TECHNICAL SUPPORT

INTRODUCTION

Levers are used to support the platform and transmit force throughout the scale. However, without pivots and bearings to support the levers, they are totally useless. Precision machining of pivots and bearings is necessary to ensure as little friction as possible is present in the lever system. The following information will help to:

- Identify types of pivots and bearings
- Identify proper pivot and bearing hardening techniques
- Identify proper grinding and honing techniques
- Identify sources of avoidable and unavoidable friction
- Define range and sensitivity

PIVOTS AND BEARINGS

Pivots are knife edges which rest in bearings to provide not only support, but as little friction and freedom to turn as possible. It is not possible to totally eliminate friction but its effects can be minimized. Pivots and bearings are designed so they can be removed and replaced. Pivots and bearings take the hardest wear and abuse of all scale parts.

Pivot Types

All pivots are designed to provide lever support with minimum friction. Since there are various scale manufacturers and designs available, the types of pivots that are used will vary.

Teardrop Pivot

The teardrop pivot derives its name from its shape. See Figure 1.

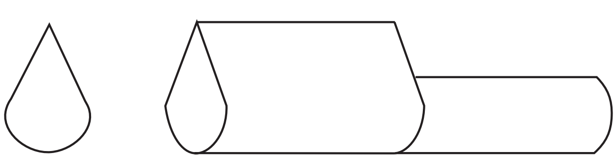


FIGURE 1

Teardrop pivots are used in scales up to 1000 lb capacity, feed mill scales, and beam scales. Other names for the teardrop pivot are the pear-shaped and pippin-shaped pivots. They are usually made from an amalgam of hardenable steel with a low carbon steel backing.

Square Pivot

Square pivots have four edges. Some square pivots have all four edges ground so they can be turned when one edge becomes worn. Some have three edges knocked off so they can be used only one way. They are used on Thurman and Cardinal hopper levers, and to support weigh beams. They are simple to change as they do not need to be gauged. Some square pivots are welded in place. Square pivots are sometimes called diamond pivots.

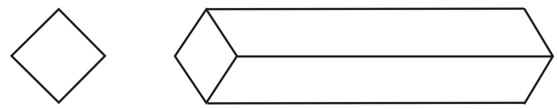


FIGURE 2

Block Pivot

Block pivots are also called pentagonal pivots because they have five sides. The tapered block pivot is flat on one side and machined to a knife edge on the opposite side. The pivot shown has one end tapered to provide minimum contact with the friction plate.

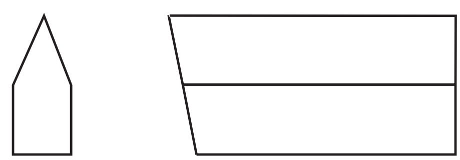


FIGURE 3

Triangular (Knife-Edge) Pivot

The triangular pivoted or knife-edge is used in precision balances of capacities up to 5kg. They are made of agate, stellite, or high-carbon alloy steel.

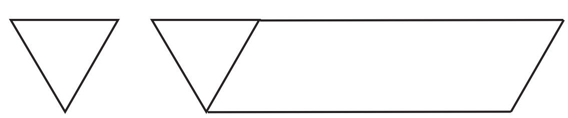


FIGURE 4

Pivot Requirements

A pivot point must retain the following characteristics over a reasonable time frame.

Sensitivity

A good knife edge in theory makes contact at one single point. However magnification of the edge will show some rounding. The rounding can be nonpermanent (elastic) or permanent. Wear will also cause increases in radius development. The bearing associated with this pivot will also yield to pivot pressure and will develop a rounded groove. The less contact the pivot makes with the bearing the more sensitive the pivot.

Accuracy

Accuracy can be affected if the pivots do not return to their correct seating position. This can be caused by friction. The tendency to not return to their proper position is more pronounced with radiused and “V” bearings than with the flat bearings.

Mechanical Stability

A pivot is caused to be mechanically unstable when subjected to shock loading and/or lateral forces when loading or unloading. Means must be provided to ensure that knife edges are not easily disturbed from their normal working positions, and, if disturbed, come back to their original positions.

Range of Movement

The angle of the knife edge must be sufficiently acute and the angle of the bearing must be sufficiently obtuse to provide sufficient range of movement and to withstand dirt buildup.

Strength

There can be considerable pressure on the knife edge because of the weight of the platform and live load. The knife edge must be able to withstand pressures on the order of 22 tons/cm^2.

Durability

Application of the load on a truck scale will cause immediate flattening of the knife edge. Subsequent loading will not cause further flattening. However deterioration of the edge continues even where a pivot has been subjected to maximum loading early in its life. The radiusing of the knife edge increases by abrasion, proportional to the angular movement. Wear is also caused by shock loading, erosion and movement of the pivots in their bearings. A knife edge with an obtuse angle is more durable than one with an acute angle. Wear is increased rapidly if the angle of movement is greater than 5°. Some stainless steel has been used but the hardness requirement is difficult to meet.

Bearing Types

Bearings have several shapes and sizes, although they are usually “V” shaped to give the pivot a natural and fixed contact point for seating itself, thus allowing for self-alignment.

“V” Block Bearing

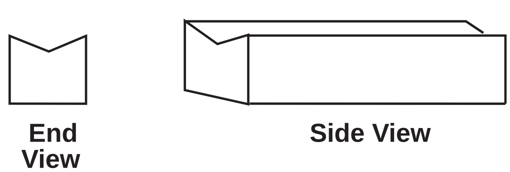


FIGURE 5

The “V” block bearing is a sharp “V” bearing commonly used in beam assemblies and tare and shelf levers. The “V” bearing is self aligning, a most desirable feature for use in scales. The bottom of this bearing should be sharp and clear cut.

Round Bottom “V” Bearing

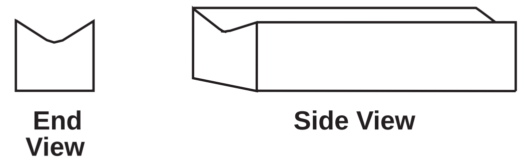


FIGURE 6

Another type of “V” bearing is the round bottom “V”. It has extensive uses, commonly in scale understructures. The bottom of the groove is not sharp but has a very slight radius (about 1/32") to accommodate inevitable rounding of the associated knife edge under loading. The angle between bearing faces is always 90° to 150°. The bearing may be cut from hardenable steel rod or bar and machined to the desired section; molded in tungsten steel or stellite; or in the case of bearings used in most counter scales, be stamped from hardenable steel plate and pressed to the required shape.

