The Science of Palletizing

The science of palletizing and how to pick the right system

Foreword

"The Science of Palletizing" is an educational introduction to the basics of unit-load forming and is designed to familiarize you with the fundamentals of palletizing.

Since all palletizing applications are unique, selecting a machine to meet your specific needs cannot be done by simply reading this book. However, this information should prove to be an essential ingredient in the selection process.

This book includes updated information from our two previous publications: "The Science of Palletizing" and "How to Pick the Right System," and "The Science of Palletizing, Volume Two – Systems." These versions were first released in 1987 and 1988 and were enthusiastically received by the material handling industry, with over 45,000 copies being circulated. In this edition, we have added updates on the latest trends in palletizing and a section on robotic palletizers, which are now playing a major role in manufacturing.

If you have additional questions not covered in this publication, or a specific application for which you require assistance, fill out the reply card at the back of the book and send it in, or call us anytime at 360-690-1380. We will be happy to respond promptly.

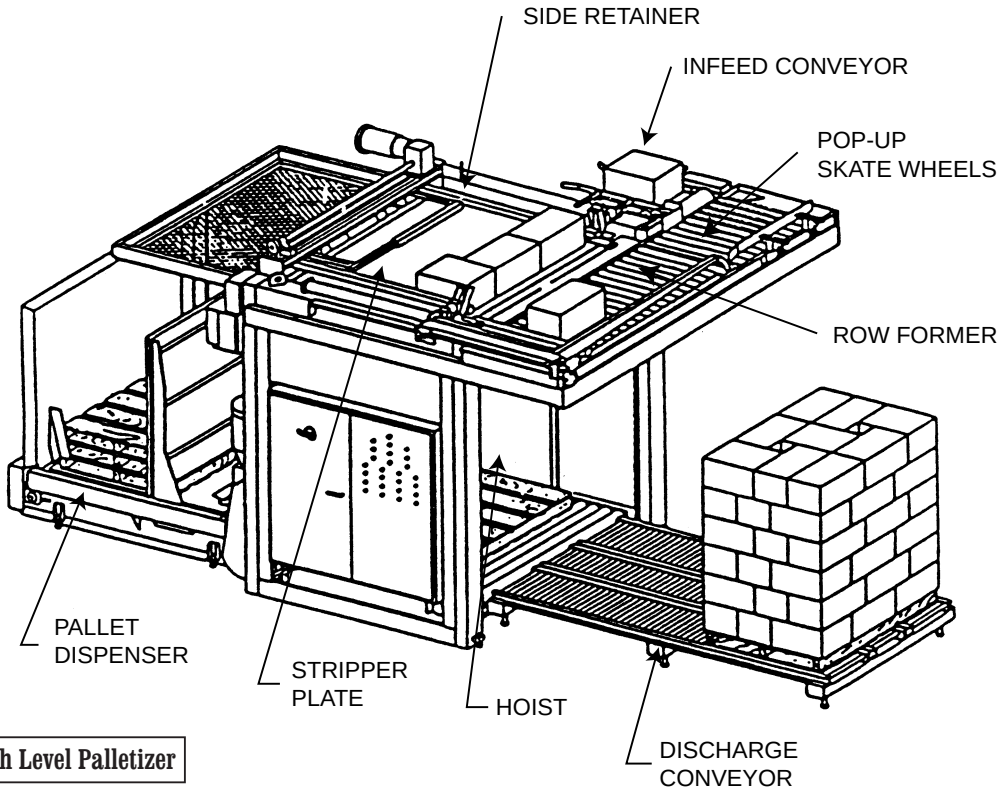
Please Note:

Many of the drawings and photographs shown in this book do not show appropriate safety guarding. The guards were left out for clarity.

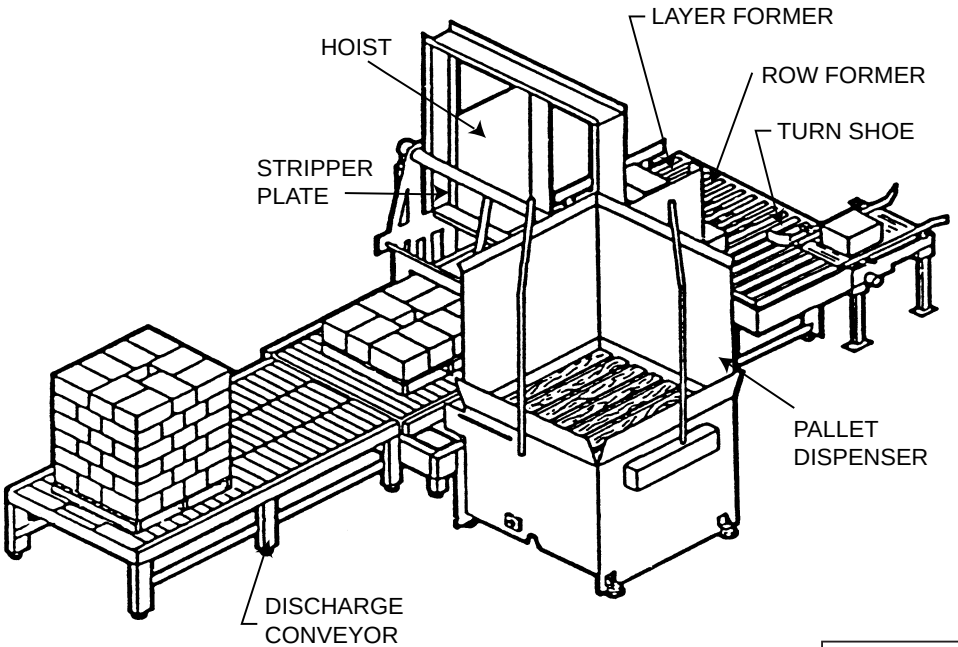
Basic Palletizer Configurations

There are two styles of non-robotic palletizers that will be discussed in the first sections of this publication: "high level" and "floor level" palletizers.

The following diagrams provide a basic overview of the location and names of the key assemblies and subassemblies.



High Level Palletizer



Floor Level Palletizer

Science of Palletizing Index

Fig. No.		Page No.
	The Science Of Palletizing	5
1	High Level Machine	5
2	Two Different Styles of Floor Level Machines	6
	Typical Products To Be Palletized	7
3	Cleansers and Detergents	7
4	Paper Products	7
5	Miscellaneous Products That Are Palletized	7
	Machine Flexibility	8
	Palletizer Conventions	8
6	Right Side Infeed – Floor Level	8
7	Right Front Infeed – Floor Level	8
8	Right Rear Infeed – Floor Level	9
9	Left Side Infeed – High Level	9
10	Left Rear Infeed – High Level	9
11	Right Front Infeed – High Level	9
	Load Variety	10
	Pallet Placement	10
12	Full Load Accurately Positioned on the Pallet	10
	Slip Sheets	10
13	Full Load Built on a Slip Sheet and a Pallet	11
14	Full Load Built on a Slip Sheet Without a Pallet	11
	Tie Sheets	11
15	Tie Sheet Inserted Between Layers	11
	Cap Sheets	12
16	Cap Sheet Placed on Top of the Load	12
	Stretchwrapping	12
17	Floor Level Palletizer with Stretchwrapper	12
18	High Level Palletizer with Stretchwrapper	13
19	Three Palletizers Feeding One Stretchwrap Machine	13
	Floor Level and High Level; Advantages and Disadvantages	14
20	High Level Palletizer with Mezzanine and Stairs	14
	Palletizers Fed by Single or Multiple Conveyor Lines	15
21	Single or Dedicated Line Feeding the Palletizer	15
22	Five Conveyor Lines Feeding Into One Palletizer	15
23	Accumulating Cases in Full Pallet Loads	16
24	This Full Load Requires 42 Cases, Six Layers at Seven Cases Per Layer	16
	Speed	17
25	10 Cases/Layer @ 30 Cases Per Minute	17
26	Four Cases/Layer @ 18 Cases Per Minute	17
27	20 Cases/Layer @ 40 Cases Per Minute	17
	Correct Speed Quotations Are Essential	18
	Modular Construction Makes System Upgrading Easier and Less Costly	18
28	25-Case-Per-Minute Palletizer Has a Single Row Pusher But No Layer Table	18
29	50-Case-Per-Minute Palletizer Has a Layer Table to Store Cases While the Hoist is in Operation	18
30	A Floor Level Machine With a Row Pusher	19
31	The Same Machine (Fig. 30) But With the Layer Table Shown in Modules	19
	Electric vs. Hydraulic	19
	Controls	20
32	Control Panel With Programmable Controller Controls	20
33	Pulsed LED Photocells	20
34	Proximity Switch	20
35	Diagnostic Display	21
36	Two Types of Graphics Operator Interface	21
	Pallets	22
37	Two-Way	22
38	Four-Way G.M.A.	22
39	Stringer	22
40	Winged	22
41	Block	22
42	Nesting	22
43	Different Styles of Plastic Pallets	23
44	Plastic Pallets With Four-Way Entry	23
45	CHEP Stringer, Mark 3 Pallet	24
46	CHEP Four-Way, Mark 55 Pallet	24
47	Plywood Pallet	24
	Pallet Dispenser Location	25
	Access to the Pallet Dispenser	25
48	Access for Loading the Pallet Dispenser	25
	Access To Discharge Conveyor for Full Load Removal	25
49	Access to the Discharge Conveyor for Full Load Removal	25
	Interfacing With Auxiliary Equipment	26
50	Interfacing With Auxiliary Equipment	26
	Discharge Conveyor	26
51	Gravity	26
52	Belt-Driven Live Roller	26
53	Chain	26
54	Slat	27
55	Roll-To-Roll Chain Driven	27
56	Three-Lane Staggered Discharge Conveyor	27
	Load Protection and Stabilization	28
57	Double Hopper Sheet Feeder for Slip and Tie Sheets	28
58	Single Hopper Bulk Loading Sheet Feeder	29
59	Double Hopper Bulk Loading Sheet Feeder	29
	Glue Systems	29
	Load Stack Quality	30
	Case Patterns	30
60	Case Stop in the Pattern Forming Area, UP	30
61	Case Stop in the Pattern Forming Area, DOWN	30
62	Square Cases Column Stacked	31

