PRESS COUNTERBALANCE ADJUSTMENT AND MAINTENANCE

Press slide counterbalance systems are used on all but the smallest presses. The correct adjustment of the press counterbalance is required for safe operation. The purpose of the press counterbalance system is to offset or *counter-balance* the weight of the press slide and upper die.

Both air and mechanical spring counterbalance systems are used. Air counterbalance systems are much more popular because:

1. They are easily adjusted;

2. Have large counterbalancing capacity; and

3. Have nearly constant counterbalancing action at any stroke position.

Correct Air Counterbalance Pressure

If the air pressure setting is too high, excessive clutch wear can result. Low settings may cause excessive brake wear and can cause the brake to dangerously overheat. Safe operation requires that the counterbalance have enough capacity to hold the slide, the upper die and its attachments at any point in the stroke without the brake applied.

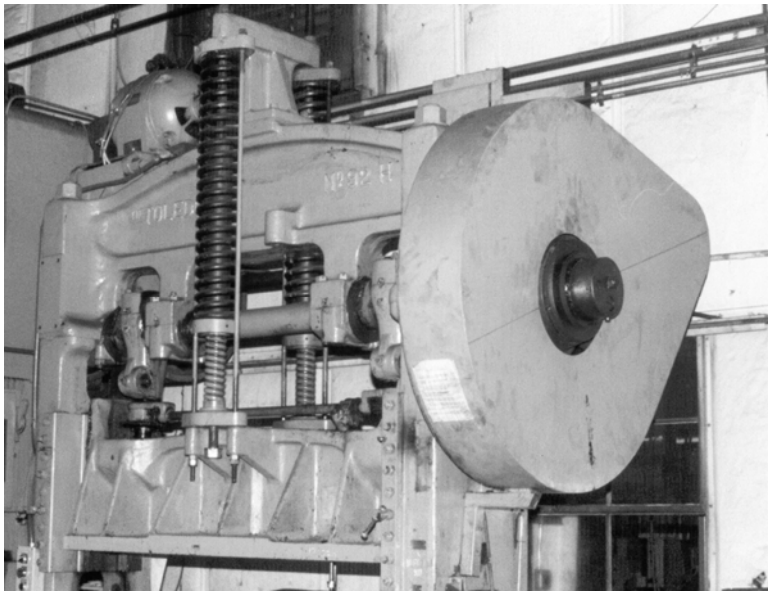

Figure 1. A spring counterbalance installed on a straightside press. Spring counterbalances must have the capability to hold the slide and its attached load at midstroke, without the brake applied. *Smith & Associates*

Spring Counterbalances

Figure 1 shows a spring counterbalance installed on a straightside press. Like the air counterbalance, the spring counterbalance must be properly adjusted. Correct adjustment is determined by making sure that it will hold the slide, and upper die at the 90-degree position on the downstroke with the clutch and brake released.

> ***From United States Federal OSHA in part: …Spring counterbalance systems when used shall incorporate means to retain system parts in event of breakage… Spring counterbalances when used shall have the capability to hold the slide and its attachments at midstroke, without brake applied...***

Air Counterbalance Safe Construction Features

Both the spring and air type counterbalances must have a means to retain machine parts in the event of a failure. This is addressed in United States Federal OSHA:

> ***…Air counterbalance cylinders shall incorporate means to retain the piston and rod in case of breakage or loosening. …Air counterbalance cylinders shall have adequate capability to hold the slide and its attachments at any point in stroke, without brake applied. …Air counterbalance cylinders shall incorporate means to prevent failure of capability (sudden loss of pressure) in event of air supply failure.***

Air controlling equipment protection is also defined in OSHA:

> ***…Air controlling equipment shall be protected against foreign material and water entering the pneumatic system of the press… A means of air lubrication shall be provided when needed…***

Other common sense requirements that apply to air counterbalances include:

1. A pressure switch to prevent machine operation with insufficient air pressure to counterbalance the slide without a die attached.

