AUTOMATIC HOIST SYSTEMS UTILIZED IN METAL FINISHING:

PAST AND PRESENT

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Electrified processes, plating, anodizing, reverse cleaning, as well as non-electrified processes such as cleaning, etching, rinsing, phosphating, chromating, etc. can be handled by automatic, preprogrammed machines that are specifically designed for individual processes. The following paper reviews typical styles of equipment, linear hoist systems as well as return type systems, utilized in the Metal Finishing Industry over the past thirty years and is an attempt to familiarize the reader with some of the more popular choices of automatic wet processing equipment available today. It is not intended to be an all-inclusive summary of equipment but rather a look at the more common equipment in operation today.

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STYLES OF EQUIPMENT

In general, two basic styles of automatic equipment are available in the industry today: Linear motion tanklines and return type machines. Both designs have been utilized for decades and both have their appropriate applications. Linear motion tanklines are serviced by preprogrammed hoists that travel the length of the tankline, per predetermined process sequences, and lift or drop work pieces into tanks for predetermined process times. The hoist(s) may travel forward or reverse and lift or drop at any station on the tankline, ultimately delivering finished work pieces to an unload station. Return type machines travel only in the forward direction and rely on an indexing motion that occurs on a fixed cycle, carrying multiple arms loaded with work pieces through a series of tanks placed in a "race track" configuration in the exact order of the process sequence. Return type machines always return the arms to the same load/unload stations, since they are permanently fixed to a chain.

A more detailed discussion of the two styles of equipment follows.

LINEAR MOTION TANKLINES

***Sidearm Hoists*:**

A structure is mounted along the rear side of the tankline that supports a pair of rails, upon which a motorized hoist rolls. A cantilevered arm that carries work pieces (called flight bars) extends out over the centerline of the tanks. The hoist has the capability to raise or lower the cantilevered arm and therefore lift or drop the flight bar at the center of each tank in the appropriate process sequence as dictated by the control system. The sidearm hoist has the ability to deposit work into a tank and then move away to move another flight bar into a different location, therefore having the ability to move multiple flight bars in multiple tanks to maximize work throughput.

Sidearm hoists are limited in lift capacity and work size by the fact that the lifting arm is cantilevered and subject to bending both horizontally due to acceleration or deceleration or vertically due to the weight of the flight bar and work. Sidearm hoists have been utilized very successfully for many years in the circuit board industry as well as for barrel processes. The distinct advantage of the sidearm hoist is the clear passage for the operator on the front side of the tankline.

Many versions of the sidearm hoist have been developed over the years with either rack and pinion or friction wheel drive systems, and endless chain, ball screw, belt and pulley, and even pneumatic and hydraulic lift systems. Up barrel rotation systems, live entry, spray wash booths, air knives, fume control booths have all been fitted to the sidearm hoist for specific applications over the years. In short, the sidearm hoist is very versatile and has been a workhorse in the industry for the past thirty years or more.

***Overhead Hoists*:**

Figure 1 - Overhead hoist

This style hoist has several versions with the common component being the pair of rails that they ride on. The rails may be suspended from the building steel or be supported by a free-standing inverted "U" structure, depending upon the individual application. The hoist may ride on top of the rails or be suspended underneath the rails, with the travel wheels riding on the flange of the I beam running rail. In some cases, ASCE railroad style running rails are mounted on top of I beams to support bridge crane type overhead hoists, with flanged steel wheels. Travel drives may be friction wheel or rack and pinion style.

Lifting of the flight bar is accomplished in several ways. Fixed double channel lift legs with self contained lift carriages operated by endless chains with lifting lugs are commonly used. The fixed lift leg hoist style straddles the flight bar and lifts the flight bar up inside the hoist, providing a very safe and stable operation. Tilting of the flight bar is also possible using this style hoist, since each lift carriage may be powered and operated separately.

Another version of the overhead hoist is called a "center lift" overhead style hoist. Depending upon the width of the flight bar, either a single or double column made of box tubing is attached vertically to the overhead bridge section of the hoist. An arm rides a set of rollers that surrounds the vertical tube(s) and reaches out in front of the column(s). Either a cable or a pulley and strap is employed to lift the arm which aligns with the pick-ups of the flight bar. The column(s) travel within the space between the flight bar pick-ups and thereby is allowed to travel the length of the line in either the full up of down position without interference.

The advantage of the center lift design is its relatively low cost and simplicity. The support rails may be spaced considerably closer than the width of the tanks. The disadvantage is the location of the lift mechanism directly over the fume path of chemical process tanks and exposure to fumes as the work travels in the uppermost position.

