STRAIGHTSIDE PRESSES

Straightside presses are named because of the vertical columns or uprights on either side of the machine. The columns together with the bed and crown form a rigid box-like housing.

Straightside Press Advantages

A major advantage of the straightside press compared to the gap-frame machine is freedom from angular misalignment under load. Maintaining true vertical motion throughout the press stroke is critical to minimize tool wear and obtain accurate part tolerances.

Production of Precision Stampings

Many high-volume close-tolerance stampings are made in straightside presses. These include electrical connectors, snap-top beverage cans, spin-on oil filter cartridge bases and refrigeration compressor housings. Tiny computer connectors are stamped at press speeds up to 1,800 strokes per minute (SPM) or more. Often two to eight or more parts are completed per hit.

Precision stampings are also produced at low speeds. For example, large refrigeration compressor housings may be stamped at press speeds of approximately 12 SPM. The housing consists of two mating halves, which must fit together precisely in order to properly align the internal parts.

All of these stampings have several common factors including:

1. Zero defects—a goal that must be approached or attained.

2. All variables must be minimized.

3. Defective stampings may result in product failures.

Examples of High Force Capacity and Large Bed Sizes

Straightside presses are available in very high force capacities. Mechanical presses are built with force capacities through 6,000 tons (53.4 mN) or more.

One of the largest single-slide straightside mechanical presses in the world is a USI-Clearing 6,000 Ton machine. The bed is 66-inches (1.68 M) wide by 494-inches (over 41 feet or 12.55 M) long. It was built in Chicago in 1968, and transported to Cleveland, Ohio disassembled.

This very large straightside mechanical press is in daily use at Midland Steel Products producing truck frame rails from high-strength steel. In some cases, the left and right rails are formed in a single hit from two blanks. The frames are used for semi-tractors, medium trucks and recreational vehicles.

Force capacities of 50,000 tons (445 MN) or more are available in hydraulic straightside presses. The very large hydraulic machines are used in warm and cold forging applications as well as various rubber-pad and fluid cell forming processes.

Mechanical versus Hydraulic Straightside Presses

Increasingly, both single and double-action hydraulic presses are used for forming large irregularly shaped parts for the automotive and appliance industries. An advantage for deeply formed or drawn parts is that full force is available anywhere in the press stroke.