2. A check valve to prevent sudden loss of pressure in the event of a sudden air supply failure.

3. The surge tank(s) are pressure vessels, which must be certified and tested in the United States in accordance with the American Societies of Mechanical Engineers ASME applicable pressure vessel code.

Air Counterbalance Function

Air counterbalances are air cylinders mounted to the press housing and connected to the press slide. The cylinder rod may be directly threaded into the slide or attached by clevis or an L-bracket.

The minimum air pressure required in the counterbalance cylinders is that required to counterbalance slide without a die in the press. This permits the press to be inched for maintenance and to allow the diesetter to measure and adjust the shut height.

It is important to run the slide adjustment motor with the correct amount of air. This will avoid overloading the slide adjustment motor and mechanism. Abuse of the slide adjustment motor and drive can cause expensive press damage.

When the die is set and bolted or clamped to the slide, the counterbalance air pressure must be increased to compensate for this added weight. As a rule, the slide air pressure is adjusted several pounds per square inch (PSI) higher than the amount required to obtain an exact balance. This aids in maintaining constant gear tooth contact and to take up bearing clearances. Correct Air counterbalance adjustment aids in the overall performance of a press as follows:

1. By counterbalancing the weight in the slide, the upper die and press linkage that are attached to the slide;

2. By taking-up bearing clearances before the die closes;

3. Assisting in stopping the press by minimizing the load applied to the brake;

4. Minimizing the load applied to the clutch to start the press into motion; and

5. By helping to maintain constant gear tooth contact by taking-up the clearance that is necessary for proper gear functioning.

Counterbalance System Components

Figure 2 shows the major components that make up a mechanical press counterbalance system. The main component is the pneumatic cylinder (D1) the piston rod of which attaches to and counterbalances the weight of the slide and upper die (not shown). Some presses have two or more cylinders. Double-action presses have separate counterbalance systems for each slide.

A pressure gauge (D2) and adjustable air regulator (D3) are provided on the press to permit accurate adjustment to the correct setting. Some presses may have regulators that are of the self-relieving type, in that they automatically bleed excess air when the pressure setting is lowered. Self-relieving regulators should have the pressure adjustment raised slightly until air is heard being admitted to the system after bleeding the pressure to a lower value. Bleeding the system can be speeded-up by opening the blow-down valve (D4).

