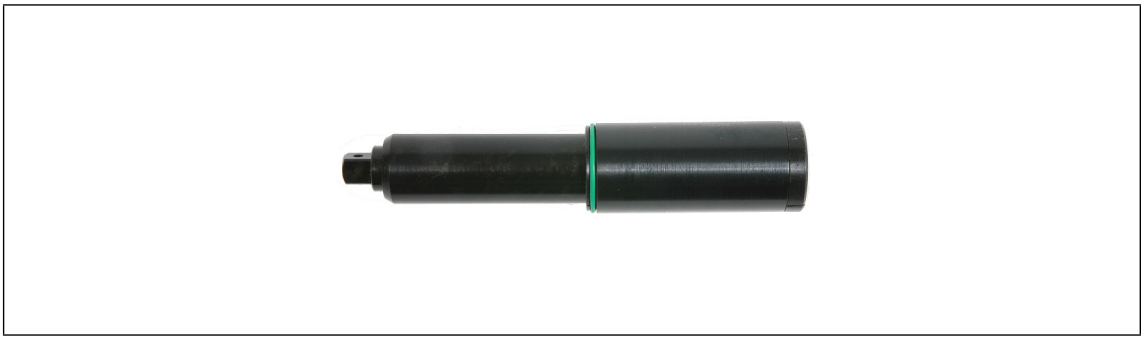


Fig. 2-3:

2.5 Spindle Drive Adaptor Length and Support

If the is expected spindle windup or excessive side loading is expected then some form of bearing supported spindle guidance should be considered.

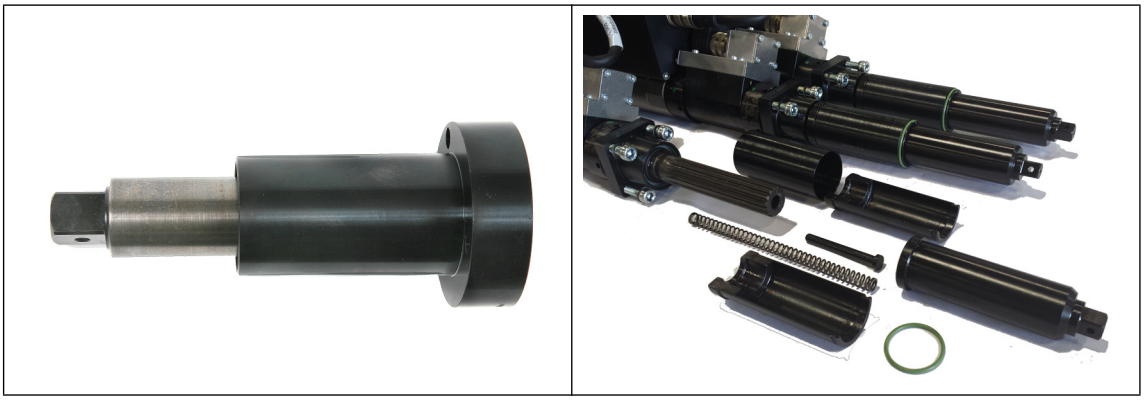


Fig. 2-4:

Any multiple that used transducerized offset drives precautions should be given to support them externally to avoid side loading.

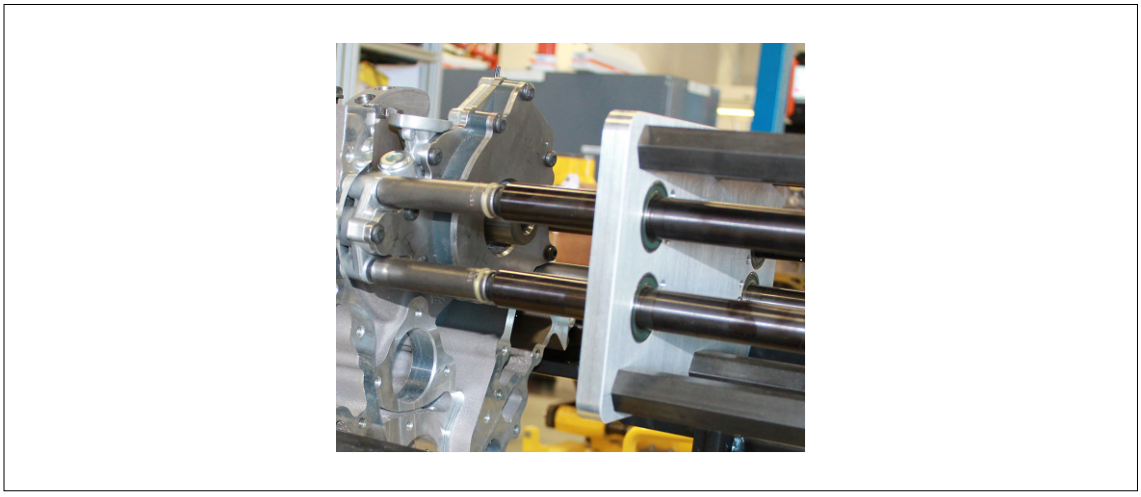


Fig. 2-5:

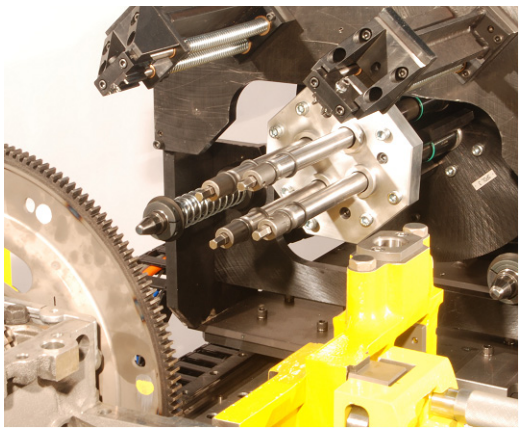


Fig. 2-6:

2.6 Spindle Orientation

In general, the mounting orientation does not play a significant factor in the spindles performance. However, each application has to be reviewed to ensure that standard mounting plates will be effective.

Fig. 2-7:

The position of the spindle:

- Vertical up/ down:
- Angular up/ down: Proper floating adaptor support. The longer the spindles the moor droop could be encountered. See spindle support section of the reference manual.
- Horizontal: Proper floating adaptor support. The longer the spindles the moor droop could be encountered. See spindle support section of the reference manual

2.7 Spindle Mounting

The components of the fixtured spindle by their general nature facilitate various methods for mounting. It is important to match the mounting plate to the hole pattern of the spindle. It is important to ensure that the mounting plate is built to handle the forces that will be realized during the torquing process.

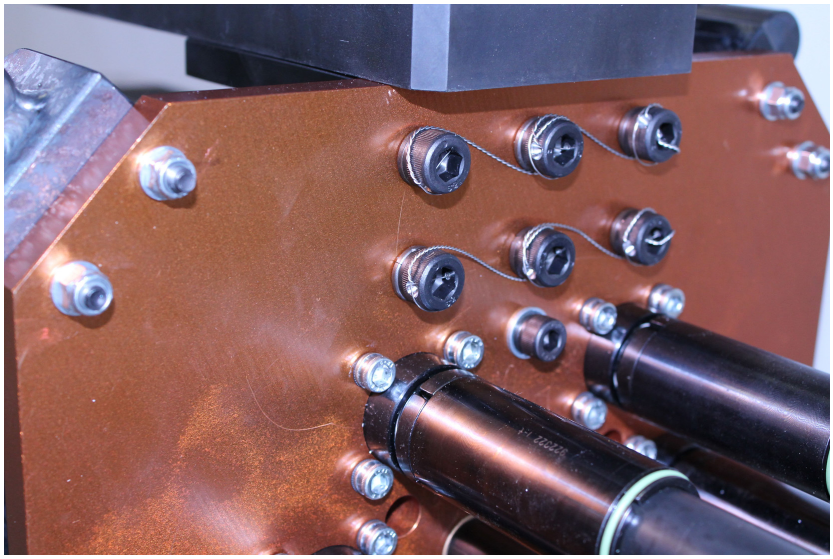


Fig. 2-8:

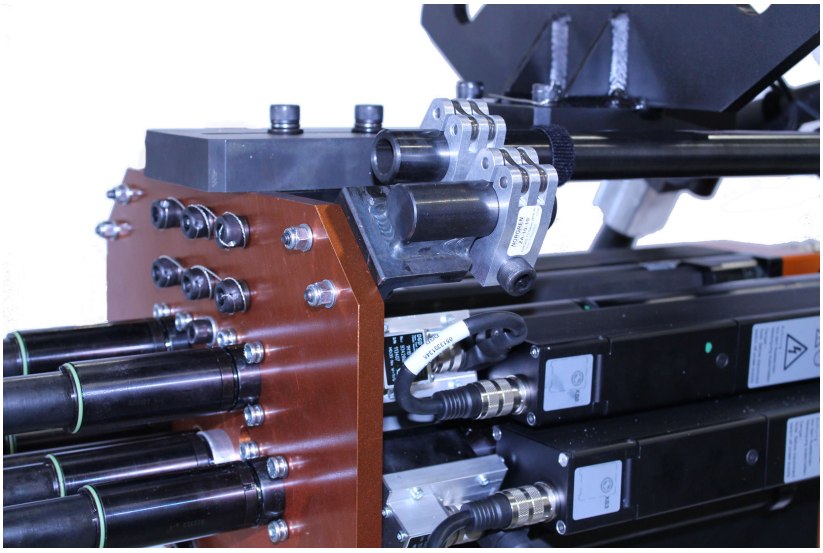


Fig. 2-9:

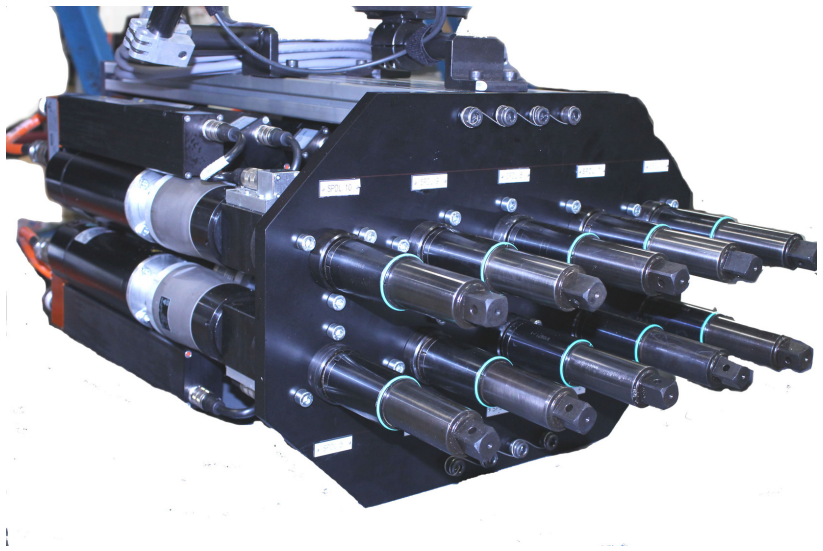


Fig. 2-10:

2.8 Spindle Enclosure

If there is a need of a frame to accommodate a group for spindles it is important to ensure that the frame is properly constructed to handle the forces that will be realized during the torquing process. This included but not limited to the side supports, covers, top plate and motor mounting plate. During the design ergonomic consideration must be given to the location of the handles, light box, display screen and suspension equipment. It is important to design the frame to be as ergonomically sound for ease of safe, comfortable and prolonged usage.

Make sure that adequate consideration is given to the serviceability of spindles and all components that are part of the frame.

Fig. 2-11: . Vertical down manually operated multiples with frame covers

Fig. 2-12: . Vertical down manually operated *open frame* multiple

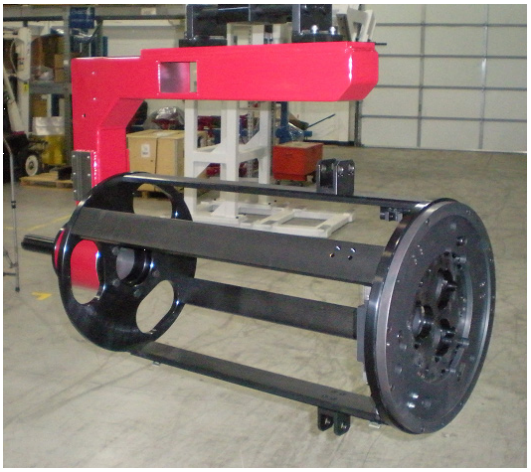


Fig. 2-13:

2.9 Torque Multiplier Usage

It is important to consider the duty cycle, spindle spacing, fastening tolerance and expected service intervals. High ratio torque multipliers will have a significant impact on the RPM of the spindles. The fixture must be built to handle the forces that will be realized during the torquing process. Reduce the RPM by the factor of the multiplication

- Accuracy is reduced by at least 5-7%.
- Ranges 5:1 to 125:1 ratio
- High Maintenance
- Expensive
- Large
- Heavy

Example: Full free speed 100 RPM with 10:1 multiplier the end result of the full tool free speed with be 10 RPM.

2.9.1 Adjustable centers

We have the ability offer manual, semi-automatic of fully automatic adjustable centers to accommodate multiple part complexity. For semi-automatic or fully automatic we offer pneumatic or electro-mechanical mechanism.