Force Derating Curves for Six Different Presses

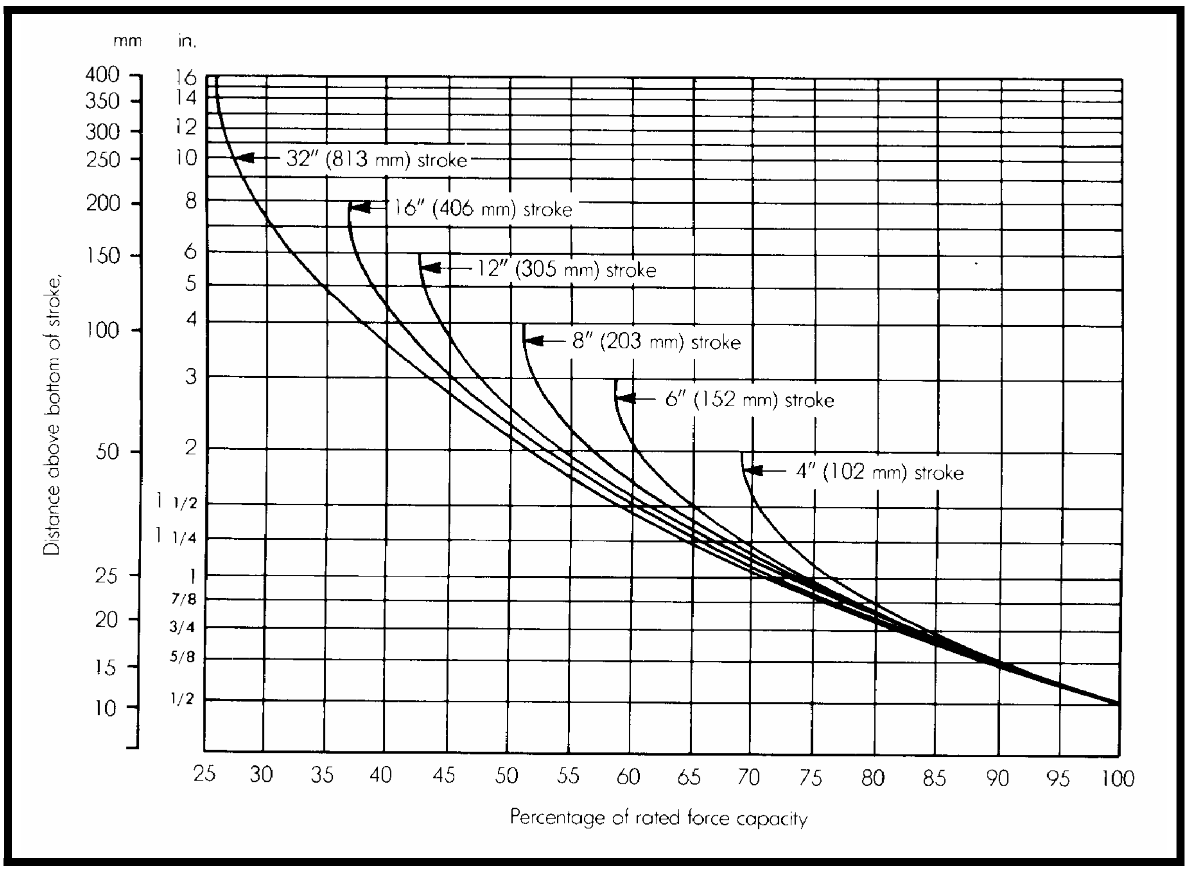

Figure 1. Percentage of force capacity for straightside presses at various distances above bottom of stroke. *Danly Machine Corp.*

Mechanical presses have the full rated force available only very near the bottom of the stroke. A chart giving distance from bottom of stroke versus available force called a force curve. The curves for six different mechanical presses are shown in Figure 1. [1]

Repair costs due to abuse and/or poor maintenance practices are high for both mechanical and hydraulic presses. Mechanical presses have an advantage of lower mechanical losses or energy consumption in most applications. An important feature available in mechanical presses is a hydraulic overload system which limits the force the press can deliver to a preset value. An example of this feature is illustrated in Figure 2.

Press Slide showing Hydraulic Overload System

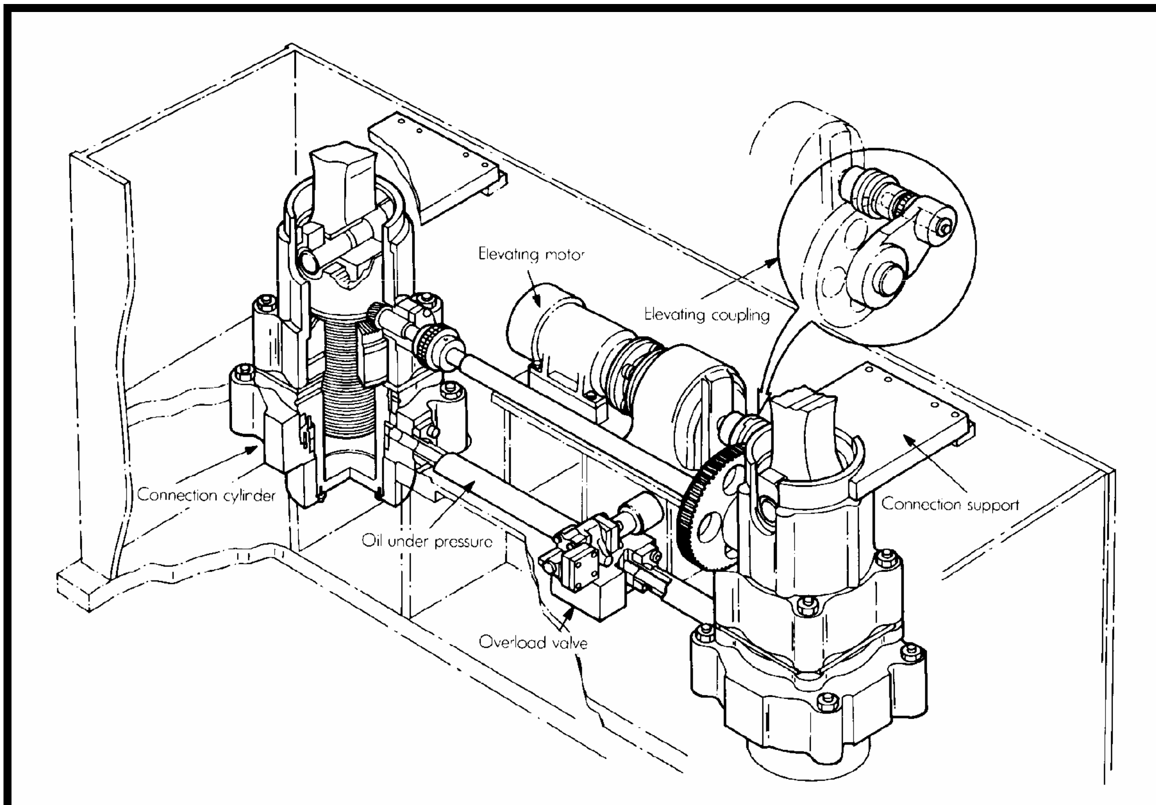

Figure 2. Precharged hydraulic cylinders under each connection provide fast acting easily reset overload protection. *Verson Corporation*