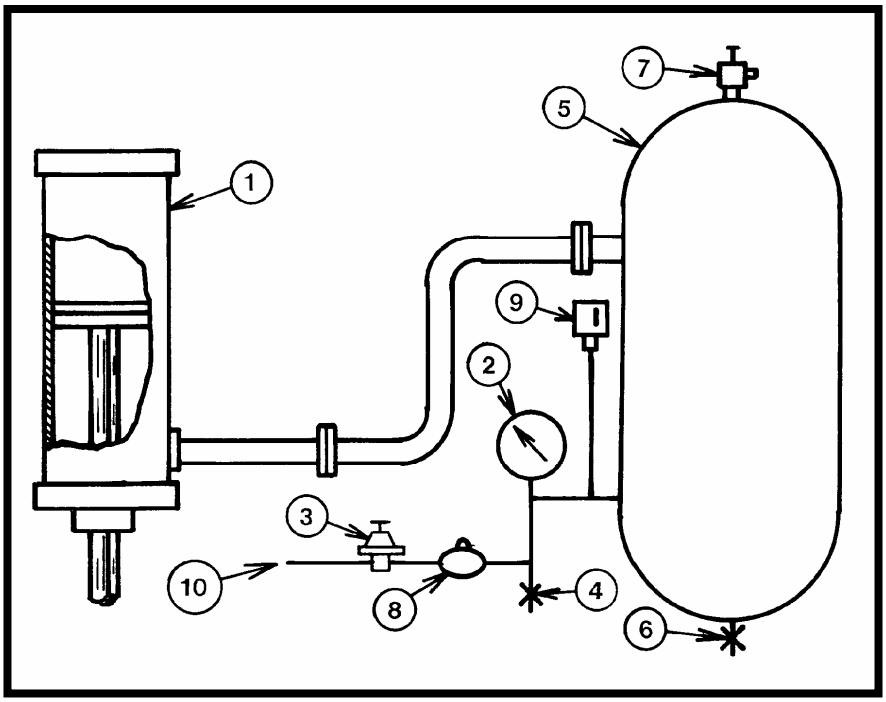

Figure 2. Diagram of a typical mechanical press counterbalance system: (D1) counterbalance cylinder with a piston rod that attaches to the press slide (not shown); (D2) pressure gauge; (D3) pressure regulator; (D4) blow-down valve; (D5) surge tank; (D6) water drain valve; (D7) safety pop-off valve; (D8) check valve; (D9) low air pressure switch; (D10) shop air inlet.

A valve is also required to prevent a sudden loss of pressure from the counterbalance system. This is the function of check valve (D8). In addition, a pressure actuated switch (D9) is included to open the main motor run circuit in the event that the pressure falls below a minimum value specified by the press manufacturer. This is required to insure the press will not run without enough air to balance the slide alone.

The pressure switch **MUST** never be adjusted below the required minimum setting specified by the manufacturer or bypassed with a jumper wire. If the correct counterbalance pressure cannot be maintained, erratic press operation may result. Several likely causes include:

1. Low shop air pressure;

2. Excessive leakage caused by work counterbalance rod or piston packing; and

3. An air leak caused by a loose pipe union or bolted flange joint.

It is false economy to make temporary repairs to a badly leaking counterbalance system by running one or more extra air hoses to the press. It is difficult to regulate the correct

pressure at the cylinder if this is done. In addition, such leaks can easily cost thousands of dollars each year in wasted air. The correct procedure is to repair the leak(s).

Retention of Counterbalance Parts

Should a counterbalance piston rod become detached from the slide or piston, the piston and rod can easily blow the cover plate off the top of the cylinder on some older presses. Often, these press parts will be propelled through the plant roof, making a second hole on the way down. For this reason, safety rules require that presses incorporate a means to retain counterbalance parts in the event that a component breaks or loosens. The press manufacturer should be consulted to find out if their older presses meet this requirement. If not, the manufacturer should cooperate in supplying the correct design for the required modifications. Badly designed add-on retaining devices can become airborne, endangering workers.

Good periodic maintenance inspections should include a check of the attachment of the piston rod to the slide. During a press overhaul, the rod ends should be checked for stress cracks with die penetrant or magnetic particle inspection. Some older presses are especially prone to this type of failure.

Example of Good Counterbalance Attachment

Figure 3 illustrates an example of a counterbalance cylinder attached to the side of the press frame and slide. The surge tank, piping regulator and other pneumatic components are also shown. This method has several advantages compared to mounting the cylinder on the top of large machines. First, it is readily accessible for inspection and maintenance. The design is robust and compact. The cylinders do protrude from the top of the machine. The clevis and pin attachment for the cylinder together with the cylinder rod attachment to the slide by means of an L-bracket assures retention of parts in the unlikely event of detachment. [1]

The Surge Tank is a ASME Pressure Vessel

OSHA provides that the surge tank(s) are Pressure vessels as follows: …All pressure vessels used in conjunction with power presses shall conform to the American Society of Mechanical Engineers Code for Pressure Vessels, 1968 Edition, which is incorporated by reference as specified in Sec. 1910.6.

[1] C. Wick, J. T. Benedict, R. F. Veilleux, "Tool and Manufacturing Engineers Handbook" Volume 2 Fourth Edition, pages 5-35 to 5-37, The Society of Manufacturing Engineers, Dearborn, Michigan 1984.