Flat and Concave Bearings

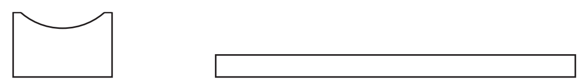


FIGURE 7

Concave bearings are used where there is little or no displacement of the knife edge as in the main bearings of truck scale understructures. They are not recommended to be used as support for the final lever connected to the scale indicator as very little lateral motion this close to the indicator can induce a large error. They offer less friction than do “V” bearings. They are made of hardenable steel roll welded to a low carbon steel backing. DO NOT replace concave bearings with “V” bearings.

Flat bearings are used in test devices and precision balances in laboratories as they offer the least amount of friction of all the bearing types. The advantage of flat bearings is they interfere very little with the scale action no matter what the pivot angle. However, they do require a checking system to keep the levers and platform in their proper positions. The instrument in which they are used must not be subject to vibrational disturbances. They are usually made of synthetic corundum (also called synthetic sapphire and synthetic ruby), agate or highly polished hard steel.

Hardening

Pivots and steel bearings are made from a steel alloy which gives the following properties:

- Hardness for wear resistance
- Toughness or strength
- Quality of not deforming during heat treatment
- Resistance to staining and corrosion

All pivots and bearings must be heat treated for hardness and tempered at the pivot knife edge and the bearing contact point. The pivot should be as hard as the bearing and vice-versa. Under large loads, pivots may mushroom, but if manufactured correctly, they will return to their original shape. A pivot should be hardened as shown in Figure 8.

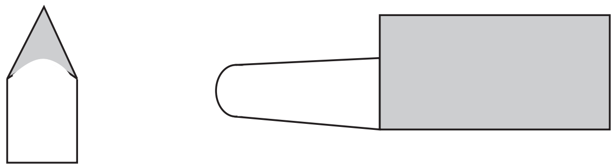


FIGURE 8

If the entire pivot or bearing is completely hardened and tempered, it will become brittle and crack under extreme loads. Conversely, if it is soft, it will wear out quickly and cause friction. Pivots and bearings, because of their hardness, very seldom wear out. Their biggest "enemy" is corrosion. To prevent corrosion while being stored, pivots and bearings are plated with nickel. However, under normal use, the nickel will wear off. That is why it is necessary to grease bearings to keep them from corroding.

Lapping

A lap is a tool made from soft metal (brass or aluminum) used for cutting or polishing to eliminate scratches and gouges from the pivot or bearing. Lapping takes off just a small portion of the surface, but must be done equally on both sides of the pivot or the angle will cause the lever ratio to change.

Grinding

In some cases it may be necessary to grind a pivot to smooth out rough surfaces. Grinding can change the location of the pivot edge, thus changing the lever multiple. It is also possible to disturb the parallel of the knife edge, which will cause friction. Care must be taken when grinding, as case-hardened materials may have their hardness ground away. This leaves a soft metal which will not be able to stand up to the normal rigors of scale operation. In this case it is more advantageous to replace the pivot then to grind them. However, sometimes you have no choice but to grind if the pivots/bearings are not readily available.

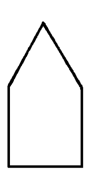
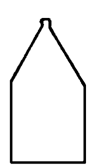


FIGURE 9



Honing

Honing a pivot is accomplished to change a lever's ratio. Honing changes the position of the knife edge in relationship to the distance to the knife edge on another pivot. Honing is used to lengthen or shorten the distance between the load and fulcrum pivots.

To hone a load pivot that is fast, you must hone the side of the load pivot farthest away from the fulcrum pivot which shortens the distance between the two knife edges, increasing the ratio. To hone a load pivot that is slow, you must hone the side of the load pivot nearest the fulcrum pivot, which lengthens the distance between the two knife edges, decreasing the ratio.

A small, coarse handstone is normally used for honing. Do not use a file! Do not make a major change in the angle of the pivot side or the pivot will not seat properly in the bearing. The pivot also will bind, causing friction and repeatability problems.

Friction

Since scales are mechanical devices they contain moving parts. When parts move against one another friction develops. It is impossible to eliminate all friction but its effects can be decreased. We will look at causes of unavoidable and avoidable friction with regard to scales.

Unavoidable Friction

Surface resistance of a pivot edge as it revolves on the bearing surface is a source of unavoidable friction. Even a fine razor edge has a surface. No matter how fine the edge of the pivot is, it will develop a small radius because it cannot withstand the strain of load. After some usage the pivot edge will wear down to a point where it will be able to withstand the load strain for years without affecting the scale accuracy. Figure 10A shows a teardrop pivot before use. Figure 10B shows the same pivot after it has worn to the point where it will give years of service.

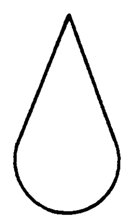


FIGURE 10A

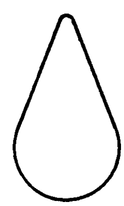


FIGURE 10B

Another source of unavoidable friction is the antifriction plate. The antifriction plate keeps the pivot and/or bearing from sliding out of place. The antifriction plate is often called a "friction plate" or just a "friction". The use of a friction plate in Figure 11 is the ideal method. The contact between the end of the pivot and the friction plate is reduced to a minimum.

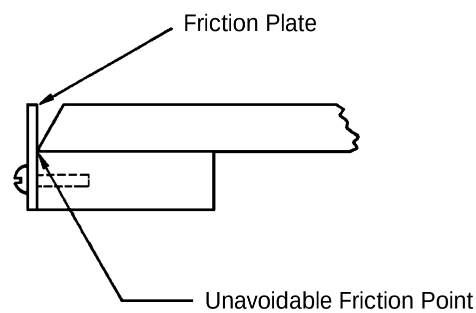


FIGURE 11

This method should be used where economy will allow and when it is technically possible. This method is being used more frequently because of its dependability. Rough handling can cause the pivot tip and/or the plate to break.

