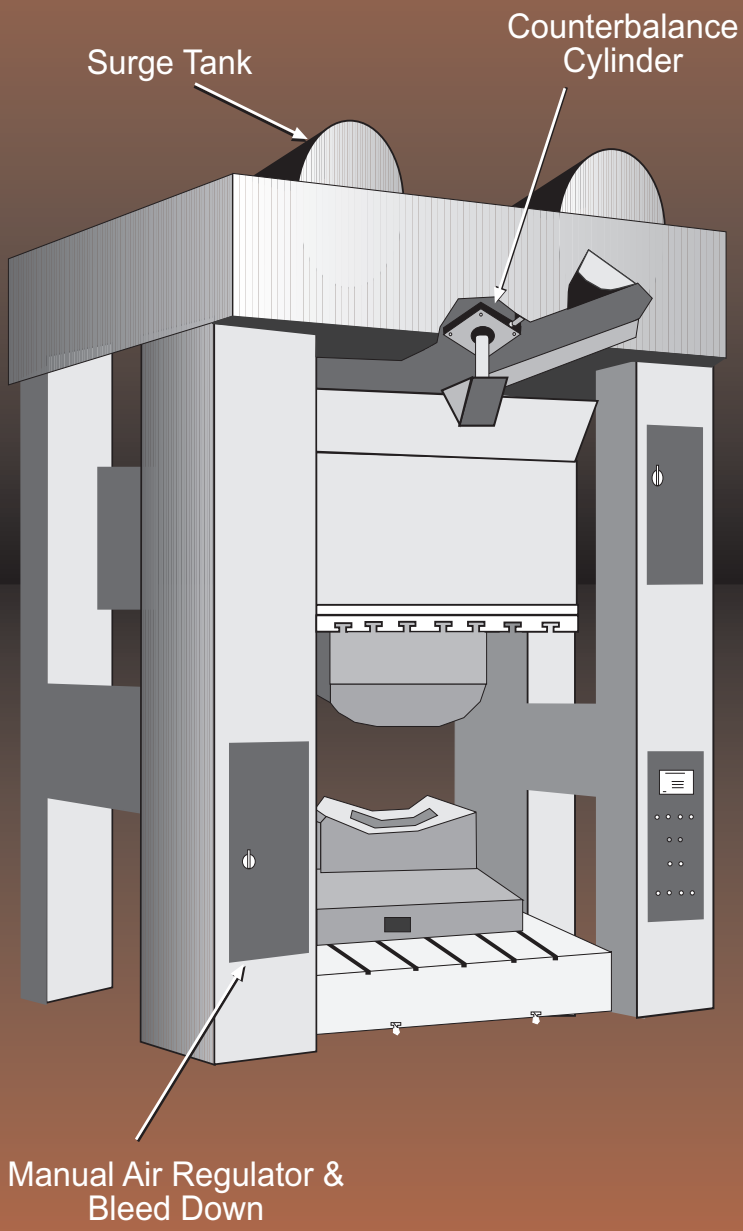
PRINCIPLES OF COUNTERBALANCE SYSTEMS

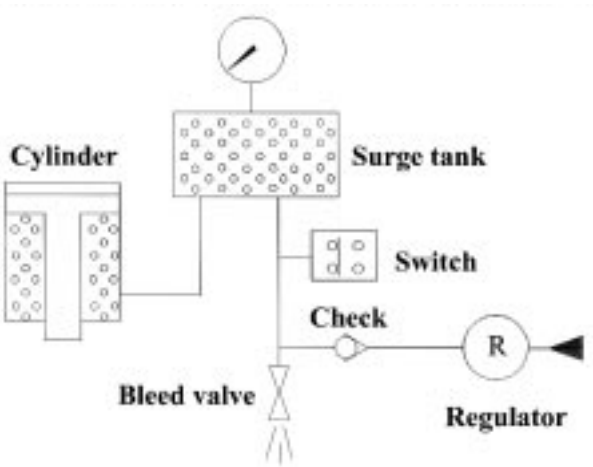


ROSS CONTROLS®

Counterbalance for Mechanical Stamping Presses

A counterbalance pneumatic system reduces gear and drive component damage that occurs from high force loadings when the press slide reverses direction after completing its work. The standard system includes two or more air cylinders attached between the slide and main frame, a pressure control regulator, a check valve, a surge tank, and a manual bleed off valve. The surge tank is used to store the air displaced from the cylinders, as it would be cost prohibitive to refill the system with every stroke of the press. The system acts like an adjustable spring. The regulator is used to set the pressure for the total weight of the slide plus the die. The press OEM provides a chart for setting the pressure for any given die weight. This setting is the pressure at the full ram up position (top dead center).