[1] C. Wick, J. T. Benedict, R. F. Veilleux, ***"Tool and Manufacturing Engineers Handbook"*** Volume 2 Fourth Edition - Forming, Chapter 5, The Society of Manufacturing Engineers, Dearborn, Michigan © 1984. This volume of the SME handbook series is highly recommended as a reference source for information on most types of forming technologies.

Hydraulic Overload protection

Hydraulic presses limit overloading by restricting the maximum pressure supplied to the actuating cylinder(s). Overload protection for mechanical presses can be provided by placing a hydraulic overload cylinder in series with the force delivered to each connection as shown in Figure 2.

When a preset maximum limit is exceeded, an overload valve dumps the precharged oil from the overload cylinders, and trips a limit switch, stopping the press. The cause of the overload condition is first corrected, and the overload system recharged by actuating a key locked switch. Such systems can accommodate maximum shut height errors of approximately 0.75-inch (19 mm).

Shear Collar Bellville Washer and Stretch Link Overload Protection

Other types of press overload devices include shear collars, bellville washers, shear pins and stretch links. These devices are simple and low in cost. Shear collars and bellville washer stack overload devices are placed under the connection in place of the hydraulic overload cylinders shown in Figure 2. Stretch links are installed in the pull rods of underdriven presses. However, there are several major problems with this type of overload protection. These include:

1. The failure point of the metal fracture link type overload devices is uncertain and the force required change with repeated cycling of the machine at forces near the fracture point.

2. The occurrence of a failure of these devices may not be immediately detected. This may result in a slide out of level condition that can score the press gibbing, damage the die and result in the production of poor quality stampings.

3. With the exception of the bellville washer type of overload device, the machine must be shut down and the failed part replaced. This results in unscheduled maintenance and production delays that are normally unacceptable.

Tie-Rods Limit Machine Overloading

Most, but not all straightside presses employ tie-rod construction. The rods hold the press housing in compression. They provide a means to move large presses in sections. Should the press become stuck on bottom they can be heated to relieve the pre-stress. The rods also limit press overloading.

As long as the press columns are maintained in a pre-loaded condition by the tie-rods, the deflection in the die-space occurs at a linear rate as a function of increasing tonnage. However, once an overload condition exceeds the tie-rod pre-load, the crown lifts off the press column. Once crown lifting occurs, press stiffness is greatly decreased, limiting overloading, as illustrated in Figure 3.

Tie-Rod Press Construction Limits Overload Damage

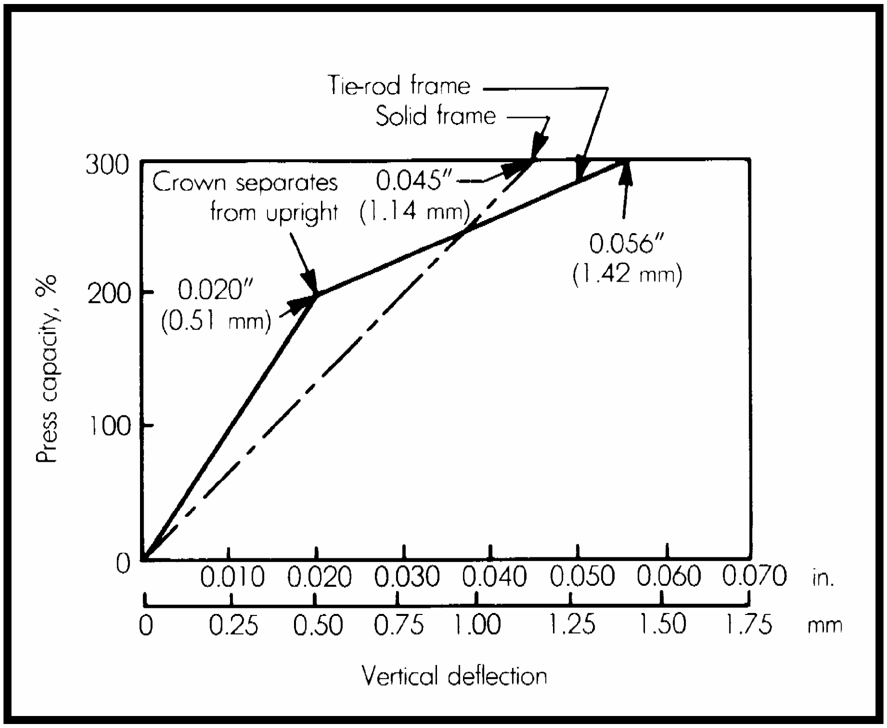

Figure 3. Typical deflection curves for straightside presses with solid frames and tie-rod frames.