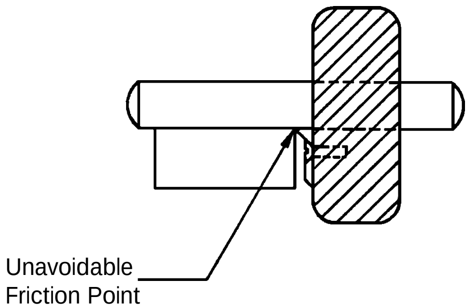


FIGURE 12

The method shown in Figure 12 is commonly used on the understructures of commercial and industrial scales. It is cheaper to build and the friction plate is reinforced by the lever body and is less likely to break. Rough handling is less likely to break this antifriction system.

Avoidable Friction

Improperly made and/or aligned bearings can be a source of avoidable friction. Normally if the bearings is bad, the pivot is also bad. A sharp pivot and smooth bearing equals minimal friction. Using the wrong pivot can cause friction. The scale understructure generally receives a severe punishment when being loaded and unloaded. Therefore, it is not advisable to use a sharp bottom "V" bearing in the understructure. As the fine edge of the pivot wears it will jam into the sharply lapped bearing bottom. Round bottom "V" bearings are much more suited for understructure applications.

A soft, blunt, or broken pivot tip and/or coarsely finished antifriction plate (steel) can be sources of friction. A crooked pivot will also cause tension and friction, as will soft pivots and bearings. A soft pivot dulls quickly and soft metal has a tendency to cling. A hard and sharp pivot edge will cut its way through bearings that are too soft, restricting the pivot's ability to rotate.

Incorrect pivot installation will cause friction. If the pivot is tapered on one end it is to be installed in one direction only. The tapered end must fit against the friction plate. This makes sure the pivot touches the friction steel at only one point. If a non-tapered edge touches the friction plate there will be an increase of friction and binding. Friction plates keep the levers from sliding out of position, thus reducing friction. Frictions are hard and brittle and can break. Hardness of the pivot must match the hardness of the friction plate. If the pivot is harder than the plate, a groove will be worn into the friction plate and the pivot can become caught and bind in the groove. It may be possible to take the nick out of the friction plate by grinding. If the plate is case hardened (hardened to only a certain depth) you may grind to soft metal. This will cause quick wearing of the friction plate and replacement with a friction plate of the correct hardness will be required.

There are other sources of friction, such as the steelyard rod rubbing against something or the platform rubbing against the frame. Keep all moving parts at a safe distance from stationary parts.

Parallel

The pivots must be straight, sharp and hard to eliminate friction and to perform their function with the most precision. They also must run parallel to each other on two planes.

Gauge Parallel

Figure 13 shows pivots in proper gauge parallel. (Distance A = Distance B)

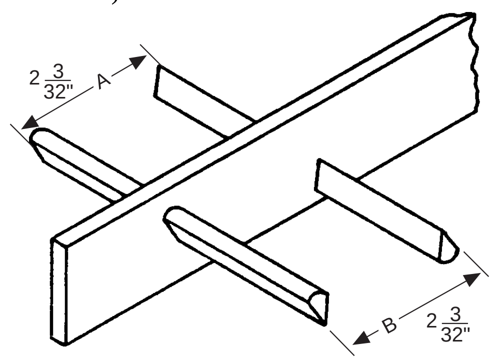


FIGURE 13

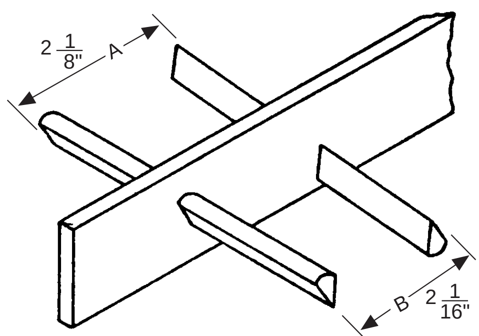


FIGURE 14

The pivots in Figure 14 are NOT in proper gauge parallel. (Distance A is greater than Distance B). The ratio of the lever is smaller at A than at B. The pivots of a lever must have a certain amount of end play in their bearing to ensure freedom of movement. Because of this end play the levers can change their positions. When this occurs there will be a change in ratio with resultant inconsistent indication.

Plane Parallel

Pivots also must be parallel to each other in a 90° plane; use a pivot gauge to measure. See Figure 15 for pivots in correct plane parallel.

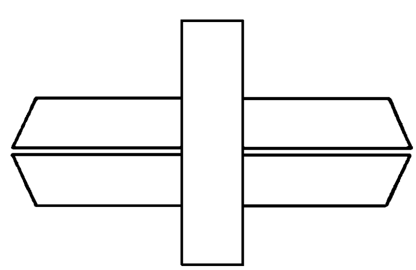


FIGURE 15

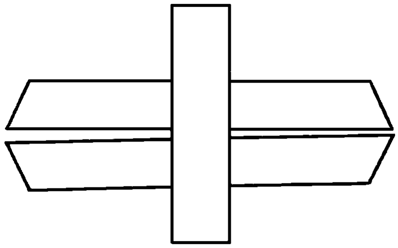


FIGURE 16

Figure 16 illustrates pivots not in proper plane parallel. Pivots set in this manner will cause inconsistency. The bearings will have a tendency to slide down on the sloping pivot and jam against the friction points, causing friction. The lever will be less sensitive besides having poor repeatability.

Service Tips

- Use an *old* file to check pivot hardness. If the pivot is hard, it will cut the teeth of the file.
- When installing pivots, use round stock, or preferably a brass hammer. A hardened hammer can break the pivot.
- Use a pivot gauge when measuring.
- If the scale is not returning to zero, check for cut or worn bearings to be replaced or lapped. In a small capacity scale, cut bearings will have a large affect. While in large capacity scales, cut bearings may work well.
- When pounding out pivots, place a block behind the lever to support the lever casting. Without support the lever may break when pounded.