In some cases a single monorail may be used with the above design, where light loads and symmetrical flight bars and work loading are used.

***<u>Rail Style Hoists</u>*:**

Figure 2 - Rail style hoist

Recently, a hoist with four wheels that rides upon a pair of stainless steel square tubes has become very popular in the industry. The design is very versatile and allows the flight bar to be tilted for drainage (to minimize drag out). Additionally, an exhaust booth may be fitted to the rail style hoist design to capture fugitive emissions emanating from the work piece during transfer from tank to tank. Coupled with covered tanks, a chemical processing room can have very high air quality, all but eliminating worker exposure to chemical fumes.

Rail style hoists generally ride on urethane wheels and are propelled by one wheel on each of the rails. Travel wheels may be driven by a common drive shaft with a single motor, or may be driven by two load-sharing motors, each coupled to a drive wheel. One side of the hoist is guided by wheels that contact the sides of the rear rail and maintain tracking of the hoist.

Several types of lifting mechanisms are available; lift carriages with endless chain; belt and pulley; and cable type. In the first type, individual lift carriages ride within channels that make up the ends of the hoist, similar in concept to those used in side arm and overhead hoists. In the second type, belts are attached to a lift boom and wind up onto pulleys attached to a lifting motor. Lift belts rely upon a torque limiter to prevent belt failure if the upper travel limit switch is not sensed (and the lift motor over travels). Lift carriages utilizing endless chains with lifting lugs have the advantage of being able to go up and over the top sprocket without bind up or danger. In some cases, cables may be uses in the same manner as lift belts, with the same considerations for over travel being a disadvantage. Cables are exposed to fumes in the same manner as belts but do not have the chemical resistance.

RETURN TYPE MACHINES

Elevator Conveyor:

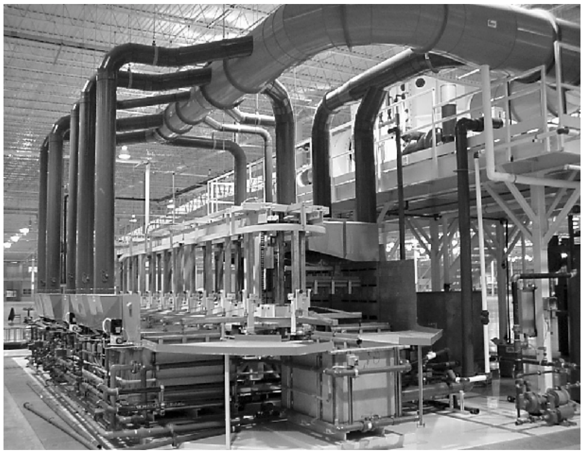

Figure 3 - Elevator Conveyor

The Elevator Conveyor is known for its high volume production capability, low maintenance, and unique cycle flexibility. It is a "dwell" type machine with intermittent motion. The movement of the machine is accomplished using simple mechanical principles to achieve smooth, precise forward index, lift and lower.

The transfer pattern is lift, pause (optional), transfer forward, lower, and dwell. Racks, trays, baskets or barrels supporting the work are attached to, or suspended from, the carrier arms and transferred through the process cycle repeatedly - exactly as desired. Single file, double file, or multiple file carrier arm configurations are available.

The typical Elevator conveyor has a maximum load carrying capacity of 300 pounds per carrier arm. Other models are available with capacities up to 1000 pounds per carrier arm. Carrier arms can be designed to accommodate a wide variety of work sizes and shapes with spacing between carrier arms ranging from 18 to 84 inches. Lift heights are possible up to 120 inches. Production rates up to 120 carrier arms per hour are possible in some instances with 60 to 80 being the most common.

Unique cycle flexibility is easily provided with options for automatic cycle selection using by-pass, delayed set-down, or advanced pick-up features. Auxiliary anodes and live entry/exit allow for custom designed process control. Work oscillation, horizontal and (or) vertical, can be used as required. Options for storage by-pass as well as sophisticated automatic grease and oil lubrication systems are available. The bolted construction and simple design of the mechanism allows easy process cycle modification as production requirements and products change.

The machine consists of a central mechanism placed between two rows of process tanks. It is made up of two elements: the forward indexing drive mechanism and the lift mechanism.

Forward Indexing Drive Mechanism

Each carrier arm is attached to a "roller skate", usually called a slide-arm assembly, which rolls on a square tube mounted vertically to attachments secured to the upper and lower chains. The chains extend the full length of the conveyor, passing around sprockets fixed to vertical shafts at both ends of the conveyor. One shaft is driven by a brake motor and gear reduction unit. The other, an idler shaft, is equipped with a take-up device. In a large conveyor, both shafts may be driven, and are equipped with take-ups.