Some press builders supply straight-side machines that do not have tie-rods. In some cases, this type of construction employs steel plate uprights that are keyed and bolted to the crown and bed as a way to lower press construction cost. In addition, some high-speed presses are made with one-piece cast gray or ductile iron frames in order to insure precision alignment and excellent vibration damping capacity. Should presses not having tie-rods be purchased, it is wise to specify some form of overload protection. A hydraulic overload system is especially recommended in such cases.

Press Slide Connections

A mechanical press connection is the point of attachment of the pitman or eccentric strap to the slide. Ball and socket type bearings are a very old design frequently used in smaller machines. The connection bearing shown in Figure 2 is another well-proven design. It has both a bronze-lined saddle-type bearing and a wrist pin to transmit force to the slide.

Connection Strength

The connection is designed to transmit large compressive forces to the slide. If subjected to an extreme overload, the ball and socket type may be damaged by a crack or deformation of the socket. Large overloads may extrude the bronze bearing material out of saddle-type bearings and the wrist pin bent or broken.

Single Action Straightside Eccentric Gear Driven Press

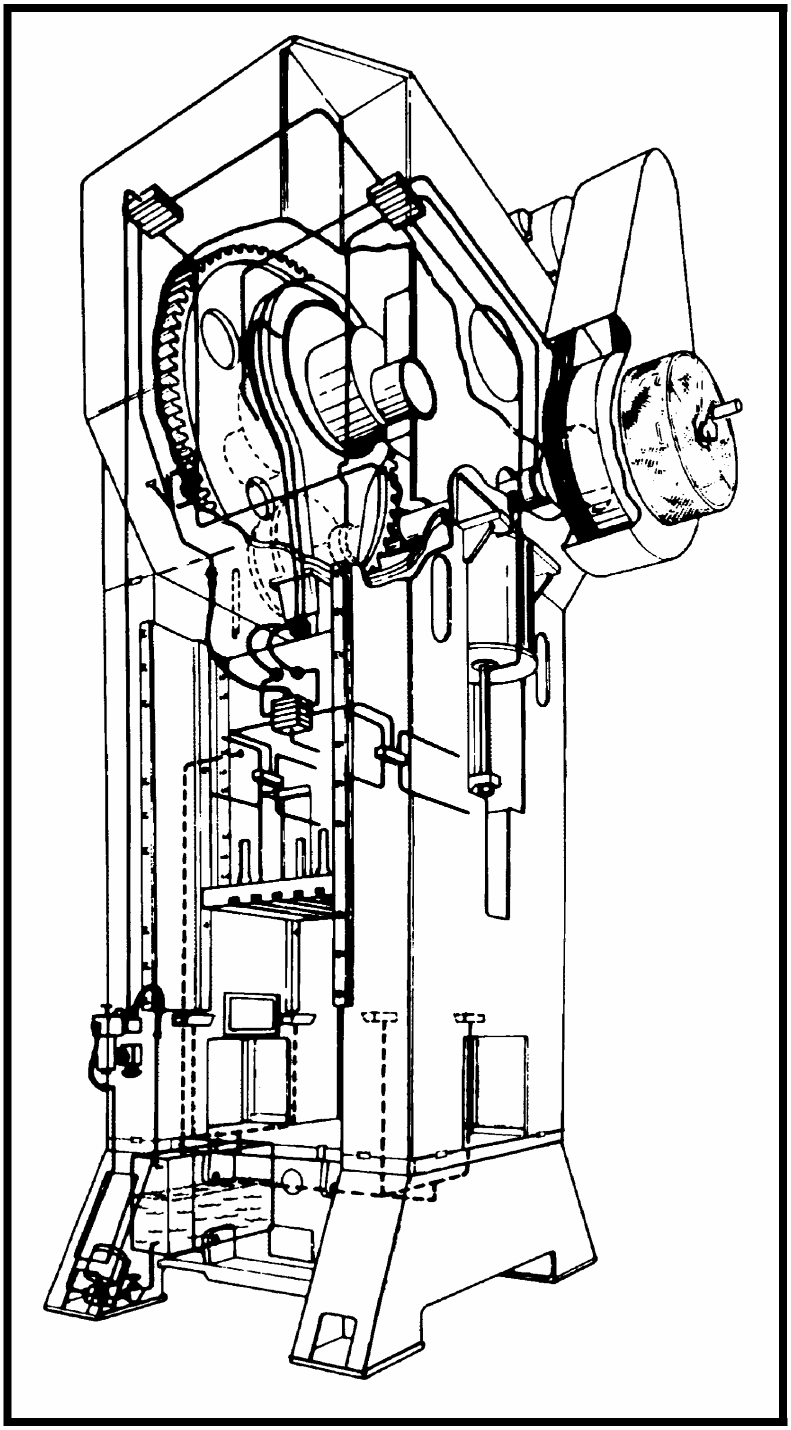

Figure 4. An example of a single-action, straightside, eccentric drive mechanical press designed for high force capacity and full tonnage available high in the stroke. Note the cascade lubrication system and double reduction gears in the press crown. *Verson Corporation*

Connection damage is most likely to occur due to excessive stripping or reverse loads. Generally, the connection is designed to withstand reverse loads of only 10% of machine force capacity although some presses are designed got higher stripping forces. Reverse loads are concentrated on the wrist pin or ball connection retaining ring screws. Failure of these parts is frequently the result of excessive snap-through forces in blanking operations. [2] [3] [4] [5]

Slide Adjustment

The connection may incorporate a screw adjustment mechanism. Larger machines have an electrically or pneumatically powered adjustment screw drive. Normally a mechanical brake in the motor automatically engages to hold the adjustment in place. In the case of presses having multiple connections, a single motor is used in conjunction with shafts, bevel gears and flexible couplings, to drive all adjustment screws in synchronism. This is illustrated in Figure 2.

Single Connection Presses

Straightside presses with single connections often are built to provide very high force capacities in a machine having a relatively small bed size. Figure 4 illustrates a high tonnage single-action, straightside, eccentric-type mechanical press.