SENSITIVITY

Sensitivity is the amount of structural displacement caused by the addition of any weight to any portion of a balanced structure. The degree or amount of sensitivity depends on the distribution of mass above and below the fulcrum point of a lever. When we talk about sensitivity in conjunction with scales, we are referring to the amount of beam travel from balance position to a new point of equilibrium.

NOTE: A beam is a graduated lever used to balance a scale. Weight can be read from the beam graduations.

Neutral Lever

If the pivot edges of a lever are on a straight line, (see Figure 17), and the mass of the lever is equally distributed above, below, right and left of the edge of the fulcrum pivot, the lever will be neutral.

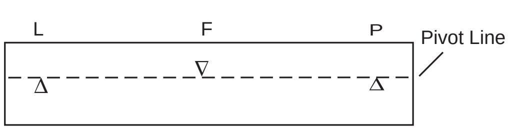


FIGURE 17

If the body of the lever is slightly heavier below the fulcrum pivot a pendulum effect will be created. The heavier the mass below the fulcrum pivot, the less sensitive the lever will be.

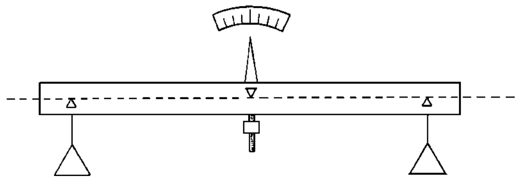


FIGURE 18

Figure 18 shows a neutral lever with an indicator and gravity ball attached. If a pan is hung on the load and power pivots the lever becomes an equal arm scale. The gravity ball will stabilize the otherwise neutral lever. The sensitivity can be increased by raising the gravity ball or decreased by lowering the gravity ball.

Gravity

All objects, including levers, have a center of gravity. If an object is suspended by its center of gravity it will remain motionless until an external force is applied. We can say the lever is balanced. If the lever is moved in any direction it will stop in the position we move it. It will remain in this position until an external force is again exerted on it.

If we suspend the lever at a point below its center of gravity the lever will become top heavy and unstable. It will turn on its axis or fulcrum. The change in position will not be abrupt, but be preceded by oscillations caused by its momentum. The number of oscillations will depend on friction and the amount of fulcrum displacement from the center of gravity.

If we suspend the lever at a point above its center of gravity the lever will become very stable. However, it will also become very insensitive.

Let's refer back to our equal arm scale in Figure 18.

With the indicator pointing to the chart centerline we will place a 1/4 ounce weight on the right hand pan, moving the indicator to the right, let's say, two graduations. We then will remove the 1/4 ounce weight and the indicator points again to the center. Now we will place a 10 pound weight on each pan. Again we have a centerline indication. If the lever is solid and does not deflect under the load, a 1/4 ounce weight placed in the right hand pan will again move the indicator to the second graduation. This indicates that the sensitivity of the lever is constant. The reason the sensitivity is constant is because all pivots are in a straight line. In other words adding weight to the load and power pivots adds weight even with the fulcrum pivot, not above it nor below it.

Open Range

If the edges of the load and power pivots are below the straight line passing under the edge of the fulcrum pivot (see Figure 19) the lever would have what is referred to as OPEN RANGE.

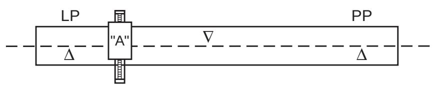


FIGURE 19

If we raise the gravity ball the sensitivity may be increased to the point of neutrality or even to instability if we raise it far enough.

However, when weight is placed on the load and power pivots the sensitivity will decrease. The bigger the load the less sensitive the lever will be. Remember the load and power pivots are below the fulcrum pivot line, so when weight is added to the load and power pivots the weight is being added below the fulcrum pivot. The results are decreased sensitivity and increased stability.

Closed Range

Let's look at a lever that is said to have CLOSED RANGE. (see Figure 20)

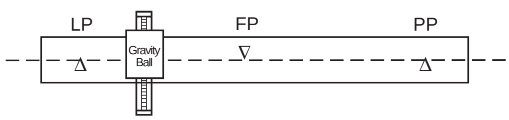


FIGURE 20

A lever is said to have closed range when the edges of the load and power pivots are higher than the edge of the fulcrum pivot.

When pans are hung on the power and load pivots the lever will be unstable (top heavy). The lever can be stabilized by lowering its gravity ball which increases the mass below the fulcrum pivot.

As the pans are loaded, the increasing load will gradually overcome the stabilizing effect of the gravity ball. This is true because the weight is felt at the loaded power pivots which are located above the fulcrum pivot line. As the weight increases it will cause first neutrality and finally a top heavy, unstable condition.

Lever Deflection

To construct a lever or weighbeam with no deflection, it may be necessary to over-dimension the body, making it very clumsy and heavy. Because of its great inertia, the lever would require more time to pick up momentum when changing directions during oscillation.

To ensure a reasonably uniform sensitivity, a slightly closed range can be used.

Levers are usually made as light as possible to decrease the weight of the lever system, minimize inertia, and to save material.

If the deflection is not too great and is temporary, it can be compensated by a closed range in the pivot line. A permanent deflection will render a scale useless. Deflection in any lever will decrease its sensitivity. If the lever is incorrectly proportioned it will change its ratio. A correctly proportioned lever with, let's say, a 10:1 ration must have a similar deflection factor. If the load arm deflects .001" then the power arm should deflect .001" to maintain the lever ratio.

Closed range, to compensate for deflection, can be utilized only in scales with predetermined, one-spot indication (beam scales) or in a scale equipped with balance indicators that only have a zero indication. Scales with graduated charts–each graduation representing a certain weight value–must not utilize closed or open range.

Using a neutral pivot line on a flexible lever would result in gradual loss of sensitivity due to the increase in mass below the fulcrum pivot as the load and power pivots deflect downward.

Levers and beams are usually constructed so the larger mass of the lever body is below the pivot line. This produces sufficient pendulum action to stabilize the scale. Closed range has an opposite effect, causing the scale to become unstable.