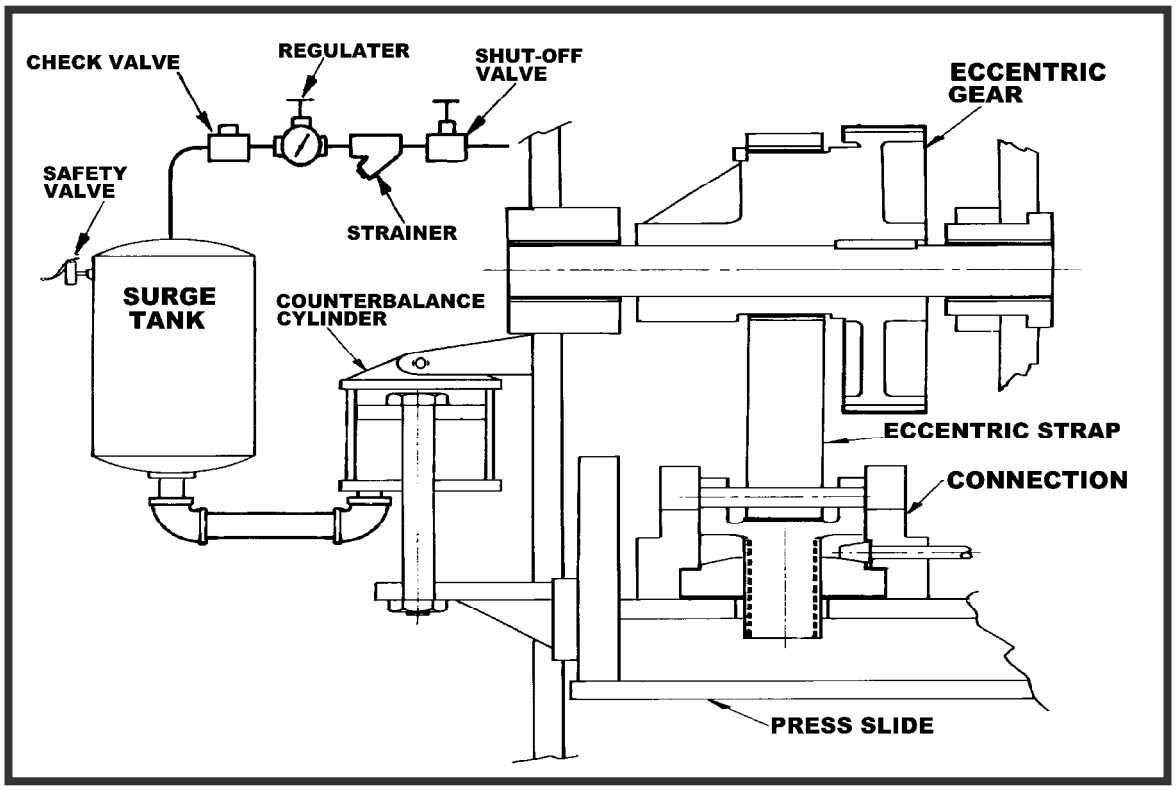

Figure 3. An example of a counterbalance cylinder attached to the side of the press frame and slide: this method is preferred to top mounting the cylinders.
Verson Corporation.

Setting Correct Counterbalance Pressure

Setting the counterbalance pressure to a value that will correctly counterbalance the weight of the slide and its attachments (upper die, risers, parallels, etc.) is generally the most certain means of achieving the right setting rapidly. To do this, three things are required:

1. The weight of the upper die including any buildup is known and available to the diesetter. Stamped the upper die weight information on the upper die fulfills this requirement.

2. An accurate table of pressure settings for the upper die weight is available to the diesetter. Providing this information on a metal tag attached to the press is the preferred method followed by press manufacturers.

3. The pressure gauge used must be accurate. Periodic testing is advised.

Pressure Setting Charts

Most presses have a chart that gives the correct pressure setting for various upper die weights. If the information is missing, a chart of correct settings can be obtained from the manufacturer. If this is not possible, the information can be determined from piston area measurements and engineering calculations.

