

TIMING SCREWS

The Packaging Line

Workhorse



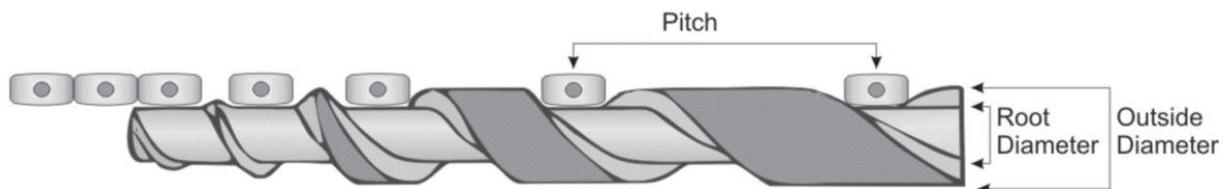
FRAIN INDUSTRIES, INC.

When time counts, we make it work.

Timing screws, often just called screws, worms or helices, have applications in virtually every operation that can occur on a packaging line. Metering containers into a starwheel on a capper or other machine is one of the most common. It is certainly not the only application for this versatile device. This article will discuss the different types and applications of screws as well as design concepts and troubleshooting.

Like a fastening screw, a timing screw is straight rod with threads. Unlike fastening screw, the thread pitch is frequently not uniform. Another important difference is that in use timing screws are rotating rather than stationary.

The nomenclature of both types of screws is similar. The key dimensions of the timing screw are:

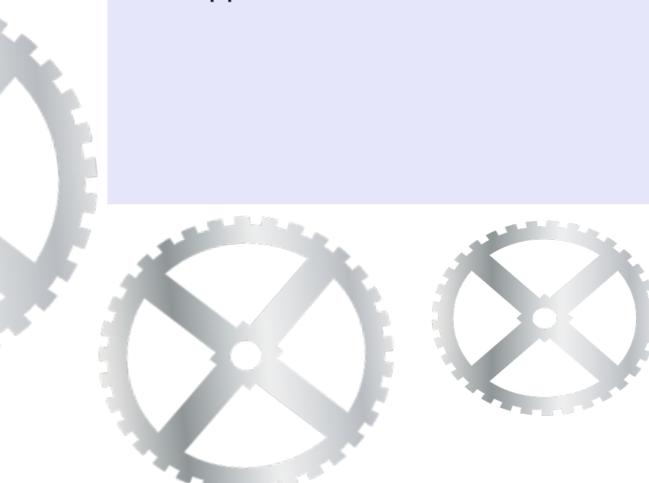


Outside Diameter – The maximum outer diameter of the screw. This is generally constant for the length of the screw though it may taper at the infeed in some designs.

Root Diameter – The root diameter, sometimes called the barrel diameter or inner diameter, is the diameter of the screw at the bottom of the pockets. It is normally constant for the length of the screw though can vary in some applications.

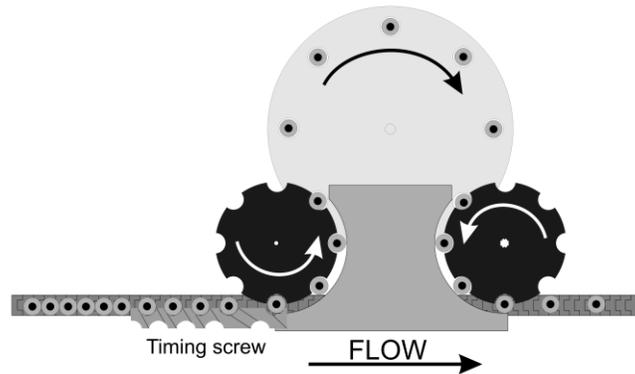
Pocket – The pocket is the space formed between the threads by the difference between root and outside diameters. The shape or profile of the pocket is generally cut to conform to the shape of the container.

Pitch – The pitch of the screw is the distance between the leading edge of one pocket to the leading edge of the previous pocket. The timing screw shown has a variable pitch as is often the case. The pitch is usually critical only at one point, such as the discharge and it is at this point that it needs to be clearly defined.