The stabilizing effect of the lever body has to be greater than the unstabilizing effect of the closed range when the scale is unloaded. As the scale is being loaded, a gradual deflection will take place which will eventually eliminate the range. This stabilizing effect of the lever body must remain active until the load and power pivots sink to the level of the fulcrum pivot. Should the stabilizing effect of the lever mass be insufficient and become nullified before the pivot line becomes neutral, the scale will become unstable at this point. A further increase in load will result in a gradually increasing loss of sensitivity.

SENSITIVITY REQUIREMENT (SR)

The sensitivity of a scale is the distance the beam or indicator travels when a certain unit of weight is placed on the scale platform. The term "sensitivity" is NOT the same as the sensitivity requirement or SR.

SR is the amount of weight necessary to make the scale travel a certain specified distance. The SR requirements for commercial scales vary depending on the type of scale. SR tolerances are prescribed in Handbook 44.

MECHANICAL SCALE GLOSSARY

A

“A” TYPE LEVER SYSTEM:
The “A” lever system, designed by Thaddeus Fairbanks in 1830, is still in use today by various scale manufacturers. It was the understructure for the first platform scale, and consists of two short levers and two long levers. All pivot edges are at the same elevation.

ABATOIR SCALE:
An overhead rail scale used in slaughterhouses. Their beams are ordinarily with a second class application. The usual load loop is anchored and used as an up-pull bearing for the load pivot, now acting as a fulcrum. The power of the understructure is actually the load of the beam and is applied to the pivot which is normally used as the fulcrum. In this application this pivot would become an up-pull pivot.

ACCEPTANCE TOLERANCE:
The limit of allowable error or departure from true value when the scale is placed in use for the first time, or placed in service within the preceding 30 days and is being tested for the first time. Acceptance tolerance also applies following official rejection for performance failure and the scale is being officially tested for the first time within 30 days following correction. The final condition under which acceptance tolerance applies is when the scale is being officially tested for the first time within 30 days following major reconditioning or overhaul.

ACCURACY:
A piece of equipment is accurate when its performance or value conforms to the standard within the applicable tolerances and other performance requirements. Accuracy can be considered precision in the measurement of quantities and in the statement of physical characteristics. Accuracy is expressed in terms of error as a percentage of the specified value (e.g., 100 lbs+/- 1%), as a percentage of a range (e.g., 2% of full scale) or as parts (e.g., 100 parts per million).

AGATE BEARINGS:
Bearings made from agate, a hard rock. Agate bearings are used to support auxiliary levers in cabinet dials. They are brittle and may shatter if dropped.

AMBIENT CONDITIONS:
The conditions (humidity, temperature, pressure, etc.) surrounding an object.

ANIMAL SCALE:
A scale designed for weighing single heads of livestock.

ANTIFRICTION PLATE:
Plates that hold pivots and bearings in alignment by limiting their lateral movement. The pivot and/or bearing is designed so it contacts the antifriction plate at one point, called the friction point. The plates must be as hard as the pivots and bearings, or notches will be worn into the plate causing more friction instead of reducing friction. Also called “friction plates” or “friction steels”.

APOTHECARIES’ WEIGHT:
Weight used primarily by pharmacists. In apothecaries’ weight, 1 pound is equal to 12 ounces.

APPROACH:
The surface which supports a **carrier** on its way to and from a **load receiver.**

APPROVAL SEAL:
A label, tag, stamped, or etched impression indicating official approval of a device.

AUTOMATIC BULK WEIGHING SYSTEM:
A weighing system adapted to the automatic weighing of bulk commodities in successive drafts of predetermined amounts which automatically records the no-load and loaded weight values and accumulates the net weight of each draft.

AUTOMATIC INDICATING SCALE:
A scale on which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range.

AUXILIARY INDICATOR:
Any indicator, other than the master weight totalizer, that indicates the weight of the material determined by the scale.

AVOIDABLE FRICTION:
Friction in a scale that can be avoided with proper installation and maintenance practices. Some causes of avoidable friction are improperly made and/or aligned bearings; installation of wrong bearings (e.g., sharp bottom “V” bearing installed in a scale understructure); improperly honed pivots; worn pivots and bearings; maladjusted checking system; soft, blunt, or broken pivot tip; coarsely finished antifriction plate; improperly placed antifriction point; soft bearings; moving parts rubbing together; worn ball bearings; and poorly made/finished dashpot and plunger.

AVOIRDUPOIS:
The series of units of weight based on the pound of 16 ounces and the ounce of 16 drams.

AXLE LOAD SCALE:
Load receivers are normally 10 to 12 feet in length used to weigh vehicle axles. The scale will determine the combined load of all wheels on a single axle or on a tandem axle.

B

BACK BALANCE WEIGHT:
Weight hung on the back balance pivot loop of a weighbeam to balance the beam during calibration.

BALANCE BALL:
Weight positioned towards the butt end, and above a weighbeam, used to balance the beam at no-load. The height of the balance ball affects beam gravity and sensitivity.

BALANCE INDICATOR:
A combination of elements, one or both of which will oscillate with respect to each other for indicating the balance condition of a nonautomatic-indicating scale. The combination may consist of two indicating edges, lines, or points; or a single edge, line, or point and a graduated scale.

BALANCING MECHANISM:
A mechanism (including a balance ball) that is designed for adjusting a scale to an accurate zero-load balance condition.

BASIC TOLERANCES:
Tolerances on under registration, over registration, or in excess or deficiency that are established by a particular code for a particular device under all normal tests whether maintenance or acceptance. Basic tolerances include minimum tolerance values when they are specified.

BEAM:
A **lever** with **graduations** and a **poise,** used as an indicating device for direct weight readout. It is the final lever in a lever system and applied in a first class lever configuration. A beam may consist of a single beam and a poise. The poise moves along the beam to vary the beam's power arm ratio. Some beams are called compound beams or weighbeams, because they have multiple power arms and multiple poises.

BEAM CAP:
Part of a portable beam scale which sits directly above, and covers the weighbeam.

BEAM OSCILLATIONS GRAPH:
A graph showing the movement (oscillations) of a beam. The graph can be used to pinpoint the source of trouble within a scale, such as friction.

BEAM SCALE:
A scale on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars, either alone or in combination with counterpoise weights.

BEAM STAND:
Part of a weighbeam system containing the fulcrum bearing which supports the beam.