Science of Palletizing Index
(continued)

Fig. No.		Page No.
63	Rectangular Cases Interlocked	31
64	Interlocked Load with Gaps Side-To-Side	31
65	Interlocked Load with Gaps Front-To-Back	31
	Pusher Gate Operation Steps	32
66	Pusher Gate Operation	32
67	Gaps Created in a Pattern Using a Pusher Bar	32
68	High C.G. and Ideal Cases	33
69	Different Size Cases in One Load	33
70	Columns of Different Color or Flavor	33
	Robotic Palletizers	34
	Robot Conventions and Terminology	34
71	Cartesian Robot	34
72	Scara Robot	34
73	Articulating Arm Robot	35
74	Gantry Robot	35
	Production vs. Distribution	35
	Types of Robots	36
75	Cartesian Robot (Columbia/Okura)	36
76	Scara Robot (Costi Robots)	36
77	Articulating Arm Robot (Columbia/Okura)	36
78	Gantry Robot (Costi Robots)	36
	Robot Summary	37
	End Effectors	37
79	Vacuum End Effector	38
80	Clamp End Effector	38
81	Finger Style End Effector	38
82	Combination End Effector	38
	Vacuum	38
	Clamp	39
83	Combination End Effector Using Carton Clamp and Pallet Tool	39
84	Multi-Pick Multi-Place End Effector	39
	Finger	39
85	Finger Style End Effector Showing the Individual Finger Spacing	39
86	Combination End Effector That Can Handle Product, Pallets and Sheets	40
	Hybrid Palletizing	40
87	Robot Stacking a Partial Layer in One Cycle	40
88	Robot Stacking a Complete Layer in One Cycle	40
	Mixed Products and End of Aisle Displays	41
89	Mixed Load by Color (Tissue)	41
90	Mixed Load by Flavor (Potato Chips)	41
91	Building a Mixed Pallet Load	41
	Channels of Distribution	41
	Factory Test	43
	Post Sale Support	44
	Systems	44
92	Typical Material Handling System	44
	Material Handling System	45
93	Typical Material Handling System Showing Recirculating Line Used with Conveyor Sorting	46
	Reasons Product is Diverted to Recirculation Line or Hand Stack Lines	46
	Bar Codes and Labels	47

Fig. No.		Page No.
94	Typical Pre-Printed Bar-Code Labels	47
95	Cartons with Preprinted Bar-Codes	48
96	Ink Jet Printing Directly onto the Carton (Marsh Co.)	48
	Bar-Code Reading	49
97	Bar-Code Reading (Keyence Corporation of America)	49
98	Long Distance Bar-Code Reading (Keyence Corporation of America)	49
	Applying Bar-Code Labels to Full Pallet Loads	49
99	Automatic Print/Apply Pallet Labeling System (Kolinahr Systems Inc.)	49
	Case Conveyors and Diverters	50
100	Air-Operated, Padded-Chain, Zero-Pressure Accumulating Conveyor (Rapistan)	50
101	Two Percent, Back-Pressure Accumulating Conveyor (Hytrol)	50
102	Ermanco's Xenorol (Ermanco)	51
103	Accumulating Conveyor (Ermanco)	51
104	Lineshaft Conveyor (Rapistan)	51
105	Curved Lineshaft Conveyor (Rapistan)	51
106	Decline Belt Conveyor (Rapistan)	52
107	Incline Belt Conveyor (Rapistan)	52
	Sorting Merges and Diverters	52
108	Air Operated Pusher (Hytrol)	52
109	Air Operated Pusher (Rapistan)	53
110	Pop-Up Wheel Sorter (Rapistan)	53
111	Steerable Roller Sorter (Rapistan)	54
112	Sliding Shoe Sorter (Rapistan)	54
	Discharge Conveyors	55
113	Pallet Bottom Boards Running Parallel to Pallet Flow	55
114	Pallet Bottom Boards Running Perpendicular to Pallet Flow	55
115	Right Angle Transfer (Rapistan)	55
116	Full Load Turntable (Hytrol)	55
	Stretchwrappers	56
117	Manually Loaded Stretchwrapper (ITW Mima)	56
118	Automatic Turntable Style Stretchwrapper (ITW Mima)	56
119	Stretchwrapper where the Film Web Rotates Around a Stationary Load (ITW Mima)	56
120	Corner Post Placer (ITW Mima)	56
	Double Stacked Loads	57
121	Full Load Double Stacking Done by the Palletizer	57
	Personal Computers vs. Programmable Logic Controllers	57
	Why Change from PLC Controls to PC Controls?	58
	Safety	59
	Summary	60
	Acknowledgements	61
	Columbia Information Service	62
	Bulletins, Brochures, Videos and CDs	63
	Columbia Technical Services	64

The Science Of Palletizing

Hand stacking cases into pallet loads for storage or direct distribution has been around since the very first packaging lines were installed. However, as production rates increased to levels of 20 cases per minute and beyond, an automatic means for stacking cases became necessary.

In the 1950s and early 1960s, several companies developed these case-stacking machines, which came to be known as "palletizers." Most of these companies developed the machines independently, yet with similar design concepts, including high-level case infeeds (at typical elevations of 8' – 0" to 10' – 0") and full load discharge elevations of 12" to 18". But one company developed a very different machine with a case infeed elevation of 30" and a full load discharge elevation of 30".

The first type of palletizer referred to here is known as a "high level" machine (Fig. 1, case infeed at 8' – 0" to 10' – 0"), while the later is a "floor level" machine (Fig. 2, case infeed at 30").

Fig. 1 High Level Machine

The Science Of Palletizing
(continued)

The terms "palletizing" and "unitizing" are used synonymously by most manufacturers of this equipment. However, there are some distinct differences between these two terms. Palletizing refers to a uniform load stacked on a wooden or plastic pallet using a predetermined case-pattern sequence and a given number of layers. Unitizing, which is also known as "load forming" or "unit load forming," carries out this same stacking procedure, but **without** a pallet. Unitized loads may or may not be stacked on a slip sheet.

Fig. 2 Two Different Styles of Floor Level Machines

Typical Products To Be Palletized

A single palletizer can handle a very wide range of products (Figs 3, 4 and 5) such as cases of canned peas, trays of soft drink, cases of beer, paper, detergent, etc. These products, once cased and sealed, are conveyed to the palletizer where they are stacked in a predetermined pattern and number of layers.

Fig. 3 Cleansers and Detergents

Fig. 4 Paper Products

Fig. 5 Miscellaneous Products That Are Palletized

Machine Flexibility

A palletizer with an adjustable pallet magazine can handle different sizes of pallets. Also, a multitude of pattern configurations and stacking heights can be programmed into a solid state programmable logic controller (PLC), or personal computer (PC) controls.

There are many advantages to using PC controls, including the use of flow diagram logic, which simplifies troubleshooting and adding case patterns. PC controls also allow on-screen access to the operators manual, safety information, preventive maintenance routines and spare parts information. Graphical information, such as diagrams that show the locations of all motors, switches, photocells, gearboxes and lubrication points, can also be accommodated in the PC.

Palletizer Conventions

The "hand" of the machine (left, right, front or rear) is determined by standing at the discharge area of the palletizer with the load coming out toward you. (Figs. 6 – 11). Cases entering the palletizer can be fed 90 degrees to the discharge (Fig. 6.) or rear fed moving parallel to the discharge (Fig. 8.). This applies to both floor level and high level palletizers.