Since the vertical guide tubes are attached to both the upper and lower chains at equal intervals all around the conveyor, the chains move all the carrier arms during forward motion, keeping equal space between them.

The complete chain assembly, including the vertical guide tubes and carrier arms, is supported by rollers, which are attached to the bottom chain and roll on the lower chain guide rails.

The positive forward indexing drive arrangement insures precise location of carrier arms, requiring minimum clearances at tank barriers. Arms cannot be accidentally moved out of position during routine tank maintenance procedures.

Lift Mechanism

A steel cam roller mounted on the back of the slide arm assembly engages a lift point - a fixed track or gate (often called a "flipper") - on the elevator mechanism whenever vertical movement is required. Where carrier arms are required to remain down in multiple station tanks, the elevator has no lift points. Where carrier arms are required to remain up to bypass specific stations, the machine is equipped with gates on the by-pass assembly. Where variable control is desired over the time a particular carrier remains in solution, either a delayed set-down or advanced pick-up mechanism is used.

For lift points, hinged gates (or "flippers") are used at the entry and exit stations of multiple station tanks; and fixed angle track over single station tanks.

Because the elevator is one unit, all lifts are made simultaneously. The elevator is lifted and lowered by a hydraulic cylinder (or multiple cylinders on larger machines) and guided in its vertical movement by cam rollers riding on square tubes welded to the face of each column. The hydraulic system incorporates a two-speed control of the lift movement for smooth operation.

Accessory Equipment

Automatic rack loaders transfer racks between the elevator conveyor and a monorail conveyor. Units are available for one, two, or four stations to load and unload either single or double file conveyors to and from a single file monorail conveyor; up to 120 racks per hour single file or 240 racks per hour double file may be handled.

On-line dryers can be built into the Elevator conveyor to save floor space. The parts leave the conveyor dry, ready for handling, assembly or packaging.

Split Rail Machine:

The split rail design machine accommodates a fixed cycle in the same manner as an elevator conveyor. The lift mechanism differs in that it lifts all of the carrier arms simultaneously with a pusher mechanism causing the indexing action. All of the carrier arms are indexed ahead one station per index stroke. The machine has the ability to leave a carrier arm in the lower submersed position in order to allow for an uninterrupted process to occur for more than one lift cycle.

Finger Machine:

The finger machine works upon the concept that arms are attached to a chain that is guided along the top perimeter of a series of tanks. Through the use of a caster wheel that is mounted to each arm carrying work (or finger) the arm is raised or lowered into a series of adjacent tanks by means of the caster riding an inclined , flat, or declined guide surface that is mounted behind the tankline. The finger machine chain may wind around a series of tanks through the use of pulleys and chain guides, with arms mounted at close proximity to each other, dictated by the size of the work being carried. Finger machines are capable of high production and are very simple. The limitation of the design is the weight of the parts to be processed and a relatively inflexible process sequence.

Oblique Barrel Machine:

The Oblique Barrel Machine has its place in barrel processing where high production and a fixed process is required. The design accommodates both electrified and non-electrified processes, as a stand alone barrel also would. This type of machine is very similar in concept to a finger machine except that each arm carries an oblique barrel (a barrel with one end larger in diameter than the other) with its smaller open end mounted on the inside of an arm. A chain that has the arms mounted to it rides on a pair of sprockets similar to an elevator conveyor machine. A roller (sprocket) mounted to the carrier arm also rides a guide surface that raises or lowers the barrel into or out of the process tanks. At the load station the oblique barrel may be automatically loaded by means of a vibratory conveyor or unloaded onto a chute or belt style conveyor. It is a very old proven design, with many of them still in operation today.

CONCLUSION

Over the past century many styles of hoists and return type machines have been developed. Products have changed and have required new processes to be developed, requiring new styles of equipment. History, however, provides us with many approaches to problems that were solved years ago. The two styles of process equipment available today are Linear Hoist Systems and Return Type Machines. Both have been around for decades. The process sequence of the parts being finished and the production rate at which they must be produced will determine which type of equipment is appropriate for the application. The area of controls is where giant steps have taken place over the past decade, due to the development of computers, windows style operating systems, and Programmable Logic Controllers (PLC's). Positioning systems have also improved in reliability and accuracy and are now available at a fraction of the cost that they were introduced at. Progress is continuously being made in area of controls programming and consistent quality is now possible. The styles of hoist systems have remained very much unchanged over the years.