BEAM SUPPORT:
The flat "table" or shelf on which the beam stand and trig stand are bolted on a type recording and/or full capacity beam.

BEARING:
A closely machined and hardened surface into which a scale's pivot rests and/or turns. The bearing can be of various shapes, such as a "V" or even a flat plate. The bearing must offer minimal friction.

BENCH SCALE:
Also called a counter scale. By reason of its size, arrangement of parts and moderate nominal capacity, is adapted for use on a counter or bench.

BUMPER:
An element which limits the travel of a **platform** or **weighbridge** structure. Usually an adjustable bolt at each corner which strikes the scale frame or pit wall at the limit of movement.

BUTT:
End of a **lever** on which the load is applied.

C

CABINET DIAL:
A weight indicator in which the pull from the scale's transverse lever is connected to the tare and capacity bars, which are in turn connected to a dial readout via an auxiliary lever. The tare and capacity bars act as the scale beams. There are unit weights that extend the range of the cabinet dial. These unit weights are added to the tare lever and act similar to the counterpoise weights in a platform scale to extend the cabinet dial range.

CALIBRATED CAPACITY:
The maximum value which the installed scale is capable of indicating. Calibrated capacity can not exceed scale capacity.

CAPACITY:
The maximum weighing limit of a scale.

CAPACITY BEAM:
The beam in a multiple beam indicating device which has the largest graduations.

CARRIER:
Any vehicle or container used to transport material or product onto the **load receiver.**

CHECKING:
A system of limiting elements which prevents the load receiver platform or weighbridge structure from moving off-center under lateral or longitudinal stress, without interfering with vertical movement.

CHECKWEIGHING SCALE:
A scale used to verify predetermined weight within prescribed limits.

CLOSED RANGE:
A condition that exists when the edges of load and power pivots are above the edge of the fulcrum pivot.

COMPOUND LEVER SYSTEM:
A combination of levers connected together, such as in a scale's understructure.

COMPUTING SCALE:
A scale that indicates the money values of amounts of commodity weighed, at predetermined unit prices, throughout all or part of the weighing range of the scale.

CONCENTRATED LOAD CAPACITY (CLC):
A capacity rating of a scale, specified by the manufacturer, defining the maximum load concentration for which the weighbridge is designed.

CONSTRUCTION-MATERIAL HOPPER SCALE:
A scale adapted to weighing construction materials such as sand, gravel, cement, and hot oil.

COUNTERBALANCE WEIGHT:
A weight intended for application near the **butt** of a weighbeam for zero load balancing purposes.

COUNTERPOISE WEIGHT:
A slotted or hanger weight, intended for application near the tip of the weighbeam of a scale having a multiple greater than 1.

COUNTER SCALE:
A scale, by reason of its size, arrangement of parts, and moderate nominal capacity, is adapted for use on a counter or bench. Also called a bench scale.

MECHANICAL SCALE GLOSSARY

CRANE SCALE:
A scale with a nominal capacity of 5000 lbs or more, designed to weigh loads while they are suspended freely from an overhead, track mounted crane.

D

DAIRY-PRODUCT-TEST SCALE:
A scale used in determining the moisture content of butter and /or cheese or in determining the butterfat content of milk, cream, or butter.

DASHPOT:
A dampening device used to reduce scale oscillations.

DEADLOAD:
The weight of the weighbridge, platform, levers, and other structural elements that apply a fixed force on the lever system or load cells (in electronic system).

DECREASING LOAD TEST:
A test for automatic-indicating scales only, wherein the performance of the scale is tested as the load is reduced.

DIAL SCALE:
A desensitized beam scale where the travel is mechanically enlarged by a projection on a chart or dial.

DORMANT SCALE:
A built-in scale with a self contained understructure.

DIVISION:
Smallest graduated interval of display and output data. Also grad, graduation or interval.

DROP WEIGHT:
A weight used to extend the range of a dial scale. Also unit weight.

E

EQUAL-ARM SCALE:
A scale having only a single lever with equal arms (multiple of 1) equipped with two similar or dissimilar load receiving elements (pan, plate, platform, scoop, etc.), one intended to receive material being weighed and the other intended to receive weights. There may or may not be a weighbeam.

EVEN ARMLEVER:
A lever having a load arm equal in length to its power arm.

EXTENSION LEVER:
A lever which connects two scale sections together.

F

FABRICATED:
Structural elements built or fastened together, as opposed to being cast or forged in one piece.

FACTORY SEALED:
A scale, load receiver, or indicator which has been completely assembled, tested, and calibrated during manufacture.

FIRST CLASS LEVER:
A lever having its fulcrum point located between its load and power points.

FLEXURE:
A flexible hinge connection which uses a bending section of thin material to transmit force.

FORCE:
The end result for which a lever is used, power pull.

FRACTIONAL BAR:
A beam of relatively small capacity for obtaining indications intermediate between notches or graduations on a main or tare bar. Also fractional beam.

FULCRUM:
The axis on which a lever rotates; the point of support on which a lever turns in raising or moving weight.

G

GIRDER CHAIR:
An element in a mechanical, compression-type lever system, to which the weighbridge is attached to transmit force to the butt end of the main lever.

GRAIN HOPPER SCALE:
A scale adapted to the weighing of individual loads of varying amounts of grain.

GRAIN-TEST SCALE:
A scale adapted to weighing grain samples used in determining moisture content, dockage, weight per unit volume, etc.

GRADUATED INTERVAL:
The distance from the center of one graduation to the center of the next graduation in a series of graduations.

GRADUATION:
Same as a division.

GRAVITY BALL:
A mass or weight required to stabilize an otherwise neutral lever.

GROSS CAPACITY:
The total capacity of a scale understructure designed to support an add-on load receiver. For example, in a lever system for hopper scales, the gross capacity must not be exceeded by the sum of the deadload (material hopper) plus the live load (material being weighed).

GROUT:
A compound (fine mortar, epoxy, etc.) used to fill voids in concrete work, or between concrete work and steel support points such as lever support stands. Grout is specially formulated for strength, elasticity, and durability.

H

HARDNESS:
Resistance to local penetration, scratching, machining, wear or abrasion.