During the review it is important to the various parts that have to be accommodated to ensure that we can access then with the same spindle configuration and that there is adequate space to fit the slide mechanisms in the enclosure.

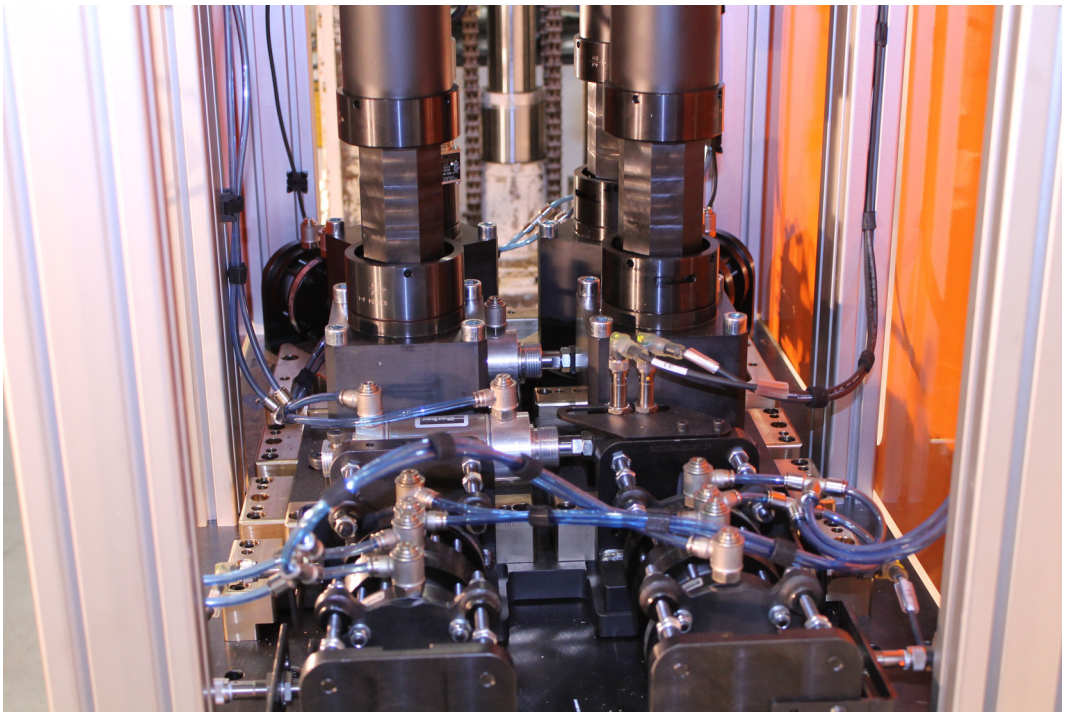


Fig. 2-14:

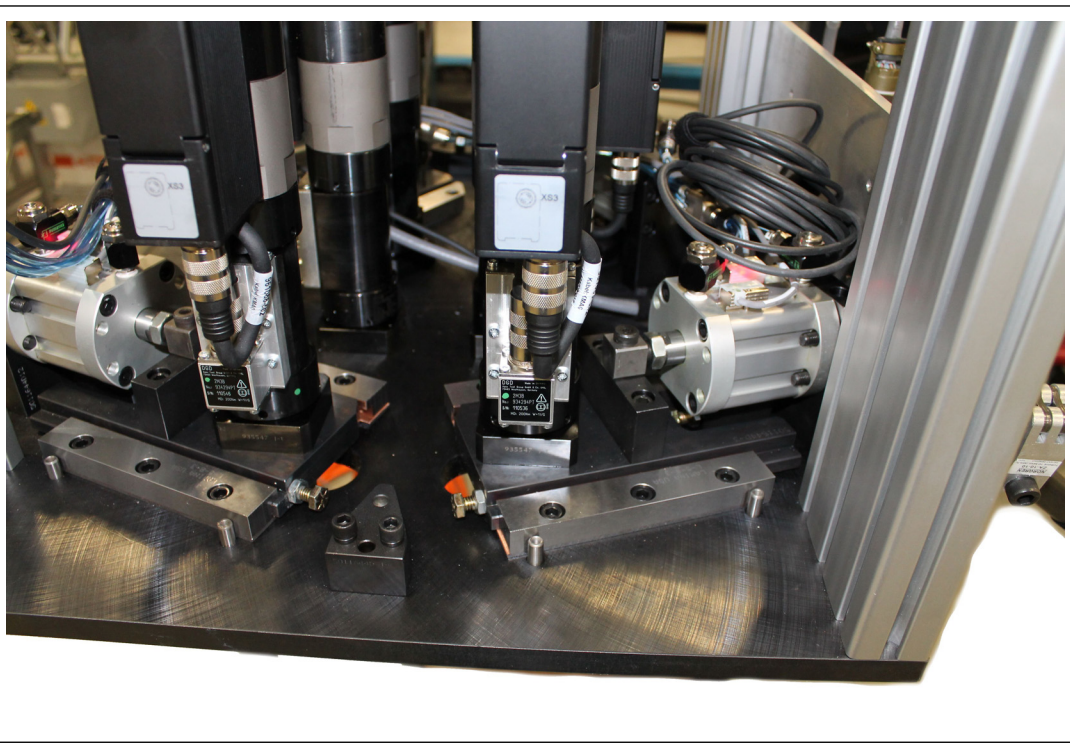


Fig. 2-15:

3 Cable Management

Proper cable management play an important role in automatic, semi-automatic stations or hand held multiples. Proper cable management will aide in lower cost of ownership, reduce the complexity of equipment for all parties involved and ease the operation of hand operated multiples of the equipment.

See P2102JH, Cable Management Reference Guide: BB Series / BTS(E) Series

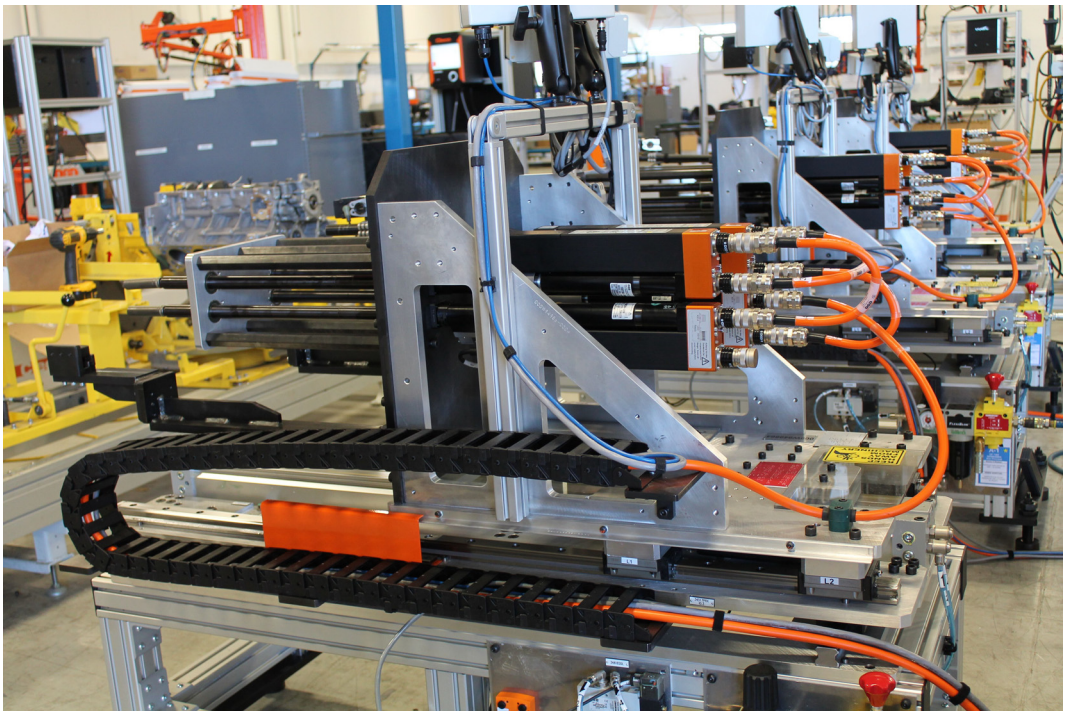


Fig. 3-1:

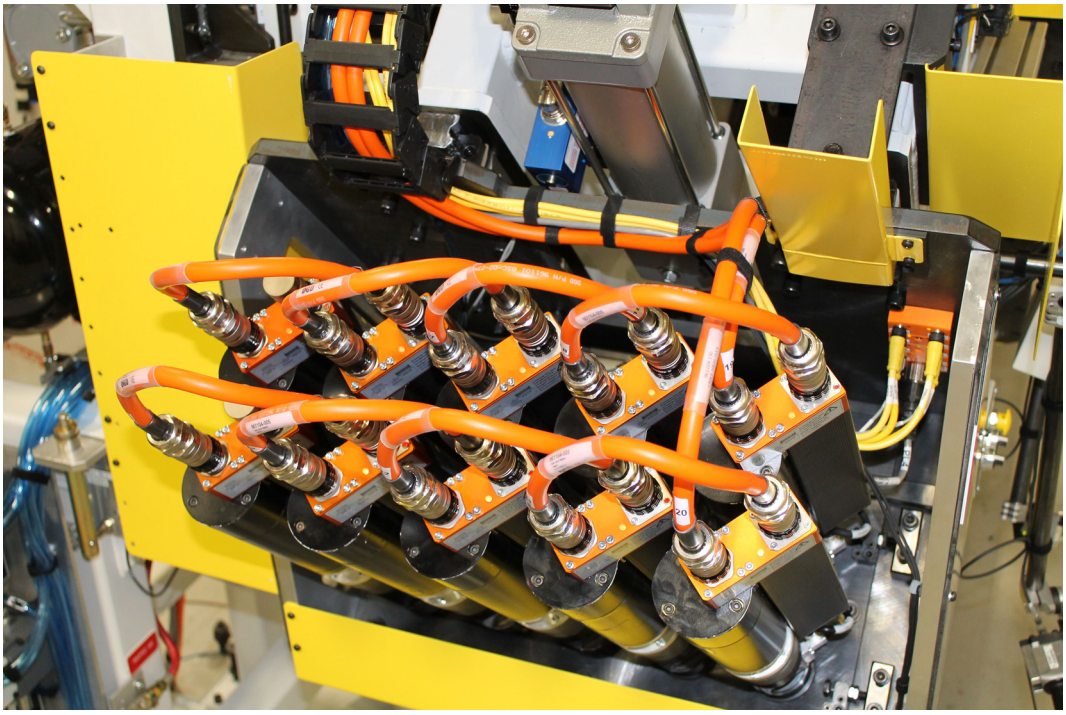


Fig. 3-2:

4 Serviceability

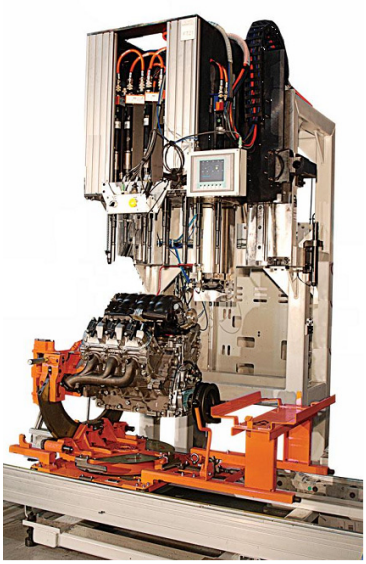
This is referred to the ability to have sufficient access to the spindle to ensure effective and efficient service on the spindle. It is critically important to have a reasonable mean time to repair (MTTR) that easy access to the spindle is provide.

This is especially important when the spindle in installed in vertical or angular up orientations below the work surface under a part.

Note: For service of the spindle please reference the applicable Service manual

4.1 Fixtured Spindle Installation Examples

Robotic assembly



Full automatic station with power-head

Vertical down manually operated multiple

Semi-automatic power-head

5 Hand Tool Vs Fixtured Tool

Hand tools by their general nature are designed to be used in the hands of an operator. A fixtured spindle is designed to be mounted for semi - auto or fully auto stations. There are typically higher equipment performance expectations for a semi-auto or auto stations that are higher than a hand tool is capable of achieving. Consequently if a hand tool is not properly sized and configured to meet the higher expectations the tool will have a higher probability of failure as opposed to a standard fixtured spindle.

MTBF Consideration

Generally the MTBF of a fixtured tool is ~ 2- 1,000,000 cycles and a hand tool is generally ~250,000 cycles.

Acquisition VS Total cost of ownership

There is often a cost trade-off related the acquisition cost vs the total cost of ownership of a hand tool vs a fixtured spindle that has to be explored. The total cost of ownership is general is more expensive for a hand tool over time when placed into a fully or semi-automatic station.

Floating Adapters

If a hand tool must be used floating drive adapters must be used. Without a floating adaptor there is no cushion provided for the tool and all shock forces impacting the tool.

Hand Tool Mounting

Do not clamp around a non-recommended clamping point. Reference the applicable hand tool manual for further guidance.