Clearly stamp the upper, lower and total die weight. This will aid safe die handling and counterbalance setting.

Stamping of Die Weights

United States Federal OSHA safety law requires that the information regarding upper die weight are made available to the diesetter when necessary for proper air counterbalance pressure adjustment. Stamping is the required method unless there is some foolproof system such as written instructions stating the upper die weight readily available to the diesetter.

Further, it is required that the total die weight be stamped if required to avoid overloading die handling equipment. The OSHA regulations specifically state "stamped" rather than marked or painted. There is always a danger that an incorrect figure may be re-painted on the die.

United States Federal OSHA provides tonnage, stroke and weight designation require all dies shall be:

> ***…Stamped with the tonnage and stroke requirements, or have these characteristics recorded if these records are readily available to the die setter. …Stamped to indicate upper die weight when necessary for air counterbalance pressure adjustment; and …Stamped to indicate complete die weight when handling equipment may become overloaded.***

Additional Benefits of Stamping Die Weights

Having the upper, total and lower die weights accurately and clearly stamped has many benefits that go beyond correct counterbalance settings. For example, if a die is sent out for work, the truck driver will need to know the weight. Many problems can be avoided if the facts need for safe die handling and transport are clearly stamped on the die.

Common Errors in Counterbalance Adjustment

Large presses have big surge tanks that may take a long time to fill. A common mistake is to make big change in the regulator setting when only a small change followed by a wait of several minutes to allow the system to stabilize is all that is needed. The diesetter should check the final setting for correct adjustment and stability before the dieset is considered complete.

Gage Accuracy

Inaccurate or missing gauges cause a common source of incorrect pressure settings. Press vibration and pressure pulsations can ruin the accuracy of a low-grade gauge in a short time.

To avoid this problem, it is highly recommended that a high-quality liquid filled gauge with a built-in pulsation snubber are used. Another helpful solution is to equip each press with a quick disconnect fitting and use a portable gauge of known accuracy. Special miniature diagnostic fitting are made for this purpose. The portable gauges should be checked against a master gauge periodically.

Automatic Pressure Adjustment

Some newer presses designed for quick die change feature automatic counterbalance adjustment based upon a computerized database of die numbers. In most cases, the correct pressure must still be determined and entered into the database. Failing to update the database and relying on manual adjustment after problems develop is an error to avoid.

Press controls based on programmable logic controllers and industrial computers for setting press operating parameters for each job number are highly reliable for setting counterbalance pressure. Provided the data and transducers are properly set and maintained, these systems have proven to be highly reliable.

Establishing Correct Counterbalance Settings

In the event that the information is missing, there are several procedures that may be used to establish the correct air pressure adjustment. It is very important that a system be in place to avoid trial and error adjustments not occur at every dieset. One way to avoid wasting time is to list the correct counterbalance pressure for the press and die combination in the diesetting instructions.

Using an Ammeter

Checking the drive motor current while the press is cycled is an accurate way to find the right air pressure setting. A reading that increases as the slide descends and drops sharply on the upstroke indicates that the pressure is too high. Amperage readings that are high on the upstroke and increase as the top of stroke is approached, indicates that the setting is too low.

When checking ammeter readings, one must consider the fact that the press motor must supply the energy lost by the flywheel as the press does work at the bottom of the stroke. A current surge is normal when that occurs.

Limitations on Using an Ammeter

Setting the counterbalance pressure with an ammeter is usable only at press speeds of 20 to 30 strokes per minute. In addition, in cases where the air pressure is very low, the weight of the slide and upper die can cause the motor to overspeed and act as a generator. Here, power is returned to the incoming line. An AC ammeter gives a positive reading without respect to the direction of current flow.