HOPPER:
A container for bulk material. In a hopper scale, the container functions as the load receiver.

HOPPER SCALE:
A scale designed for weighing bulk commodities whose load receiving element is a tank, box, or hopper mounted on a weighing element.

I

INCREASING-LOAD TEST:
The normal basic performance test for a scale, in which observations made as increments of test load are successively added to the load-receiving element of the scale.

INDEX:
The particular portion of an indicator that is directly utilized in making a reading.

INDICATOR:
The weight-indicating element of a scale.

INDICATOR CAPACITY:
The largest weight which the weight indicating device is capable of reading. In a dial or beam, the capacity is mechanically limited.

INGREDIENT:
A material; one element of a batch.

J

JEWELER'S SCALE:
A scale adapted to weighing gems and precious metals.

L

LEVETRONIC:
A term used by Fairbanks Scales to identify a mechanical compound lever system equipped for electronic weight indication.

LIVE LOAD:
The weight of material and/or any carrier applied to the load receiver during the measurement.

LIVESTOCK SCALE:
A scale of 60,000 pound capacity or less, equipped with stock rails and gates and adapted to weigh livestock standing on the scale platform.

LOAD ARM:
The distance between the load point and the fulcrum point of a lever.

LOAD POINT OR PIVOT:
The point on a lever where the load force that is being weighed is applied.

LOAD-RECEIVING ELEMENT:
That element of a scale that is designed to receive the load to be weighed, (e.g., platform, deck, rail, hopper, platter, plate, scoop).

LOAD RECEIVER CAPACITY:
The greatest weight which may be safely applied to the load receiver; limited by design of the weighbridge suspension and understructure.

LPAN:
Acronym for "Less Parts Above Neck". Applies to load receivers marketed without indicating devices. Derived from mechanical load receivers where the "neck" accommodated the transverse lever tip, and LPAN deleted all indicator and steelyard connection parts.

M

MAIN BAR:
A principal weighbeam bar, usually of relatively large capacity, as compared with other bars of the same weighbeam. On an automatic-indicating scale equipped with a weighbeam, the main weighbeam bar is frequently called the "capacity bar".

MAIN GIRDERS:
The major structural elements of a weighbridge, running the length of the platform and providing it support. Also "main beams".

MAIN GRADUATION:
A graduation defining the primary or principal subdivision of a graduated series. In a mechanical lever system, the first lever to which the force on the weighbridge is transmitted.

MAIN-WEIGHBEAM ELEMENTS:
The combination of a main bar and its fractional bar, or a main bar alone if no fractional bar is associated with it.

MULTIPLE:
The mechanical advantage of a lever, calculated by dividing the distance from the fulcrum pivot to the tip pivot by the distance from the fulcrum pivot to the load pivot. Also called RATIO or Xn.

MULTIPURPOSE LEVER:
A lever that does more than one job at a time. It has four pivots installed. A common multipurpose lever is the center extension lever used in a truck scale. It receives power from both the end extension lever and one set of main levers.

MULTI-REVOLUTION SCALE:
An automatic-indicating scale having a nominal capacity, that is a multiple of the reading-face capacity, and that is achieved by more than one complete revolution of the indicator.

N

NOMINAL CAPACITY:
The nominal capacity of a scale is the largest weight indication obtainable by the use of all reading elements in combination. Nominal capacity is usually marked on the scale by the manufacturer.

NOSE IRON:
A manually-adjusted connection assembly at the tip of a lever which can be moved in and out and locked into position to adjust the lever multiple.

O

OPEN RANGE:
A condition that exists when the edges of the load and power pivots are below the edge of the pivot line.

OVER-AND-UNDER INDICATOR:
An automatic-indicating device, incorporated in or attached to a scale. Comprising an indicator and a graduated range with a central or intermediate "zero" graduation, and a limited range of weight graduations on either side of the zero graduation, for indicating weights greater than/less than the predetermined values for which other elements of the scale may be set.

P

PIPE LEVER:
A mechanical scale lever fabricated of tubular and plate elements, usually incorporates the functions of two main levers.

PIVOT/BEARING:
A low friction mechanical connection using a hardened steel knife edge pivot and grooved bearing to transmit force in a lever system.

POISE:
A movable weight mounted upon or suspended from a weighbeam bar, and used in combination with graduations and frequently with notches on the bar to indicate weight values.

POSTAL SCALE:
A scale designed to determine weight or delivery charges for letters and parcels, delivered by the US Postal Service or private shipping companies.

POWER ARM:
The distance between the power point and fulcrum point of a lever.

POWER POINT:
Where the force or load is counter-balanced. This point is also referred to as the point of pull.

PREPACKAGING SCALE:
A computing scale specially designed for putting up packages of random weights in advance of sale.

PRESCRIPTION SCALE:
A scale or balance intended to be used in the ordinary trade of pharmacists to weigh the ingredients of medicine and other formulas prescribed by physicians.

R

RATED CAPACITY:
The rated scale capacity is the maximum capacity for which the scale should be used.

RATIO TEST:
A test to determine the accuracy with which the actual multiple of a scale agrees with the designed multiple. This test is used for scales employing counterpoise weights, and is made with standard test weights substituted in all cases for the weights commercially used on the scale.

READING FACE:
The element of an automatic-indicating scale on which weight values are automatically indicated.

READING-FACE CAPACITY:
The largest weight that may be indicated on the reading face, exclusive of the application of any unit weights, weight ranges, or other elements.

RECORDING SCALE:
One on which the weights of applied loads may be permanently recorded on a tape, ticket, card, or in the form of a printed, stamped, punched or perforated representation.

ROCKWELL METHOD:
A method of harness testing under which the depth of penetration of an indenter, under arbitrary conditions, of test is determined. The indenter may be a steel ball of some specified diameter or a spherical-tipped conical diamond of 120 degree angle and a 0.2 mm tip radius. A minor load of 10 kg is first applied which causes an initial penetration and holds the indenter in place. The dial is set to “zero” and the major load of 60, 100, or 1590 kg is applied. Upon removal of the major load, the reading is taken with the minor load still applied. The hardness number may be read directly from the scale which measures the penetration. The scale is arranged so soft materials, with the deep penetration, give low hardness numbers. A variety of indenter and major loads are possible. The most common are an indenter of a 1/16" ball and a major load of 100 kg. (Refer to ***ROCKWELL HARDNESS & ROCKWELL SUPERFICIAL HARDNESS OF METALLIC MATERIALS, ASTM E18-61)***

S

SCALE:
A complete weighing device, with a combination of a load receiver and an indicator, that measures the force of gravity on a body.