The gear train is of the double reduction type. A large gear on either side drives the eccentric. This type of machine is very useful for heavy forming, as well as both warm and cold forging work. The double-geared eccentric is capable of transmitting a great amount of torque. Presses of this type are capable of developing full tonnage relatively high in the press stroke. This factor makes them very useful for closed die forging work. Another important application is forming and back extrusion work in munitions productions.

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[2] D. Smith, ***"Die Design Handbook,"*** Section 4, Shear action in Metal Cutting, The Society of Manufacturing Engineers, Dearborn, Michigan, 1990. This material contains both a procedural approach and mathematical analysis of the snap-through energy problem.

[3] D. Smith, ***"Using Waveform Signature Analysis to Reduce Snap-Through Energy",*** SME Technical Report MF90-11, Society of Manufacturing Engineers, Dearborn, Michigan, © 1990. This report contains a case study of how a severe snap-through energy release problem was solved at Webster Industries in Tiffin, Ohio. Waveform signature analysis of tonnage meter strain gage data was used to apply the theory contained in reference two. The strain sensors on all presses were reinstalled in order to obtain valid waveform data. The theory and practical application of tonnage meter strain sensors is covered in detail.

[4] D. Reid, ***"Fundamentals of Tool Design",*** Third Edition, Chapter seven: "Design of Pressworking Tools", The Society of Manufacturing Engineers, Dearborn, Michigan, © 1991. This source has the mathematical treatment of reference two and before and after improvement waveform examples from reference

[5] D. Smith, ***"Quick Die Change",*** Chapter 29, Control the Process with Waveform Signature Analysis, the Society of Manufacturing Engineers, Dearborn, Michigan, © 1991. This reference source contains a slightly condensed version of reference three.

Heavy welded plate construction and a narrow bed and slide result in low frame and bed deflection. A press of this type is ideal for blanking work involving thick high-strength materials. Very stiff machines, with bed sizes no larger than necessary, are subject to much less snap-through energy release than presses with bed sizes that are much wider than necessary for the application.

In order to avoid ram-tipping problems, the load must be carefully centered. While this is always very important, it is especially necessary in single point presses. Keeping the load centered minimizes the pressure on the gibbing and lessens die wear.