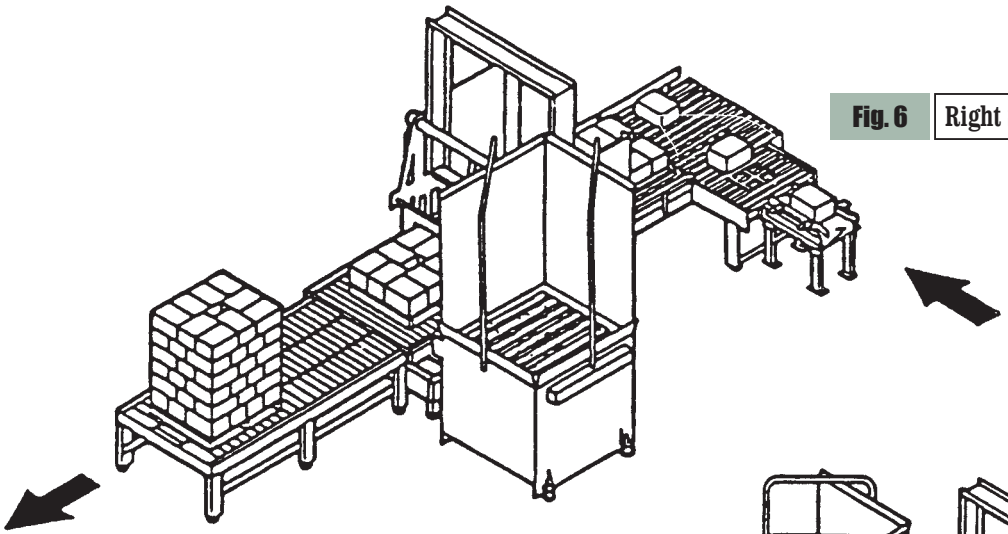


Fig. 6 Right Side Infeed – Floor Level

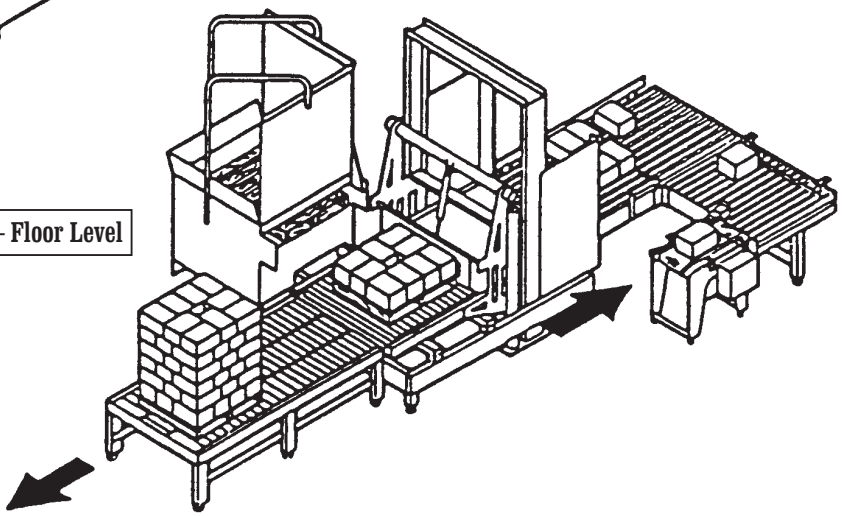


Fig. 7 Right Front Infeed – Floor Level

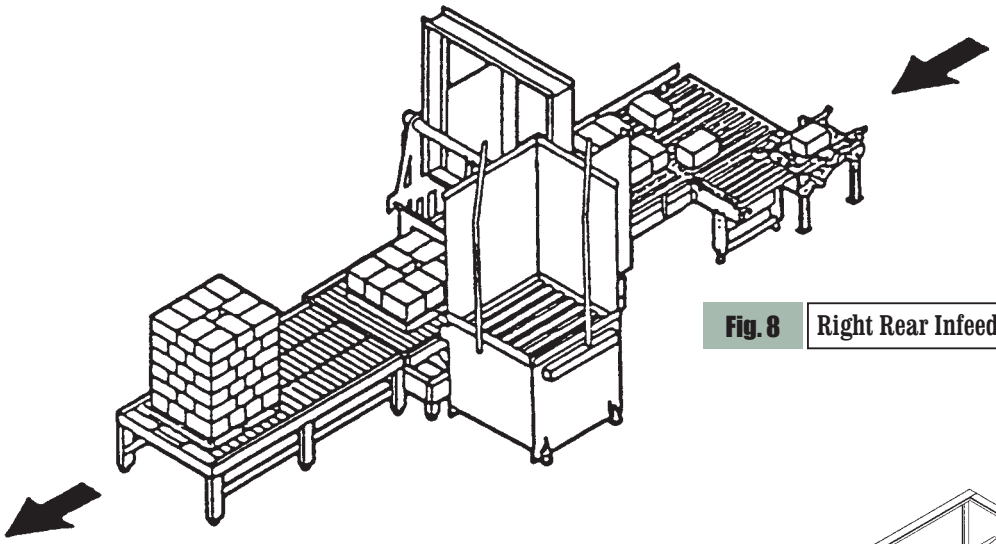


Fig. 8 Right Rear Infeed – Floor Level

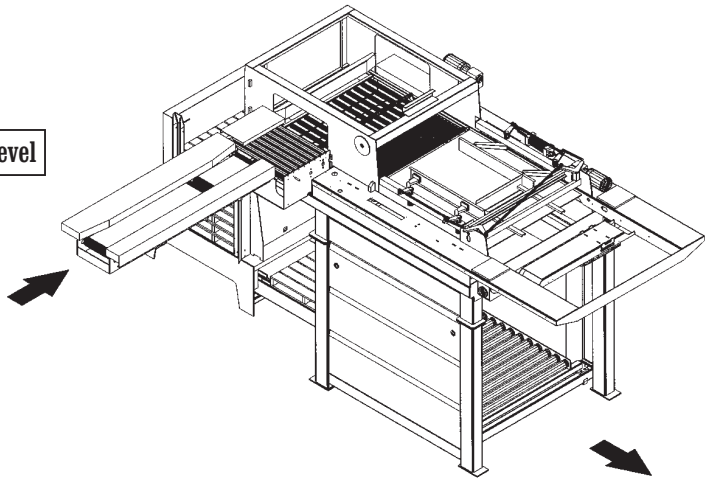


Fig. 9 Left Side Infeed – High Level

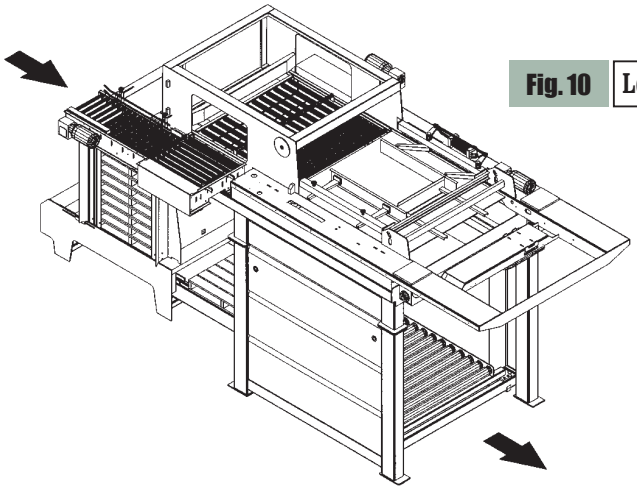


Fig. 10 Left Rear Infeed – High Level

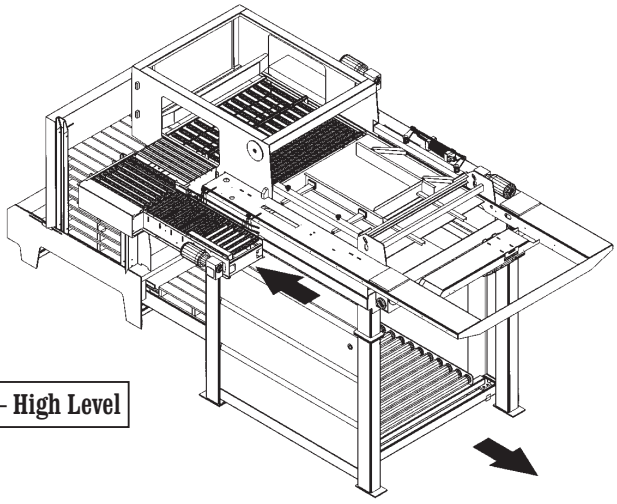


Fig. 11 Left Front Infeed – High Level

Load Variety

The standard load sizes available on a single palletizer typically range from 36" long by 36" wide to 50" long by 50" wide. The standard machine height capacity is typically 80". However, depending on your need, you can find machines to handle longer and wider load capacities, and very tall or very short loads; as high as 120" and as short as 36".

Today's palletizers can manipulate products from as small as 5" to 6" square. They can stack as many as 64 cartons per layer, or a single carton per layer up to a 50" by 40". Smaller cartons might be pharmaceutical products, while large cartons might be reams of folio paper for engineering drawings or calendars. Product weights and full load weights also vary dramatically. Cartons may weigh from two up to 250 pounds, while full pallet loads may be up to 6,000 pounds.