Using a Stroke per Minute (SPM) Meter

Tachometer SPM indicators that operate by measuring the RPM of the drive motor or flywheel can be used in place of an ammeter. If the press speeds up on the downstroke, the setting is too low. A loss of speed means the air pressure is too high.
Tachometer type SPM meters are more reliable than ammeters since they are not fooled by current regeneration. However, SPM meters that measure the time each stroke takes rather than actual speed throughout the stroke cannot be used for this purpose.

Counterbalance Adjustment with a Dial Indicator

The dial indicator method can be used to establish correct counterbalance pressure if the press counterbalance adjustment information is not available. To use this method:

1. Stop the press at 90 degrees on the downstroke,

2. Follow proper lockout safety procedure,

3. Place a dial indicator so the tip touches the slide,

4. Exhaust the air from the counterbalance to a value below that required to counterbalance the slide. Do not release the brake,

5. Slowly raise the counterbalance air pressure until the dial indicator shows that the counterbalance has lifted the slide; and

6. Finally, make a record of this setting so this procedure will not need to be repeated.

A quick check of counterbalance pressure can be made by stopping the press and motor at 90 degrees on the downstroke. The slide should remain stationary or drift up slightly when the inch buttons are used to release the brake. Not all press controls permit this check to be performed.

Either the dial indicator or brake release method at midstroke should be used if a chart of correct counterbalance air pressure for different upper die weights is to be developed. This method is also useful for double-checking to be sure that the data on a newly developed chart is accurate.

Developing Counterbalance Charts

A chart listing air pressure readings for different upper die weights can be developed should the one on the press be unreadable or missing. The data for each press is then experimentally determined using the methods discussed.

If a paper chart is used, the master copy in the office and a copy made as needed when the one placed at the press become soiled. It should be placed in a protective plastic sleeve and hung near the counterbalance adjustment regulator. It is preferable to enter the data in the press maintenance file and attach a stamped metal tag to the press.

Counterbalance Maintenance

Lubrication

Lube must be supplied to both the cylinder piston packing and the rod gland packing. Dry piston packing on large presses emits a characteristic sound best described as that of a cow mooing. If the problem is not corrected promptly, the packing will fail.

Lubrication is either supplied by a manual hand-pump or metered automatically. In each case, it is important to make sure that the correct lubricant is applied as needed. This must be part of the total preventive maintenance program.

The packing should give decades of service if properly lubricated. If the rod packing gland or piston packing are permitted to run dry for very long, the packing will fail and the rod, piston and cylinder body become scored. This will result in downtime and expensive repairs.

Draining of Water

Water will accumulate in the surge tank(s) and must be drained by a valve provided for that purpose. Otherwise, there will not be sufficient space in the surge tank and excessive pressures will result in erratic press operation. In some cases, the safety valve will open at the bottom each stroke, resulting in wasted compressed air.

The frequency of draining will depend upon the dryness of the air supply. Usually a weekly schedule is sufficient. Under conditions of high temperatures and humidity the compressed air dryer may be overloaded, and a daily schedule may be required.

Other System Components

OSHA rules also require that a means be provided to prevent a sudden loss of pressure from the counterbalance system. A check valve may be installed to serve this function. In addition, a pressure-actuated switch is included to open the main motor run circuit in the event that the pressure falls to too low a value. Tests should be conducted periodically to assure that each shut off device would shut off the main motor as intended. From United States OSHA:

…Air counterbalance cylinders shall incorporate means to prevent failure of capability (sudden loss of pressure) in event of air supply failure.

The piping must be periodically inspected for leaks. Pipe unions and the large bolted joints in the surge-tank piping often work loose from press vibration, especially if shock loads are experienced. Air leaks may result in system malfunctions. A leak that is loud enough to be heard is costing a great deal of money every year.

The shock and vibration associated with pressworking can cause flange fittings, pipe unions and fittings in general to loosen and leak. All press piping should be kept in good repair and inspected periodically for leaks. Often this is best done at night or on a weekend when production is not running. The main air valve to each press can be shut off and any pressure drop noted over a period of time.

NOTES: _____

NOTES: _____