Electrical Controls on a Two Point Straightside Press

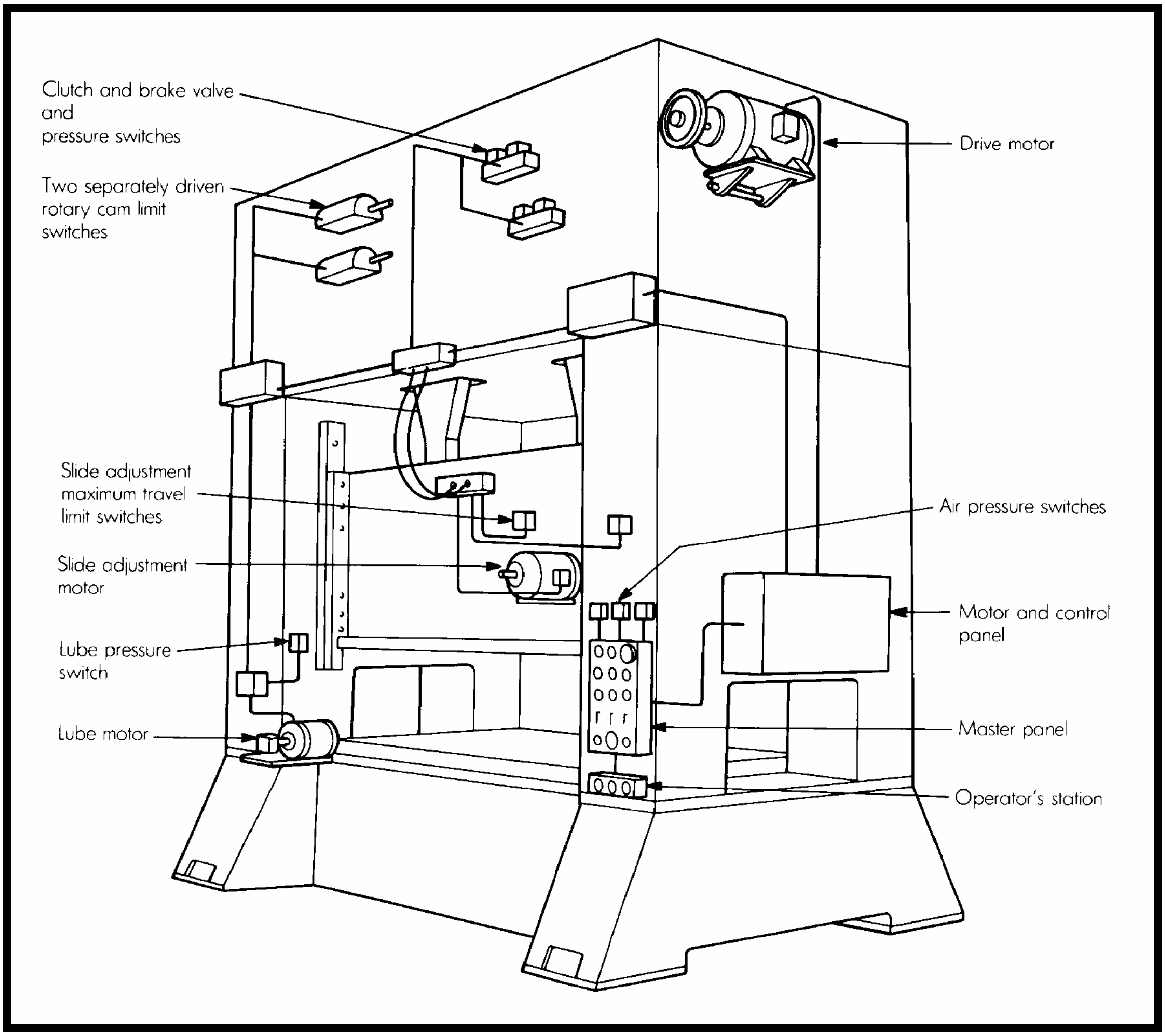

Figure 5. A two-point eccentric-driven straightside press with the electrical control components illustrated. *Verson Corporation*

Two Point presses

Both crankshaft and eccentric driven straightside presses with two connection points are in very widespread use. Ram parallelism and front to back alignment is provided by the gibs together with the two connections. The slide shown in Figure 2 has two connections that are driven by gear-actuated eccentrics.

Two point presses are guided by the correct adjustment of the pitman straps from left to right. Some front-to-back guiding of the slide is provided by the saddle bearing and wrist pin type connection. However, the gibbing provides the majority of the front-to-back guiding. Again, it is important to center the load especially from front-to-back.

Figure 5 illustrates a two-point eccentric-driven straightside press. Typical electrical control components needed to power and control the machine are shown. Note that the rotary cam switches are separately driven. This adds an extra measure of safety in addition to chain breakage monitors.

Eccentric Drive for Two and Four Point Presses

Double or quadruple gear driven eccentrics normally rotate in opposite directions to aid in slide guiding and avoid lateral thrust. This feature is found in most two and four point presses, which are top-driven by eccentrics.

The timing of the gearing from the left to right side of all presses press is critical. Couplings are provided on the shaft driven by the clutch which are either adjustable or may be fitted with offset keys.