Pallet Placement

Careful pallet handling is needed to ensure correct load position on the pallet and that pallet jams are avoided. If pallets have nails sticking up or boards missing, there is a very high probability of a pallet jam or a problem occurring on the discharge conveyor once the pallet is loaded. To prevent such problems, the pallet must be backed up against a mechanical stop when deposited onto the load building conveyor. This positions the pallet front to back while the side-to-side positioning is accomplished using side tier retainers. These also position each layer of product thereby assuring very square loads positioned accurately on the pallet (Fig. 12.).

Fig. 12 Full Load Accurately Positioned on the Pallet

Slip Sheets

Slip sheets, tie sheets and cap sheets are frequently used with food products. Slip sheets are sometimes placed on top of the pallet (Fig. 13.) where they act as a vapor barrier to guard against moisture on the ground or from wet pallets. Loads may also be built on slip sheets without pallets (Fig. 14.). These full loads are moved by lift trucks utilizing a push-pull attachment. This grips the lip of the sheet and pulls the load onto a plate (which replaces conventional forks). When unloading, the truck uses a pantograph pusher to slide the slip-sheet off the plate.

Fig. 13 Full Load Built on a Slip-sheet and a Pallet

Fig. 14 Full Load Built on a Slip-sheet Without a Pallet

Tie Sheets

While rectangular cases may be interlocked to provide stability, square cases can only be column stacked. Tie sheets can be automatically inserted between pre-selected layers to provide stability. They are generally used with column-stacked loads, square cases (Fig. 15.), or when many cases must be layered (20 or more). Other means to improve stability include incorporating strapping or string tying machines into the basic palletizer.

Fig. 15 Tie Sheet Inserted Between Layers

Cap Sheets

A cap sheet is used to protect the top of a load and is placed while still in the palletizer (Fig. 16) or at a position downstream, such as in the stretch wrap machine. Cap sheets are made from many different materials: Film protects the pallet load from environmental elements while heavy fiberboard minimizes damage when several loads are stacked on top of each other in the warehouse or during shipping.

Fig. 16 Cap Sheet Placed on Top of the Load

Stretch-wrapping

A very common and effective means of stabilizing a full palletized load is to have it stretchwrapped after it leaves the palletizer. Typically, the stretch wrap machine is located approximately 10 feet from the palletizer discharge. The full loads are fed automatically into the stretchwrapper where they are wrapped and discharged, ready for shipping (Fig. 17 and Fig. 18).

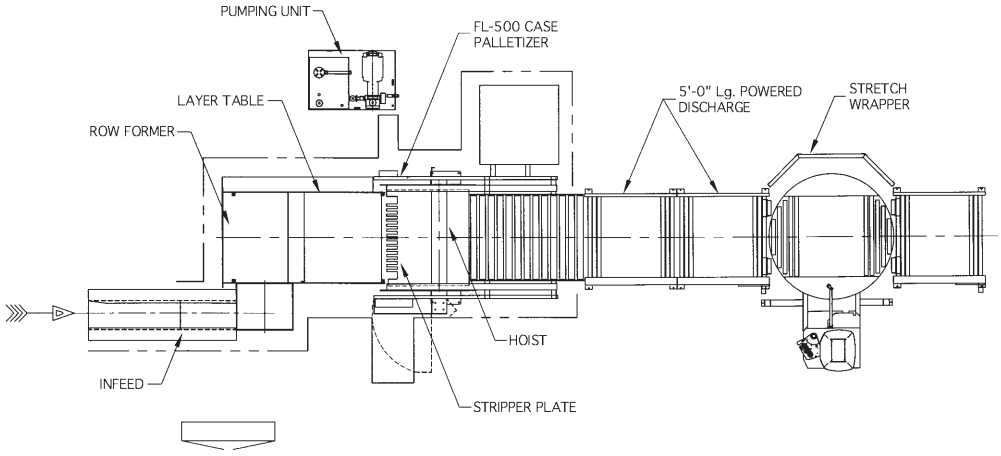


Fig. 17 Floor Level Palletizer with Stretchwrapper

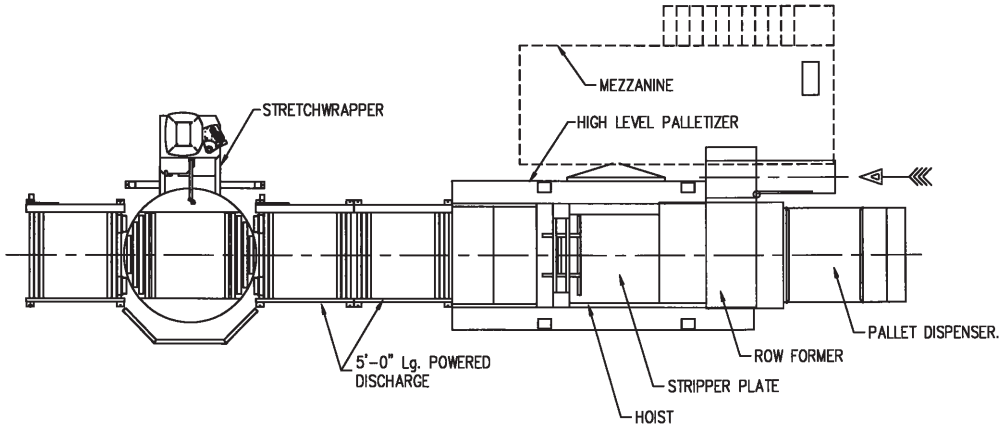


Fig. 18 High Level Palletizer with Stretchwrapper

When several palletizers are fed into one stretch wrap machine, it's common for a transfer or shuttle car to be used. The shuttle car picks up the full loads at each palletizer's discharge and delivers them to the stretch wrap machine infeed (Fig. 19). This method is very effective, less costly than a full-load discharge conveyor and does not restrict fork truck access to the palletizers so the trucks can be used to fill pallet dispensers.

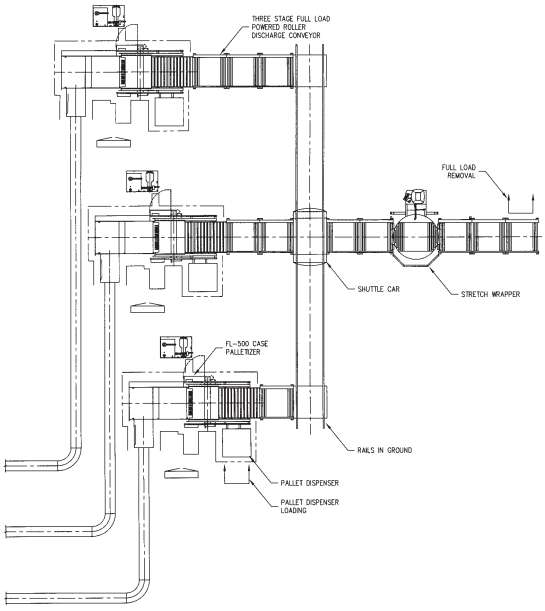


Fig. 19 Three Palletizers Feeding One Stretch Wrap Machine

Floor Level and High Level; Advantages and Disadvantages

Floor level palletizers have a case infeed entry level of approximately 30" (Fig. 2.). This makes them ideal for close coupling to case packers and case sealers, which have discharge elevations anywhere from 20" to 36". High level case palletizers have infeed elevations from 7 feet to 12 feet (Fig. 1). They are more suited to situations where the palletizer is located some distance from the case packer or sealer. An overhead conveyor is required to transport the cases from the case sealer to the palletizer.

One of the primary advantages of the floor level palletizer over the high level model is that a fork truck operator can monitor the floor level operation. And the operator can do this while filling the pallet magazine or removing a full load from the discharge conveyor. The 30" infeed elevation makes this possible.

A fork truck operator cannot easily control a high level machine because the operating position is 7' to 12' above the operator's line of sight. In addition to having to use a curved mirror placed above the machine (showing everything in reverse), the operator would have to leave his fork truck and climb the stairs to the mezzanine to observe the operation of the machine or straighten any case jams that might occur.

High level machines require this mezzanine/stairway configuration (Fig. 20), for operators to take care of case jams. Also, if a high level palletizer goes down for any reason, it is far more difficult to hand stack since the cases are entering the machine from above.

Also, service and maintenance work on a high level machine can be more difficult due to the elevation where cases are turned and arranged into layers.

The most significant advantage of the floor level machine is that the elevator or hoist lifts one layer at a time as it's built on a heavy-duty discharge conveyor. The high level machine hoist is required to support the full load as it is being built. The added work load of the high level machine hoist results in significantly more wear and tear over the lifetime of the machine.

Since the floor level machine hoist lifts only one layer and the load is stationary until it is discharged, it is effective at stacking unstable loads. These loads could possibly fall apart on a high level machine because it moves the hoist and load up and down for every layer.