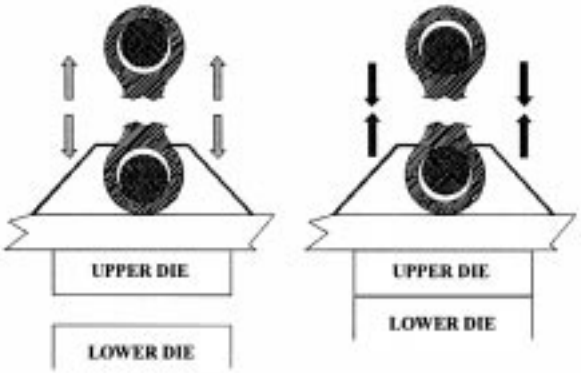
Standard Counterbalance System



Surveys show, however, that **95% of companies have their pressure set at maximum plant pressure or 80-90 psi and never adjust it !!!!** The press is powered by an electric motor driving a flywheel which stores energy, a crank shaft to convert rotary motion to lineal motion, and a clutch and brake to engage and disengage the electric drive while allowing the motor to run and the flywheel to turn.

Press position is given in degrees, which represents the position of the crankshaft during the press cycle. 0^0 is spoken of as TDC (top dead center) and 180^0 is where the work is done (bottom). As the crank moves from TDC to 180^0, we are in the downward stroke while $180^0 – 360^0$ is the upward stroke. During the downward stroke, the weight of the slide and die are acted on by gravity. This "pulls" them away from the press drive and puts the entire power transmission into "tension" opening up all the tolerances. When the upper and lower dies meet, the upper die decelerates until all of these openings close and the drive goes into "push." After this shock loading, the die is driven through the work and then immediately reversed to pull the die back up, putting the system back into tension.

Shock at die strike without counterbalances



Improper Counterbalance settings affect just about every area of the press performance. The "don't ever adjust it" program is one of the major causes for new die rework. The original die manufacturer designs the tooling to perform at a precise force and speed. When the new die is delivered to the customer and put into an unbalanced press, its performance is not as expected. This leads to corrective actions such as a grinding tool, shim, or phone call to the manufacturer to complain about part quality.

The underbalanced condition (low pressure setting) is very serious as it allows tremendous shock to occur during the reversal stage damaging the crank, bushing, bearing, and crown as well as letting the press lose parallelism between the dies. In addition, underbalanced pressure increases operating costs because of the heavier load that the electric motor has to lift back up.

Thus, the effects of the underbalanced condition can be:

- Die damage
- Lower than acceptable part rates and higher scrap costs
- Diminished safety as a result of the system "not being able to hold the load up" (required under OSHA 1910.217)

- Loss of parallelism between the upper and lower die surfaces
- Increased die wear
- Excessive gib wear
- C.B. cylinder packing wear

An overbalanced condition consumes a great amount of the energy in the flywheel. This can actually cause a "stuck press" condition where there is not sufficient energy remaining after the stamping work to overcome the die separation forces, reversal forces and the loading forces.

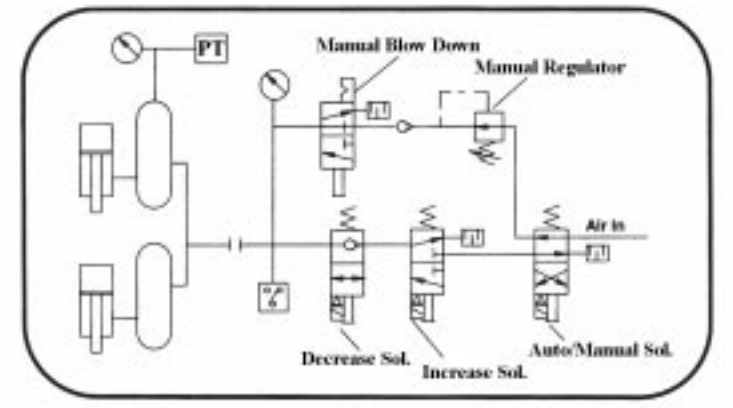
The effects of the overbalanced condition can be:

- Stuck Press Condition
- Damage to shut height equipment
- Loss of production due to tripping motor overloads
- Higher air consumption costs
- Excessive clutch and brake wear
- High maintenance costs from premature wear of the cranks, bearings and crown.
- Inconsistent die velocity
- Inaccurate stopping of the press
- Lower than acceptable part rates and higher scrap costs

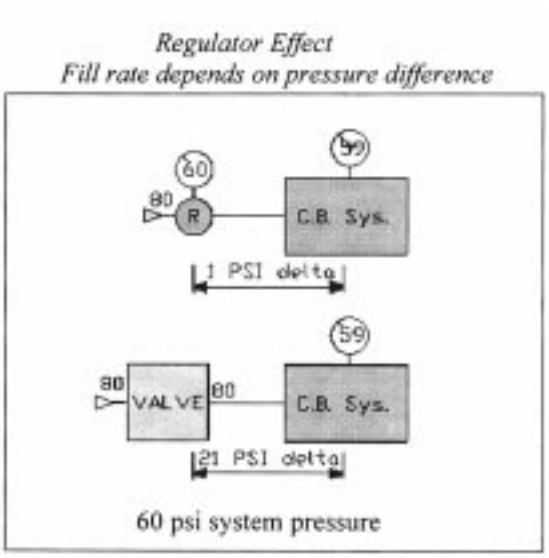
The ROSS Counterbalance system integrates modern air valve technology with electrical controls to monitor and maintain an appropriate counterbalance pressure. There are several ways to approach an A.C.B. (Automatic Counterbalance), depending upon the complexity of the setting input device. By definition, A.C.B. is a system that receives an input value for a particular die and then monitors and maintains the C.B. pressure automatically. In the simplest system, the operator manually inputs this value from a die/pressure table. In more sophisticated systems, this can be pre-loaded using a die "recipe" program. The operator inputs a die number during set up, or the system can even include a scanner to "read" the die number automatically, and then the set value is retrieved from the stored tables.

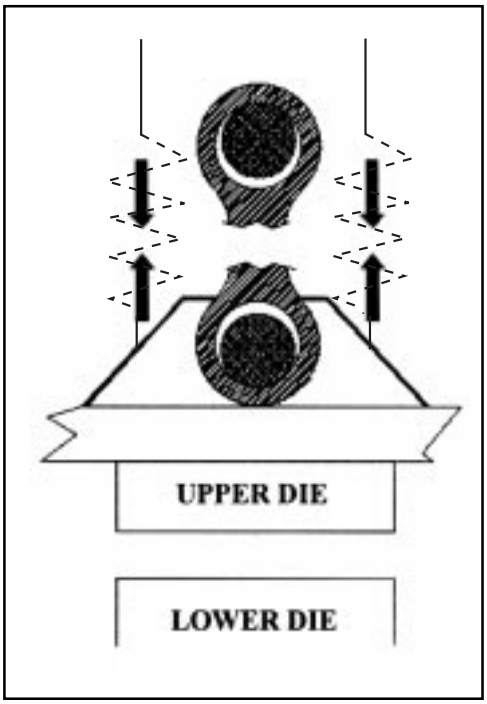
So, what is wrong with the equipment that came on the press? Nothing! But, it is a system with a number of minimal performance characteristics. First of all, it is desirable to correct the pressure as quickly as possible and to maintain the pressure deviation to a preset allowable tolerance window. The "standard" system does not do this. The recovery time to increase pressure is long due to the regulator effect; it has no way of decreasing pressure, should it be necessary.

The amount of air that can be pushed through the system depends on the difference in pressure. Since the regulator is set at the same pressure as the system, the minimal delta results in a very low flow rate. A counterbalance is a dynamic system, so the standard unit also "corrects" for any deviation. In addition, the standard system does not provide monitoring or pre-known acceptable tolerances, and the only alarm signal is when the "minimum" pressure is not available. In the world of ISO, monitoring and pre-engineered acceptable tolerances are becoming necessities.