Advantages of Underdrive presses

Most underdrive presses in North America installed in the large automotive stamping plants built in the post WWII industrial expansion period. The main feature, compared to a top drive machine, is that a lighter housing and no tie rods are required. The housing serves to guide the slide contain control equipment and the counterbalance system.

Less ceiling height is required since clearance is not needed for the drive components. However, a deep basement is needed. A basement or press pit is often required for the efficient removal of scrap, so this may not be a disadvantage.

Underdrive presses are built with single, double and triple actions. The triple-action machine is not advised for new construction. Good product design practices have eliminated the need for the third action in nearly all current die designs. If a third action is required, the press is much more complex because a toggle dwell action is needed for the inner slide. This adds greatly to the cost of the machine. In addition, the dwell time adds approximately an additional second to the machine cycle time.

Four-point Underdrive Straightside Press

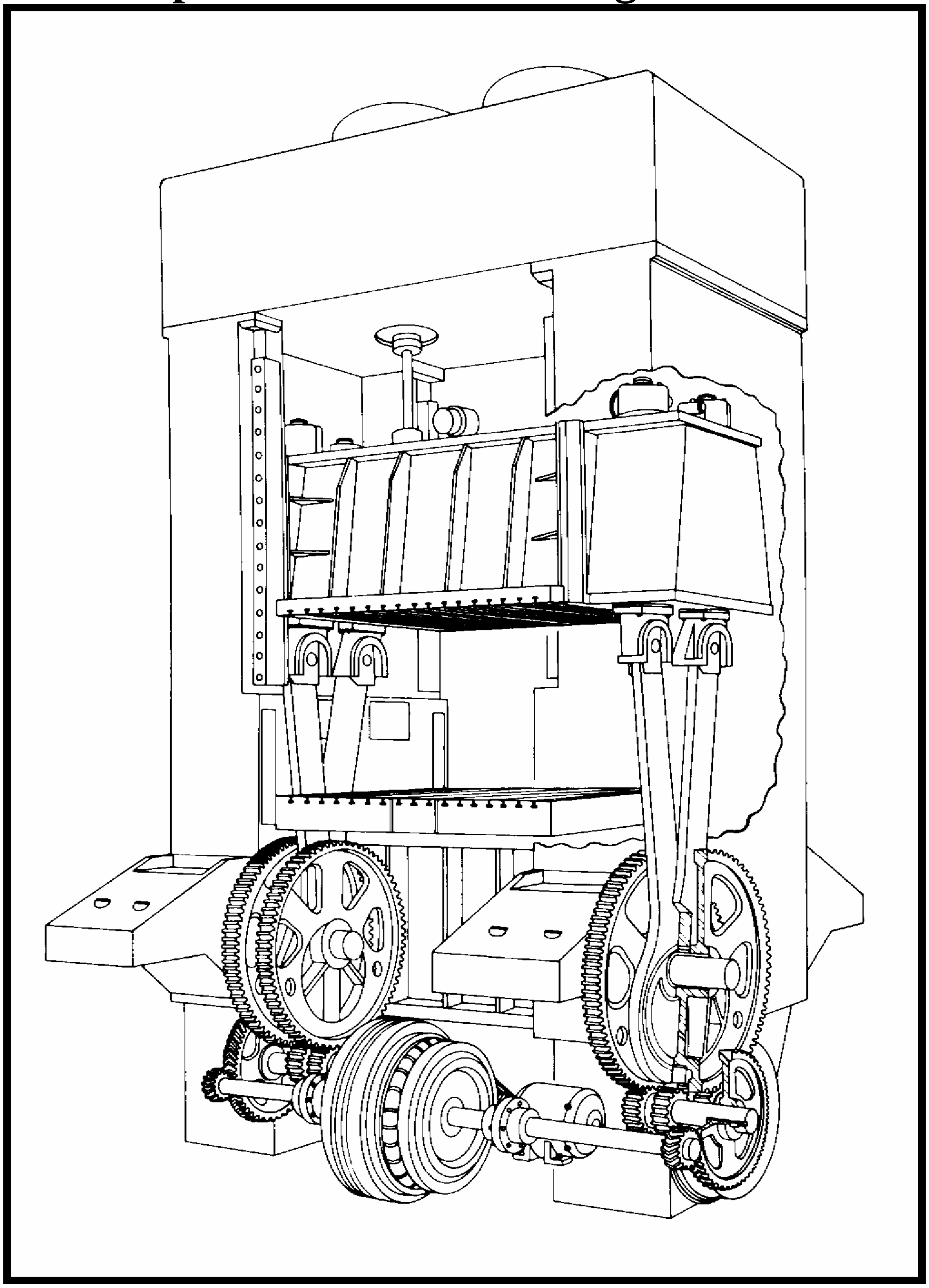

Figure 6. Four-point underdrive straightside press. Presses of this type are still in widespread use for producing automotive body panel stamping. [6] *USI-Clearing*

[6] D. Smith, ***"Die Design Handbook",*** Section 13, Dies for Large and Irregular Shapes, The Society of Manufacturing Engineers, Dearborn, Michigan, © 1990. Also, see section 27, Press Data. The mechanical triple action drawing press is essentially obsolete for automotive and appliance sheet metal forming applications. However, specialized multiple action hydraulic presses are used to accomplish difficult deep drawn parts in a single operation.