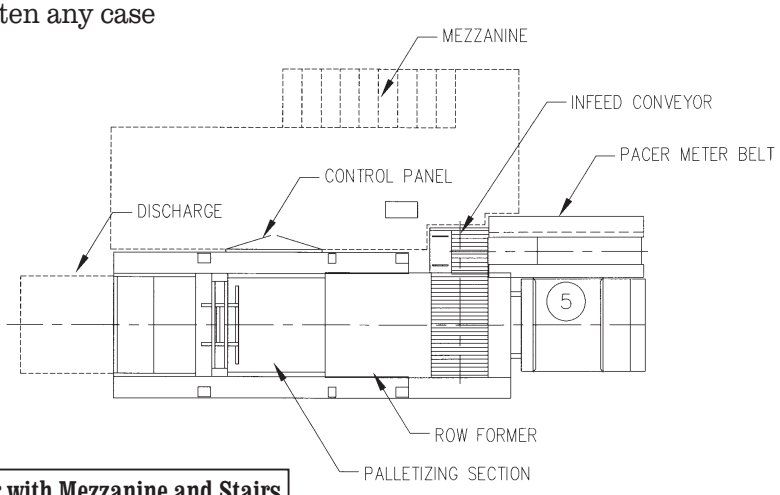


Fig. 20 High Level Palletizer with Mezzanine and Stairs

Palletizers Fed by Single or Multiple Conveyor Lines

The majority of palletizers in operation today are fed by a single conveyor from one packing line. This is called a dedicated machine (Fig. 21.).

It is also possible to have several packing lines feeding into one higher speed palletizer (Fig. 22.), thereby reducing the number of palletizers required. However, multiple line palletizing introduces a new consideration. There will be a need for an accumulating conveyor to s tore a full pallet load of product prior to palletizing where a dedicated floor level palletizer fed by a single line can be close coupled to the case sealer.

In the case of multiple product lines being fed into a single higher speed palletizer, the machine must be capable of running at a speed approximately 10 to 20% greater than the total accumulated rates of each of the conveyor lines feeding it. In other words, if three packaging lines running at an accumulated rate of ten cases per minute per line were feeding into one higher speed palletizer, it must run 10 to 20% faster than the thirty cases per minute being accumulated. The palletizer must handle from 33 to 36 cases per minute total.

In the example shown here (Fig. 22.), five lines are feeding into one palletizer. Each line may have a different product; some lines may carry corrugated cartons, some may carry trays or some may carry poly bundles. The products, however, are not mixed on each accumulation conveyor.

When a full load is detected on one of the accumulating conveyors, that line's meter belt starts and a count photocell counts the required number of packages onto the delivery conveyor. When the count is complete, the meter belt stops and the packages are allowed to accumulate on that conveyor again.

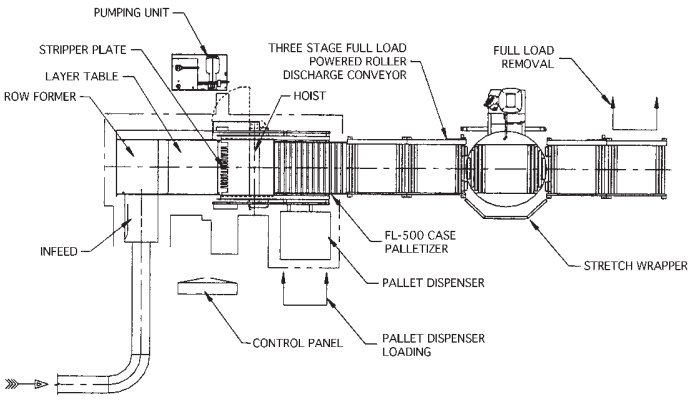


Fig. 21 Single or Dedicated Line Feeding the Palletizer

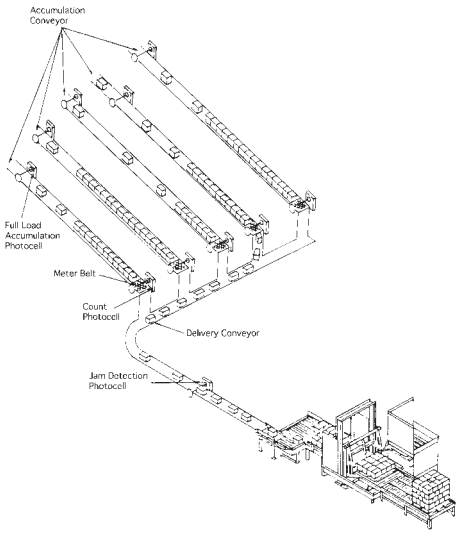


Fig. 22 Five Conveyor Lines Feeding into One Palletizer

Palletizers Fed by Single or Multiple Conveyor Lines (continued)

As soon as another line has a full load accumulated, it will also meter and count the packages onto the delivery conveyor immediately behind the first load. The conveyor control system releases each line based on either a first come first served or other prioritized basis. Several loads may be on the delivery conveyor at one time with one load of corrugated followed by a load of trays or poly bundles or vise versa. It is not unusual to have a quarter of a mile of delivery conveyor length.

The full loads on the delivery conveyor are tracked by either the PLC or a bar code, which is read prior to the packages entering the palletizer. The PLC controlling the conveyor system or bar code reader signals the PLC controlling the palletizer, indicating which product is next in line to be palletized. The product data has already been preprogrammed into the palletizer PLC, including pattern configuration and number of layers. As soon as the previous load has been built by the palletizer the machine automatically resets the program to the new data, adjusting row and layer guides if necessary.

As mentioned previously, when feeding multiple product lines into a single palletizer, consideration must be given to the accumulation of a full pallet load of each product prior to feeding them to the palletizer (Figs. 23 and 24). The length of each accumulation conveyor is typically 1½ times the full load length (assuming similar accumulation rates). This allows additional accumulation while one line is metering the products to the palletizer.

Let's take a typical example. If one packaging line is producing 18" long cartons and requires 80 cases to complete a full load, this equates to a full load length of 120 feet times 1½ which equals a total accumulation conveyor length of 180 feet. This simple equation would be repeated for the additional lines feeding the same palletizer.

You can see from this simple example that if the five accumulating conveyor lines each require 180 feet of conveyor, it can be costly depending on the type of conveyor chosen, especially when installation and commissioning are included. However, this cost must be weighed against the cost and installation of five palletizers.

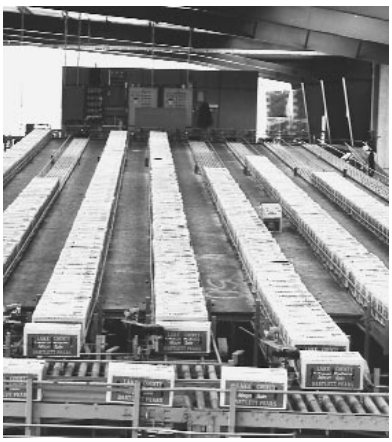


Fig. 23 Accumulating Cases in Full Pallet Loads

Fig. 24 This Full Load Requires 42 Cases, Six Layers at Seven Cases Per Layer

Speed

Speed seems to get the most consideration when pricing palletizers. However, the assumption that higher price equals faster speed is inaccurate.

One of the fundamentals of palletizing is that the more cases per layer, the faster the speed. Therefore, a machine that handles a 10-case-per-layer pattern configuration at 30 cases per minute may have a limitation of 18 cases per minute for a four-case-per-layer pattern configuration. Also, the same machine may run a 20-case-per-layer pattern configuration at 40 cases per minute (Figs. 25, 26 and 27).

When a customer considers speed requirements, he will often factor the maximum speed that his packaging line can run and add a "safety factor" of 25%. Palletizer manufacturers will give consideration to carton size and case pattern configuration to come up with a speed that includes an additional safety factor. Sometimes this duplication of safety factors can sway a customer from a lower speed to a higher speed machine. It is a common problem that with the attendant additional costs, a project may no longer be viable.

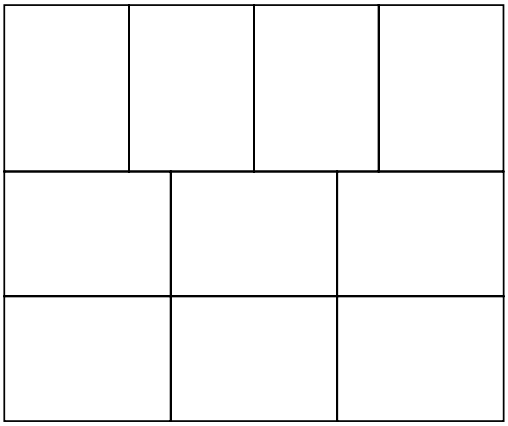


Fig. 25 10 Cases/Layer @ 30 Cases Per Minute

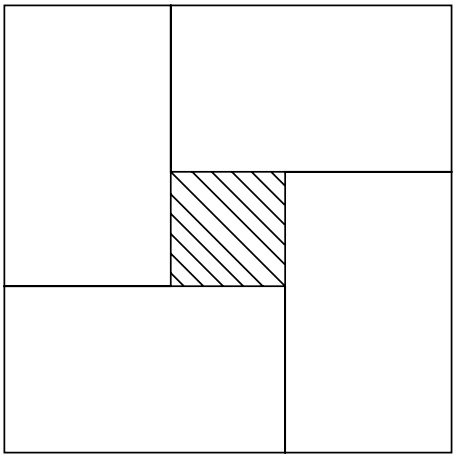


Fig. 26 Four Cases/Layer @ 18 Cases Per Minute

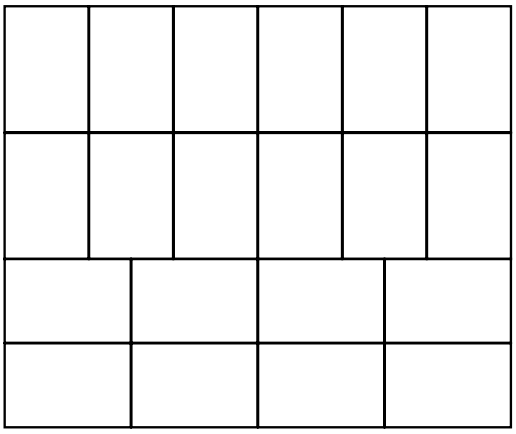


Fig. 27 20 Cases / Layer @ 40 Cases Per Minute

Correct Speed Quotations Are Essential

The customer must be assured by the palletizer manufacturer that the quoted speeds for the pattern configurations he requires are based upon round-the-clock operation, and are sustainable and not surge rates.