SCALE CAPACITY:
The maximum weight to which the weighing device is calibrated; limited to the least value of the indicator, load receiver, or calibrated capacity.

SCALE MULTIPLE:
The multiplying power of the entire lever system of levers or other basic weighing elements. On a beam scale, the multiple of the scale is the number of pounds on the load receiving element that will be counterpoised by 1 pound applied to the tip pivot of the weighbeam.

SCALE PLATFORM:
The flat, level deck or surface of a load receiver on which the load is positioned for weighing.

SCALE SECTION:
A part of a vehicle, axle-load, livestock or railway track scale consisting of two main load supports, usually transverse to the direction in which the load is applied.

SEAL MARK:
A mark placed on a part or assembly during factory sealing, to indicate the correct position of alignment for re-assembly.

SECOND CLASS LEVER:
A multiplying lever whose load point is located between its fulcrum and power points.

SECTIONAL CAPACITY:
A rating of the maximum recommended live load which may be applied to any section of the load receiver. **Or** the greatest live load which may be divided equally on the load pivots of a section without causing stresses in any member in excess of the working stresses allowed.

SECTION TEST:
A shift test in which the test load is applied over individual sections of the scale. This test is conducted to disclose the weighing performance of the individual sections, since scale capacity test loads are not always available and loads weighed are not always distributed evenly over all main load supports.

SELF-CONTAINED:
A load receiver or an entire scale which is shipped and installed as one pre-assembled structure.

SENSITIVITY:
The value of the test load on the load receiving element of the scale that will produce a specified minimum change in the position of rest of the indicating element or elements of the scale.

SENSITIVITY REQUIREMENT:
A performance requirement for a non-automatic-indicating scale; the minimum change in the position of the rest of the indicating element or elements of the scale in response to the increase or decrease, by a specified amount, of the test load on the load-receiving element of the scale.

SHIFT TEST:
A test intended to disclose the weighing performance of a scale under off-center loading.

SIZE:
The size of the scale is the dimensions of the platform surface.

STEELYARD ROD:
The connecting element between the nose iron and weight indicator in a mechanical scale.

T

TARE:
The weight of any containing or supporting device used to transport material onto or away from a scale.

TARE MECHANISM:
A mechanism designed for determining or balancing out the weight of packaging material, containers, vehicles, or other materials that are not intended to be included in the net-weight determinations.

TIP:
The power end of a lever; opposite end of a lever from the butt end.

U

UNDERSTRUCTURE:
The frame and other base supporting structures of a load receiver.

UNIT WEIGHT:
A weight contained within the housing of an automatic indicating scale (cabinet dial) and mechanically applied to and removed from the mechanism. The application of the **unit weight** will increase the range of the automatic indication, normally in increments equal to the reading face capacity.

V

VEHICLE SCALE:
A scale adapted to weighing highway, farm, or other large industrial vehicles, loaded or unloaded.

W

WEIGHBEAM:
An element comprising one or more bars equipped with movable poises, or means for applying counterpoise weights, or both.

WEIGHMENT:
A single complete weighing operation, including loading the scale, achieving balance, determining weight and unloading the scale.

PRODUCT SUPPORT POLICY

Rice Lake Weighing Systems (RLWS) warrants all properly Distributor or OEM installed RLWS systems to operate per written specifications as confirmed by the Distributor/OEM and accepted by RLWS. All systems and components are warranted against defects in materials and workmanship for one (1) year after system start-up. The one-year warranty obligation is contingent upon clear documentation which establishes the start-up date. In the absence of irrefutable documentation which establishes the system start-up date, one year warranty coverage will commence upon date of shipment of equipment from Rice Lake Weighing Systems.

RLWS warrants that the equipment sold hereunder will conform to the most current written specifications authorized by RLWS. RLWS warrants the equipment against faulty workmanship and defective materials. If any equipment fails to conform to these warranties, RLWS will, at its option, repair or replace such goods returned within the warranty period:

1. Upon discovery by Buyer of such non-conformity, RLWS is given prompt written notice with a detailed explanation of the alleged deficiencies.
2. At the option of RLWS, the equipment is returned to RLWS at the expense of the Buyer.
3. Examination of such equipment by RLWS confirms that the non-conformity actually exists, and was not caused by accident, misuse, neglect, alteration, improper installation, improper repair or improper testing; RLWS is sole judge of all alleged non-conformities.
4. Such equipment has not been modified, altered, or changed by any person other than RLWS or its duly authorized repair agents.
5. RLWS will have a reasonable time to repair or replace the defective equipment. Buyer is responsible for shipping charges both ways.
6. In no event will RLWS be responsible for travel time or on-location repairs, including assembly or disassembly of equipment, nor will RLWS be liable for the cost of any repairs made by others.

THESE WARRANTIES EXCLUDE ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NEITHER RLWS NOR DISTRIBUTOR WILL, IN ANY EVENT, BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

RLWS AND BUYER AGREE THAT RLWS SOLE AND EXCLUSIVE LIABILITY HEREUNDER IS LIMITED TO REPAIR OR REPLACEMENT OF SUCH GOODS. IN ACCEPTING THIS WARRANTY, THE BUYER WAIVES ANY AND ALL OTHER CLAIMS TO WARRANTY.

SHOULD THE SELLER BE OTHER THAN RLWS, THE BUYER AGREES TO LOOK ONLY TO THE SELLER FOR WARRANTY CLAIMS.

No terms, conditions, understanding, or agreements purporting to modify the terms of this warranty shall have any legal effect unless made in writing and signed by a corporate officer of RLWS and the Buyer.

RICE LAKE WEIGHING SYSTEMS
230 WEST COLEMEN STREET
RICE LAKE, WISCONSIN 54868 **Tel:** 715-234-9171 **Fax:** 715-234-6967