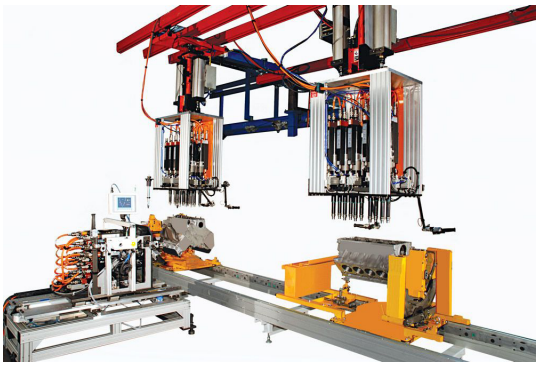
Angle Head Use

Most right angle tools have the ability to be fixtured using a mounting bracket. These should be used whenever possible.

6 General reference

1.

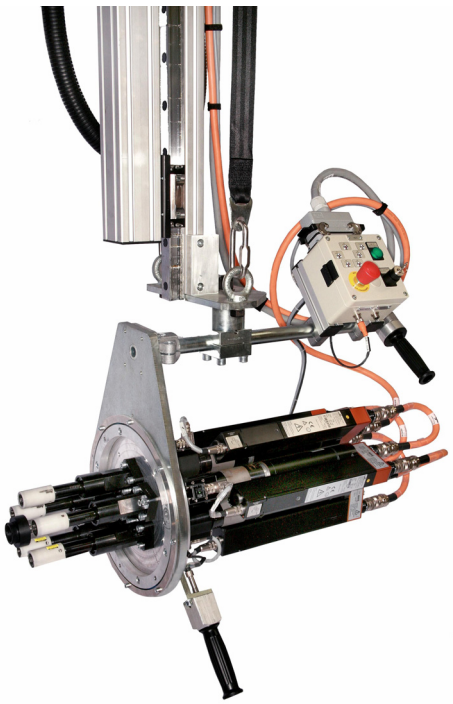
2.



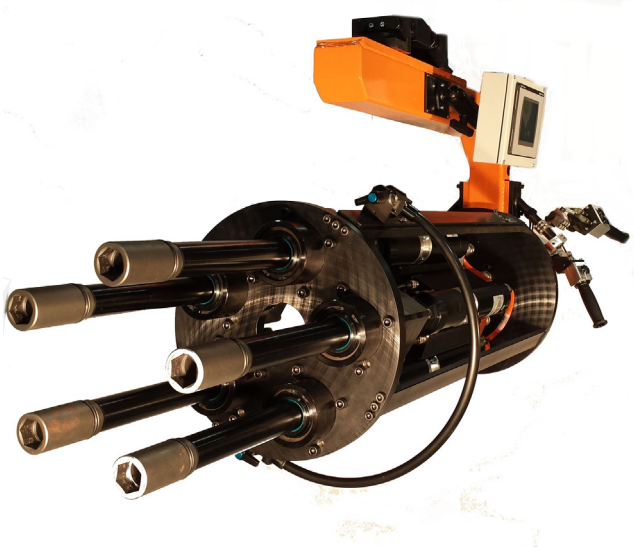
3.

4.

5.



6.



7.

7 Glossary of Terms

Adaptor	A mechanical connection between the motor and the planetary gearing
Angle encoder	A mechanism to measure angle rotation
Angle head	An attachment to the front side of the gearing that is used for access where a 900 access is required.
Angle Head	A mechanism that facilitates a 900 position of the drive spindle to the center lien of the motor
Conventional spindle	A fixtured spindle with a servo module mounted in a remote control panel
Drive adapter	The end of the spindle with the square drive.
Duty Cycle	The cycle time of the operation
Floating adapters	The spring loading mechanism
Intelligent spindle	A fixtured spindle with a servo module mounted to the side of the drive motor.
Locking ring	This is the mechanical locking mechanism between the motor and adapter and torque transducer and the gearing
Motor	Drive motor
Motor mounting plate	This the plate in which the spindle(s) are mounted. For a power-head an integrator may choose to provide the mounting plant MTBF: Mean time before failure
MTTR	Mean time to repair
Multiple	Single or multiple spindles in a group that are operated by a human and suspended from an articulating arm or balancer.
Offset spindle	An attachment to the front side of the gearing drive spindle that is used for access to tight center distances by offsetting the center line of the drive spindle.
Offset Spindle	An adaptor that facilitate an offset center lien from the motor
Planetary gear set	A set of gearing that multiples the output of the torque of the motor to achieve a desired final torque.
Power-head	Single or multiple spindles in a group that are mounted to a automatic machine
Resolver Analog	
Reversing Gear Packs	A mechanism that facilitates the reversing of the center line of the drive spindle to facilitate a compact packaging of the spindle
Side covers	These are covers that are used on multiples or power-heads to enclose the spindles and frame. Typically side covers are used when safety is a concern due to shifting spindles, vision systems, part fixtures are used for a multiple.
Side support	This is the side structural support for a multiple or power-head frame.
Square drive adapter	An adaptor that has an internal spline that slides over the output spindle and facilitates the attachment of a drive socket.
Torque transducer	measuring device that measures the torque applied
TS	Tightening servo for an in line intelligent spindle
TUS	Tightening U servo for a reversing gear pack type spindle.
U motor	An attachment to the backside of the gearing that facilitates the ability to have a compact spindle. The actual motor bends around the gearing un a U shape.