Air Piping, Tanks and Controls on a Straightside Press

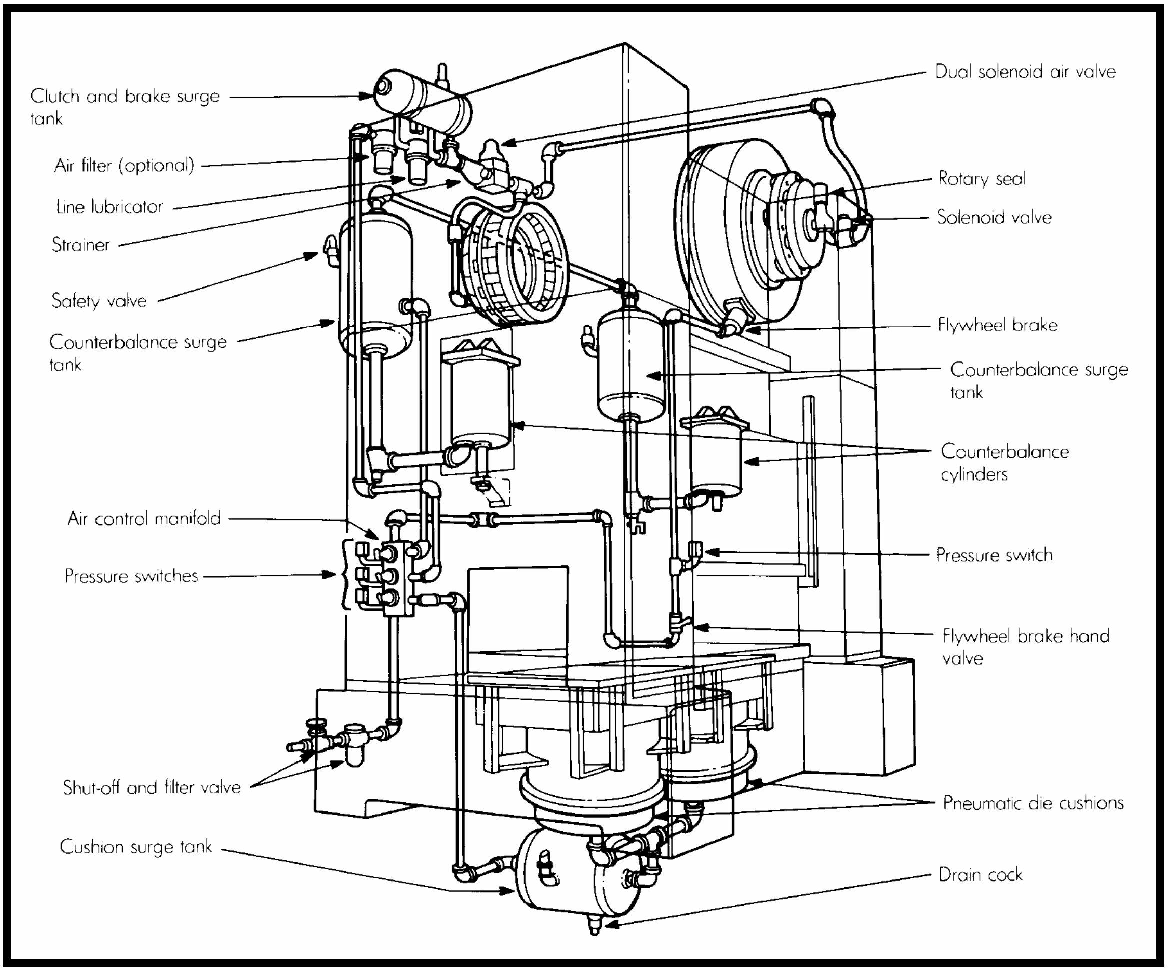

Figure 7. Pneumatic piping tanks, and controls installed on a straightside press.
Verson Corporation

Placement of Pneumatic Controls

Figure 7 illustrates the placement of pneumatic piping tanks, and controls for a typical straightside press. The system is typical of a good pneumatic arrangement for a press equipped with an air-actuated friction clutch and die cushions.

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