The ROSS system takes readings at a pre-set window where the pre-engineered OEM values may be used as the setting pressure. This system also allows for the maximum amount of fill air per cycle due to the pressure not being regulated and a unique check valve design feature which eliminates the need to shut off the fill valve during the cycle, eliminating "back flushing." This important feature is often missed. Air is contained within the system for economic reasons, and the pressure rises as the press strokes because of the reduced volume. If the pressure exceeds the plant air pressure, the air reverse flows out of the press and into





Proper counterbalance (pre-compression effect)

the plant system. This requires that a standard valve be shut off at a predetermined point (minimizing the fill time). This point could be automatically determined by adding costly comparative circuitry. So, most other A.C.B. units using full flow designs preset the allowable fill window and "live with it." The ROSS system uses a special valve designed to provide the automatic shut off using the characteristics of air providing the largest fill window automatically.

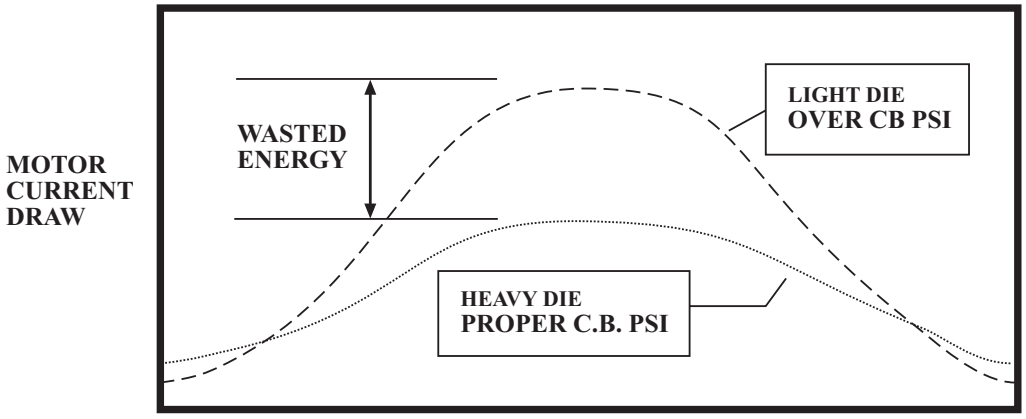
So what is the correct pressure? An acceptable overbalancing pressure is whatever pressure is necessary to maintain the mechanical tolerances of the press drive components in a closed state. This will provide ram parallelism, minimize wear, reduce strain on the press, reduce operating costs and enhance safety.

Reference Material -- Press Counterbalance Systems

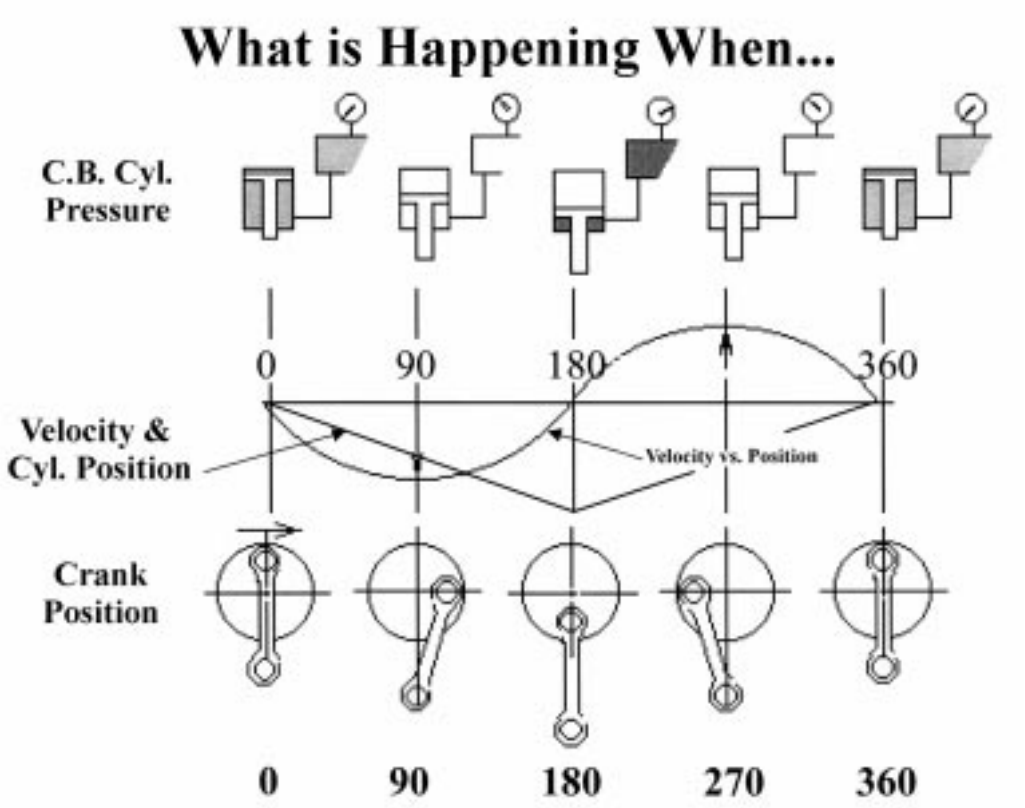
Why not dump the C.B. air to atmosphere on each stroke and eliminate the surge tanks?