Generally, when speeds are quoted for a given palletizer, they are based on an eight- to 10-case per-layer pattern configuration. A fully automatic, low-speed palletizer will operate at an approximate speed of 25 cases per minute (eight to 10 cases per layer, five layers). On the upper end of the speed range, some palletizers can handle 100 to 120 cases per minute (eight to 10 cases per layer, five layers).

In many cases, the purchase justification for a fully automatic palletizer becomes easier when the speed exceeds the ability of a hand stacking line, or when so many people are stacking that labor costs become prohibitive.

Modular Construction Makes System Upgrading Easier and Less Costly

Another major consideration at the time of initial purchase is whether the machine can be upgraded to greater speed. A customer's initial requirement might be for a low speed machine with a rate of 25 cases per minute (Fig. 28). However, he may know that in two to three years down the road, capacity needs could double (Fig. 29), necessitating an upgrade.

Fig. 28 25-Case-Per-Minute Palletizer Has a Single Row Pusher But No Layer Table

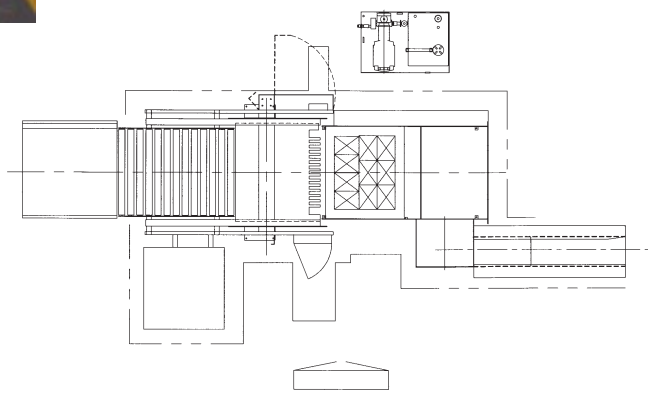


Fig. 29 50-Case-Per-Minute Palletizer Has a Layer Table to Store Cases While the Hoist is in Operation

During the load-out cycle, when the full pallet load is being discharged, the layer table enables the machine to keep running, storing a full layer on the table and one row of cases in the row pusher area.

Floor level machines are very conducive to the modular concept. They can be upgraded to increase speed (Fig. 30 and Fig. 31), and the direction of infeed can be easily changed to accommodate possible machine relocation.

While upgrading a high level palletizer is possible, it is generally more expensive. The support section must be extended when new sections are added and expansion typically requires a major modification of the operator mezzanine.

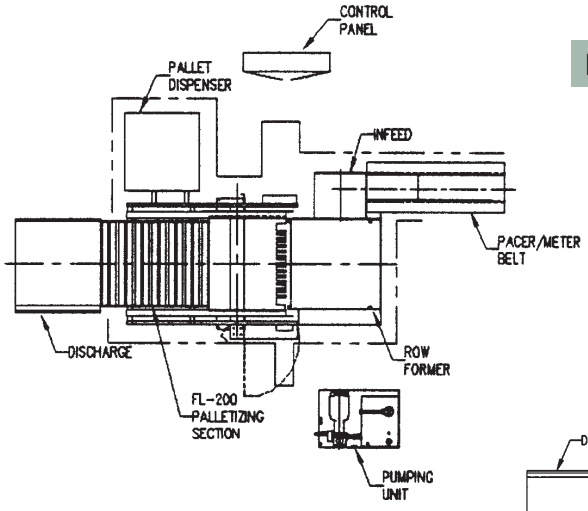


Fig. 30 A Floor Level Machine With a Row Pusher

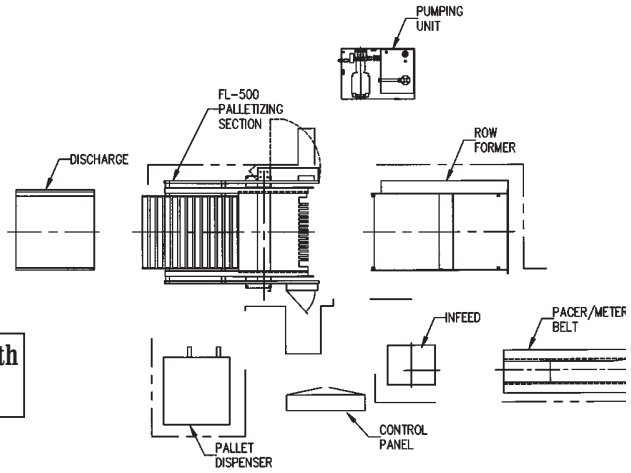


Fig. 31 The Same Machine (Fig, 30) But With the Layer Table Shown in Modules

Note: the hand of infeed has also been changed from left rear to right rear infeed.

Electric Vs. Hydraulic

The drives required to operate a fully automatic palletizer can be electric or hydraulic. Air is used for the cylinders controlling the pattern forming stops. Both have advantages for their selected functions.

"Continuously running functions" operate more efficiently with electro-mechanical drives (rollers, chains, etc.) while "linear functions" operate more efficiently with hydraulic cylinders (hoist lift, stripper plate, etc.). Hydraulics can cost-effectively control deceleration and cushioning for precise load placement, gentle product handling and high speeds. With state-of-the-art, straight-thread, O-ring fittings (SAE 514) fluid leakage is virtually eliminated.

Controls

Many control packages are available for a palletizers. The most popular are standard, off-the-shelf, programmable controllers manufactured by major U.S. companies (Fig. 32). These programmable controllers come with excellent documentation and almost always have training packages available.

Photocells used with palletizers and associated conveying systems are currently pulsed infrared LED and are offered as standard equipment (Fig. 33). These are not affected by either sunlight or rotating beacons on forklift trucks.

Standard electrical proximity switches (Fig. 34) now used on palletizers have generally replaced the older electro-mechanical limit switches, which were less reliable because of moving parts and needed frequent adjustment.

Fig. 32 Control Panel With Programmable Controller Controls

Fig. 33 Pulsed LED Photocells

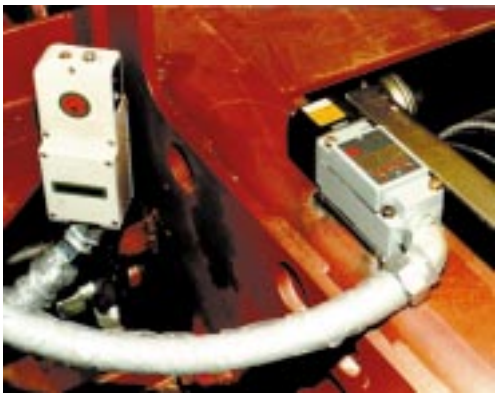


Fig. 34 Proximity Switch

Also available for current palletizer models are various fault and status diagnostic units (Fig. 35). These can provide functions as simple as messages indicating machine status and fault indication. Typically, these single line displays can indicate up to 100 pre-programmed messages.

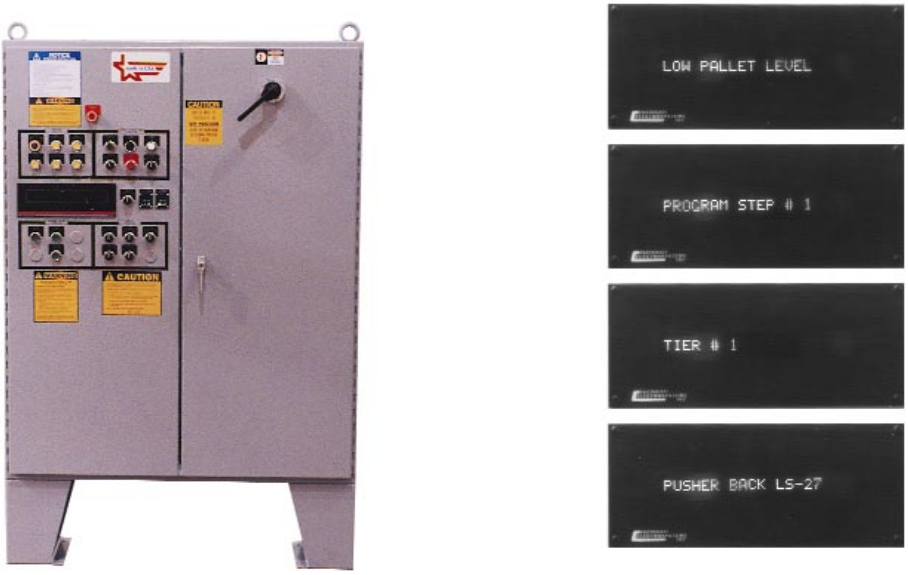


Fig. 35 Diagnostic Display

More sophisticated, graphics-based operator interfaces also are available. These typically come complete with color monitor and associated keypad (Fig. 36). These systems can lead operators through palletizer startup and shutdown procedures, provide status at all times, and combine any alarm function with corresponding diagnostic information to help locate the cause.