Application

In the illustration below, the screw is being used to **synchronize bottles** entering the infeed starwheel of a rotary filler. The timing screw is rotating at a 1:8 ratio.



For every 1/8th revolution of the starwheel the screw will complete 1 revolution, releasing 1 bottle directly into each starwheel pocket. If the distance between pockets on the starwheel is 6", the discharge pitch of the timing screw must also be 6" to match.

In any packaging line, it is a good practice not to relinquish control of the container once it has been acquired. This is even more important on higher speed lines. One use of timing screws is to **transfer containers** between machines. In the above example, a screw might pick up the bottles as they exit the discharge starwheel (6" pitch) and carry them to the infeed starwheel of the next machine. If that starwheel also has a 6" pitch, the pitch of the screw will be the same though its length.

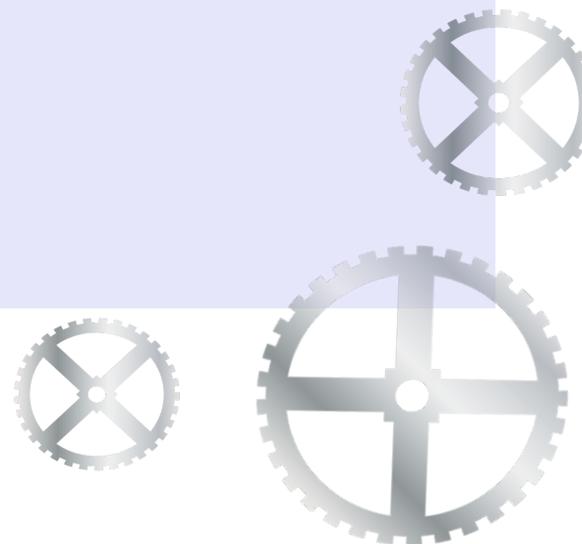


For a given length and difference between infeed and discharge pitches, more pockets are generally better. More pockets mean a gentler acceleration and less tipping of the containers. In some cases, such as transfer screws, the number of pockets may be critical to synchronizing. When purchasing replacement screws, the number of pockets between infeed and discharge can be important for line control purposes.

Length – Defining the screw length can sometimes be confusing. Generally the threads will run the entire length but sometimes there can be unthreaded sections at the infeed or discharge. In addition to the screw itself, there may be a drive hub mounted at the infeed and/or discharge ends of the screw. These non-threaded sections may or may not be counted as part of the overall screw length. Best practice, where the length is critical such as ordering a new screw, is to make a

rough sketch of the screw showing thread and overall length as well as details of any hubs or other special treatment at the ends.

Rotation – Timing screws can rotate clockwise or counterclockwise but should normally be oriented so that they rotate down on the container rather than lifting it up.



Timing screws can be used **singly** or in **multiples**. Some containers, such as those with an oval footprint, must be oriented precisely for proper labeling. A single screw, no matter how closely cut, will probably allow some rotation. A pair of counter rotating screws, one on each side of the container will align it more precisely. Tall, unstable containers may have a tendency to fall over in a single timing screw. A pair of screws, one mounted above the other, can be used to prevent this.

Timing screws are commonly made from engineering plastics such as **Delrin** and **ultra high molecular weight polyethylene** (UHMWPE). Plastics are available in a wide range of colors and these can be used to color code screws, along with other change parts and settings to simplify changeover. Screws may also be made of metal such as **brass, steel** or **aluminum** where the product, such as metal cans or glass bottles and/or high speeds might cause excessive wear to the screw. It is important that the material used be compatible with the container to avoid scuffing.

— Design Concepts

Although commonly called timing screws, they have many other applications besides **timing** and **synchronization**. Screw designers are always coming up with new and innovative uses. One such was a design to carry broccoli stalks through a slicing machine. Another application used a pair of timing screws instead of a conveyor to gently transport incandescent light bulbs. Some common uses of screws include:





Collating – The timing screw is cut to allow 2 or more containers in each pocket. The screw discharges 2 containers per revolution with space between each group as a function of screw pitch and relative conveyor speed.

Combining – Two lines of containers come together at a pair of screws. These screws are 180 degrees out of phase so that the discharge of each screw smoothly combines containers into a single file.