A 1,000 ton double acting press contains an average of 180 cu. ft. of air. The horsepower (H.P.) to produce air is 5 scfm per H.P. To refill the system of the 1,000 ton press in one minute would take **45 H.P.** At 40 strokes per minute (spm), there is 1/80 minute to fill the system, so the required H.P. is:

2,880 H.P.!!



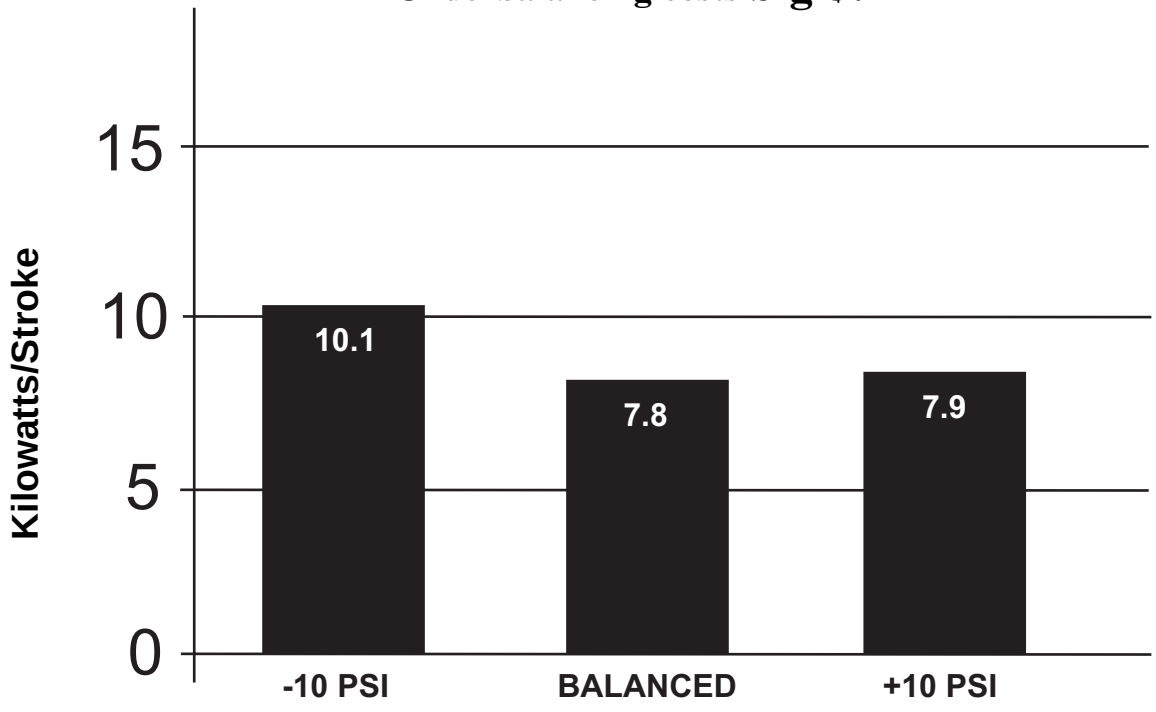
COST OF OVERBALANCING (CONSTANT CB PRESSURE vs. DIE WEIGHT)



So what does a few extra psi mean?

For a press with two 20" bore (508mm) cylinders,
an extra 10 psi of pressure produces 3 tons of extra unneeded force.

To Over or Underbalance? That is the question.
Underbalancing costs big $!



Cost justification for A.C.B.

- Conserved electric costs (to run the flywheel)
- Conserved air costs (to run the compressor)
- Cost of die repair
- Reduced scrap savings
- Savings of die repairs
- Cost reductions of labor due to higher part yield
- Profit from added production
- Total savings= JUSTIFIED

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