Fig. 36 Two Types of Graphics Operator Interface

Pallets

One area that causes many problems for palletizing operations is pallet handling. If pallets stacked in the dispenser have protruding nails or missing bottom boards, pallets jams or problems on the discharge conveyor once the pallet is loaded are likely.

There are many different styles of pallets: two-way, four-way G.M.A., stringer, winged, block and nesting (Figs. 37 - 42). Although all pallets used to be made of wood, plastic pallets — many made from recycled PET bottles — are becoming more common. (Fig. 43).

Fig. 37 Two-way

Fig. 38 Four-way G.M.A.

Fig. 39 Stringer

Fig. 40 Winged

Fig. 41 Block

Fig. 42 Nesting

All pallets can run on automatic palletizers with the exception of the nesting style. These usually have six or nine tapered support legs which nest into tapered holes in the pallet below. This technique allows a lot of pallets to be stacked and takes up very little vertical height compared to the use of standard pallets. However, the base of each support leg is very small, with a typical surface area ranging from 2 to 6 square inches. This small surface does not support the pallet well as it is conveyed out of the palletizer carrying the full load. These pallets may also cause damage in the warehousing operation if heavy, full pallets are to be stacked three or four loads high. The full weight rests on the small legs of the bottom load. Also, the small legs can puncture or otherwise damage the top layer of the bottom load.

The typical variation in pallet dimensions that can be handled by automatic pallet dispensers is plus or minus ½" on the length or width and ¼" on height.

Many different styles of plastic pallets are available. Most have the ability to be picked up by a fork truck in either direction (Fig. 44). They have flat bottom surfaces so they can run on a roller conveyor either wide-way leading or narrow-way leading. This gives plastic pallets an advantage over regular two-way or four-way G.M.A. pallets. And while the initial cost of plastic pallets is higher than wood, they generally last longer, reducing the cost per trip.

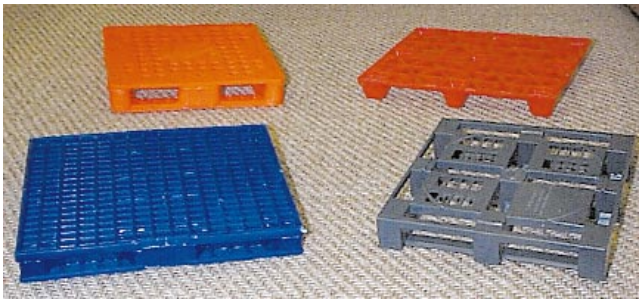


Fig. 43 Different Styles of Plastic Pallets

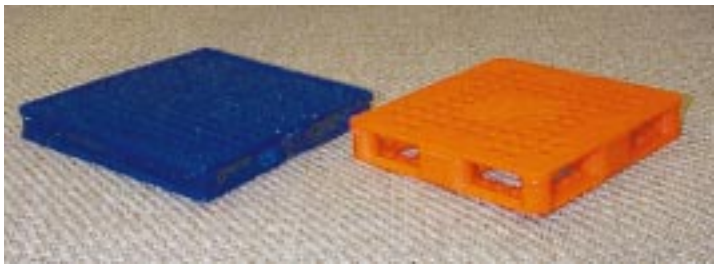


Fig. 44 Plastic Pallets With Four-Way Entry

Pallets
(continued)

With the wide variation of pallet conditions for an automatic palletizer, it is extremely important to have a pallet inspection program in place to minimize downtime.

In 1990, a National Pallet Rental Pool Program was introduced in the U.S. by CHEP after successfully implementing similar programs around the world. CHEP produces and maintains pallets that are as close to perfect as can be expected for automatic palletizers. They have large surface areas to support the products being palletized and bottom boards that run on just about any conveying surface. (Figs. 45 and 46.)

Fig. 45 CHEP Stringer, Mark 3 Pallet

Fig. 46 CHEP 4-Way, Mark 55 Pallet

Many types of pallet ejectors and dispensers are available for both floor level and high level palletizers to handle the pallets mentioned here. In addition, special dispensers are available to handle the solid plywood pallets often used in high rise storage and retrieval systems (Fig. 47).

Accurate pallet placement is needed to ensure correct load position on the pallet. To do this, the pallet is dispensed onto the load building conveyor and backed up against a mechanical stop. This positions the pallet front to back while tier retainers ensure side-to-side positioning. These side retainers also position each case layer to ensure very square loads positioned accurately on the pallet.

Fig. 47 Plywood Pallet

Pallet Dispenser Location

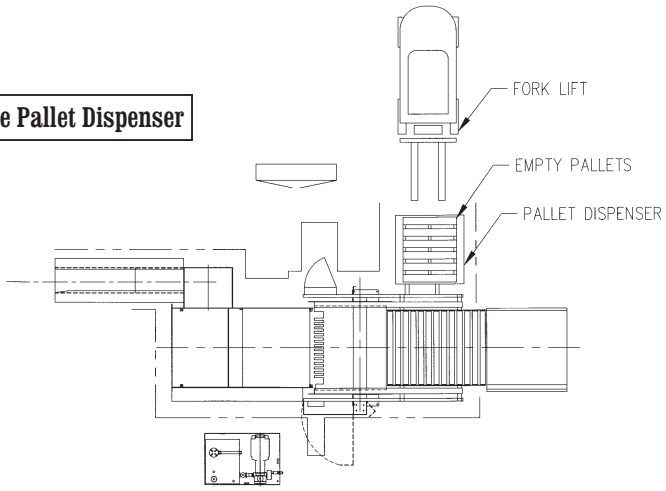
When a palletizer is being laid out in a plant, the very first consideration is pallet orientation. Three points are crucial:

1. Access for loading the pallet dispenser (Fig. 48).
2. Access for removing full loads from the discharge conveyor (Fig. 49).
3. Interfacing the discharge of the palletizer with auxiliary equipment such as stretchwrappers, automatic guided vehicles, shuttle cars, etc. (Fig. 50).

Access to the Pallet Dispenser

Normally, pallets are handled by a fork truck with the forks inserting into the normal pallet entry, not through the G.M.A. cutout (four-way G.M.A. pallet). The stack of pallets (typically 12) can be loaded into the dispenser all at one time. The access area in the entry direction needs to be a minimum of 10 feet. Anything above 12 feet will be of even greater benefit the fork truck driver.

Fig. 48 Access for Loading the Pallet Dispenser



Access to Discharge Conveyor for Full Load Removal

The same constraints are faced by the fork truck operator in removing the full loads from the discharge conveyor.

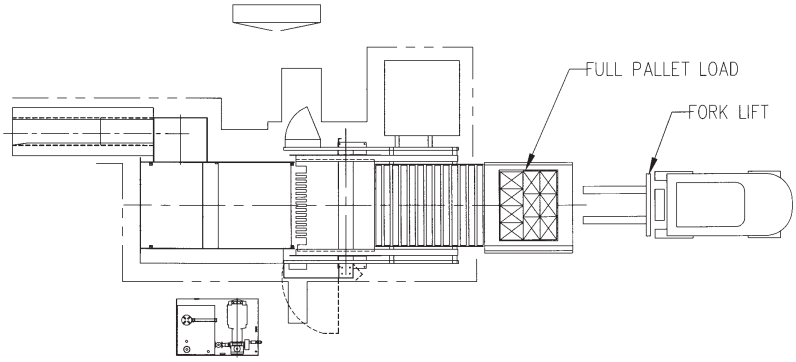


Fig. 49 Access to the Discharge Conveyor for Full Load Removal

Interfacing With Auxiliary Equipment

Pallet orientation is critical when full loads are to be fed into a stretch wrap machine. Bottom pallet boards should be perpendicular to the discharge-conveyor rolls for the pallet to make a smooth transition onto the turntable of a stretchwrapper or onto the roller surface of a transfer car.