POWER TOOLS SALES & SERVICE CENTERS

Please note that all locations may not service all products.
Contact the nearest Cleco® Sales & Service Center for the appropriate facility to handle your service requirements.

Sales Center
Service Center

NORTH AMERICA | SOUTH AMERICA

DETROIT, MICHIGAN
Apex Tool Group
2630 Superior Court
Auburn Hills, MI 48236
Phone: +1 (248) 393-5644
Fax: +1 (248) 391-6295

LEXINGTON, SOUTH CAROLINA
Apex Tool Group
670 Industrial Drive
Lexington, SC 29072
Phone: +1 (800) 845-5629
Phone: +1 (919) 387-0099
Fax: +1 (803) 358-7681

MEXICO
Apex Tool Group
Vialidad El Pueblito #103
Parque Industrial Querétaro
Querétaro, QRO 76220
Mexico
Phone: +52 (442) 211 3800
Fax: +52 (800) 685 5560

BRAZIL
Apex Tool Group
Av. Liberdade, 4055
Zona Industrial Iporanga
Sorocaba, São Paulo
CEP# 18087-170
Brazil
Phone: +55 15 3238 3870
Fax: +55 15 3238 3938

EUROPE | MIDDLE EAST | AFRICA

ENGLAND
Apex Tool Group GmbH
C/O Spline Gauges
Piccadilly, Tamworth
Staffordshire B78 2ER
United Kingdom
Phone: +44 1827 8727 71
Fax: +44 1827 8741 28

FRANCE
Apex Tool Group SAS
25 Avenue Maurice Chevalier - ZI
77330 Ozoir-La-Ferrière
France
Phone: +33 1 64 43 22 00
Fax: +33 1 64 43 17 17

GERMANY
Apex Tool Group GmbH
Industriestraße 1
73463 Westhausen
Germany
Phone: +49 (0) 73 63 81 0
Fax: +49 (0) 73 63 81 222

HUNGARY
Apex Tool Group
Hungária Kft.
Platánfa u. 2
9027 Györ
Hungary
Phone: +36 96 66 1383
Fax: +36 96 66 1135

ASIA PACIFIC

AUSTRALIA
Apex Tool Group
519 Nurigong Street, Albury
NSW 2640
Australia
Phone: +61 2 6058 0300

CHINA
Apex Power Tool Trading (Shanghai) Co., Ltd.
2nd Floor, Area C
177 Bi Bo Road
Pu Dong New Area, Shanghai
China 201203 P.R.C.
Phone: +86 21 60880320
Fax: +86 21 60880298

INDIA
Apex Power Tool India Private Limited
Gala No. 1, Plot No. 5
S. No. 234, 235 & 245
Indialand Global Industrial Park
Taluka-Mulsi, Phase I
Hinjawadi, Pune 411057
Maharashtra, India
Phone: +91 020 66761111

JAPAN
Apex Tool Group Japan
Korin-Kaikan 5F,
3-6-23 Shibakoen, Minato-Ku,
Tokyo 105-0011, JAPAN
Phone: +81-3-6450-1840
Fax: +81-3-6450-1841

KOREA
Apex Tool Group Korea
#1503, Hibrand Living Bldg.,
215 Yangjae-dong,
Seocho-gu, Seoul 137-924,
Korea
Phone: +82-2-2155-0250
Fax: +82-2-2155-0252

Cleco®
Production Tools

Apex Tool Group, LLC
Phone: +1 (800) 845-5629
Phone: +1 (919) 387-0099
Fax: +1 (803) 358-7681
www.ClecoTools.com
www.ClecoTools.de