Dividing – A pair of screws is cut and synchronized so that the OD of each screw alternately pushes the container into the pocket of the other. Guide rails at the discharge separate the discharge of the 2 screws into two lines.

Dwell – In some operations it is desirable to pause a container momentarily. The application of wax to a wine bottle cork is one example. A pocket on a timing screw is cut so that it has a zero pitch for a portion of a revolution. This allows the screw to run continuously at a constant speed while the container pauses momentarily.

Turning – A pair of timing screws is cut such that oblong or oval containers may be turned 90 degrees from parallel to cross-wise on the conveyor or vice-versa.

Inverting – A timing screw combined with rails can be used to invert a container, for example to pass it over an air jet for cleaning. The container can be discharged in the inverted position or reverted to its normal position.





— Troubleshooting

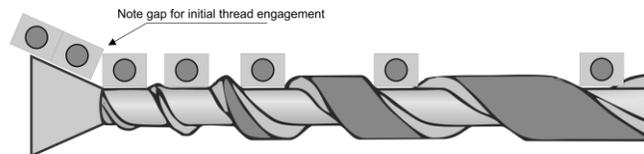
Attention must be paid to the **screw infeed design**. Failure to do so may result in the thread hitting the container rather than the space between. When this happens, the container or the screw can be damaged or a jam can occur. Round containers are generally fairly simple to feed since their shape leaves a "V" between bottles for the thread to initially engage. In lower speed applications, it may even be possible to feed round bottles to the screw randomly.

In general, all screws will work better with a **backlog** of at least 3-6 bottles at the infeed. The backlog assists in pushing the container into the screw as well as ensuring that the container is properly aligned with the first thread. **Line controls** should be used to stop the machine anytime the backlog drops below a certain minimum. This can be done with a simple photoeye mounted upstream of the screw infeed.

Non-round containers can be more difficult particularly in the case of a square or rectangular container with non-rounded corners. These will run fine once in the screw pocket but the lack of a gap makes initial thread engagement difficult. One way to solve this is via the use of an **inverse taper** or **cone infeed**.



Conveyor rails guide the container into the screw at an angle. As they straighten out in the body of the screw, a gap is created into which the screw thread can be introduced.



Screws frequently run at a continuous speed timed to the machine they are feeding. Traditionally has been done with been with mechanical linkage to the machine's main drive system. In recent years the trend has been away from single large motors with complex drives. These have been replaced by a number of small servo motors dedicated to a single task such as driving the timing screw. This simplifies machine construction, maintenance and adjustment.

Timing screws may run intermittently for applications such as positioning a group of bottles under inline filler nozzles. These screws might need to position 8 bottles, then, on a signal, make 8 rotations to bring 8 more empty bottles under the nozzles. Single revolution clutches can be used to achieve this. This clutch connects the drive motor with an 1:8 ratio. On a signal from the filler, the clutch engages for a single revolution then stops and locks in the home position. The 1:8 ratio gives 8 revolutions of the screw.



In some cases, such as infeed to an inline labeler, precise timing is not required. The screw is used to **orient** and provide a minimum separation to **prevent jams**. Where this is the case, the screw is often driven by a DC motor with a potentiometer speed control. Discharge spacing of the containers is a function of screw speed relative to conveyor speed.

Some screws are designed so that they can be **rotated** on the drive shaft and must be carefully timed each time they are mounted. This may save a few dollars on the screw and drive cost but at the expense of lost time on every changeover. Timing screws should always use keyed or pinned shafts so that they can only be mounted in the correct, properly timed orientation. Any adjustment to timing should be done on the screw and then locked in place for precise mounting on future changeovers.

A common misconception about timing screws is that the trailing edge of the pocket should push the container along the conveyor. This can lead to containers falling over in the pocket. The reality is that in most cases, the conveyor should push the container against the leading edge of the pocket. The rule of thumb is that the conveyor, at the screw discharge, should run about 10% faster than the linear speed of the screw.



Conclusion

Timing screws are so common in packaging applications that they are often taken for granted. They are simple but valuable devices that contribute much. A bit of understanding of their nature will improve their performance.

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