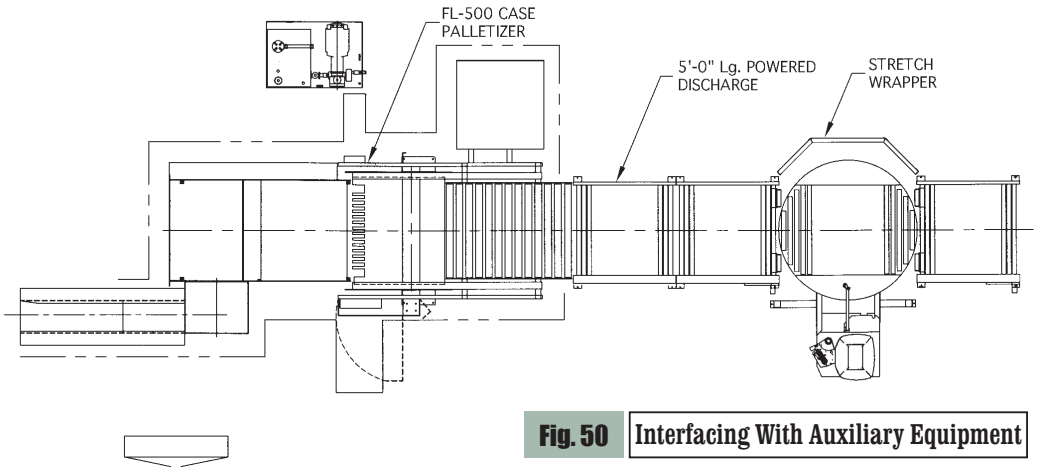


Fig. 50 Interfacing With Auxiliary Equipment

Discharge Conveyor

Many types of discharge conveyors are available for removing full loads from palletizers, including gravity (Fig. 51), belt-driven live roller (Fig. 52), chain (Fig. 53), slat (Fig. 54), and roll-to-roll chain driven (Fig. 55) conveyors.

Fig. 51 Gravity (Columbia)

Fig. 52 Belt-Driven Live Roller (Hytrol)

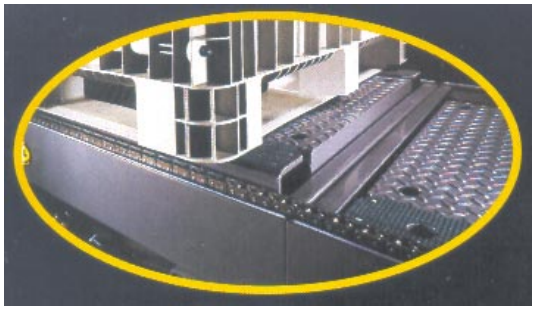


Fig. 53 Chain (Hytrol)

The gravity roller is the least expensive of discharge conveyors. However, it's not recommended for extra high loads or high column-stacked loads. Also, a length of 15 feet is considered maximum.

Belt-driven live roller and chain-driven live roller are the most common types of discharge conveyors. They are used when the pallet bottom boards are traveling perpendicular to the rollers. When used in five-foot sections, these conveyors can stage loads into a stretchwrapper or onto a shuttle car.

If the pallet bottom boards are parallel to the discharge rollers, they can lead to excessive vibration. The number of bottom boards also becomes critical in determining whether the pallet can travel along the discharge conveyor without shaking the load apart.

A full load discharge conveyor with close-centered rollers can eliminate some of the vibration. But the number and size of the bottom boards, diameter of the rollers and the roller's center dimension must be considered.

A two- or three-strand chain conveyor is the preferred method of handling pallet loads when the bottom boards are running the "wrong way." The slat conveyor is also ideal because its surface is flat and capable of conveying full pallet loads both with and without pallets. And a three-lane discharge conveyor, which consists of three parallel lanes (Fig. 56) with the center lane staggered against the two outside lanes, enables the roller centers to be closer, better handling wrong-way pallets.

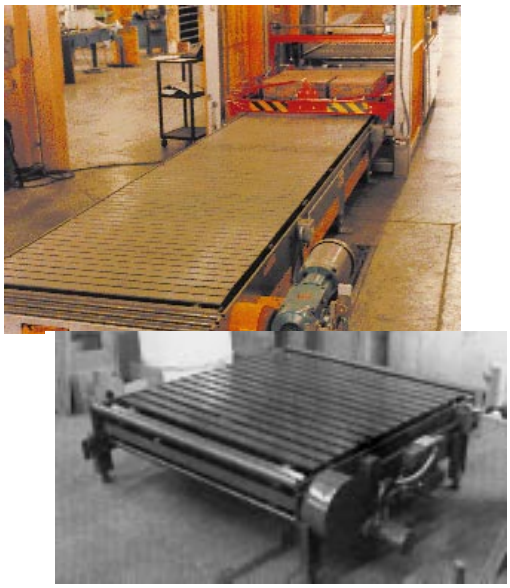


Fig. 54 Slat (Columbia)

Fig. 55 Roll-To-Roll Chain Driven (Hytrol)

Fig. 56 Three-Lane Staggered Discharge Conveyor

Load Protection and Stabilization

The terms “slip sheet” and “pull pack sheets” are synonymous. They refer to the sheet on which the load is stacked. If the load is stacked on a slip sheet without a pallet, the sheet is generally made from heavy fiber board and is moved by a lift truck using a push-pull attachment.

Tie sheets are placed **between** load layers for stabilization. They’re used primarily when cases are square and no interlocking case pattern sequence can be employed. Tie sheets can be thin kraft paper or fiberboard.

Cap sheets are used to protect the top layer of product. These sheets are often made of the same material as slip or tie sheets and are usually stretchwrapped into the load.

Various types of sheet feeders are available for both floor level and high level machines. If slip sheets and tie sheets are required on the same machine, two feeders may be necessary since the sheet materials are very different. However, floor level machines now have double-hopper sheet feeders available to accommodate both types of sheets (Fig 57).

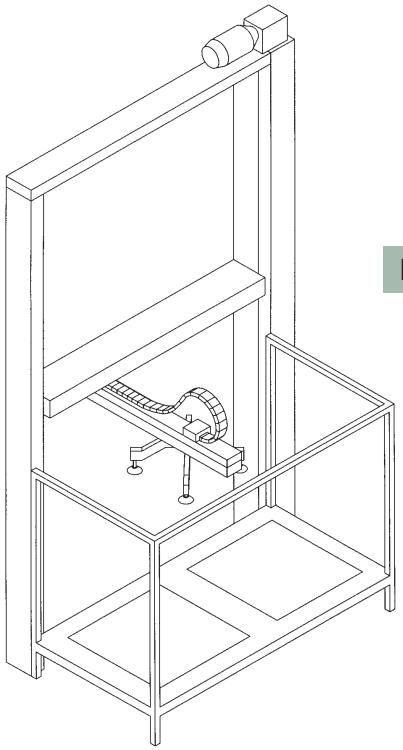


Fig. 57 Double Hopper Sheet Feeder for Slip and Tie Sheets

Typical sheet feeder capacity is between 12" and 24" , which may last for one shift. However, there are bulk-loading sheet feeders available, with single and double hoppers, to allow 36" to 40" of sheet capacity (Fig. 58 and Fig. 59). These are used when higher production or less-frequent sheet-feeder filling is required.

Bulk-loading, slip sheet feeders are also available for high level machines for placing the sheets on a pallets. When tie sheets are required for high level machines, they have to be placed in a hopper located on the upper elevation, and are usually placed by an operator standing on the platform or mezzanine.

Strappers or string tyers are very useful to ensure load stability. Loads can be extremely unstable if cases are small and square, if there are numerous layers with many cases per layer, if the cases are in columns, or if the case has a high center of gravity (Hi CG). A strapper or string tyer is incorporated into the palletizer and programmed to strap or tie single or multiple layers making the load extremely stable when moving out of the palletizer.

Another alternative is to use a stretchwrap machine to wrap layers as they are placed onto the load. But this becomes very complicated, slows down the palletizing process and is quite expensive.

Fig. 58 Single Hopper Bulk Loading Sheet Feeder

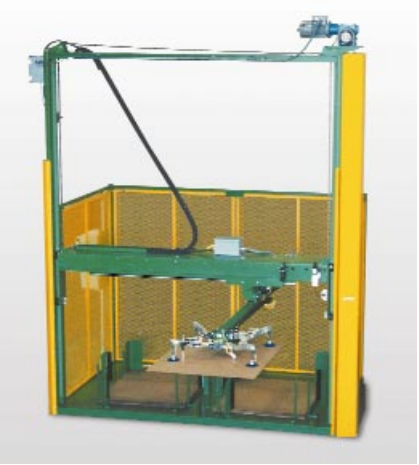


Fig. 59 Double Hopper Bulk Loading Sheet Feeder

Glue Systems

Many types of glue systems are available for load stabilization. These are used when loads are shipped long distances by road or rail. The majority of glue systems are hot melt and are often controlled by the palletizer, ensuring that the top layer of cases is not glued unless a cap sheet is being used.

Load Stack Quality

An automatic palletizer should have the ability to build loads with consistent accuracy and repeatability. However, there are a number of factors that cause difficulties.

Under ideal situations, pallets would be flawless and cases would be perfectly square or rectangular. With these conditions, an automatic palletizer could stack accurate loads with a repeatability of less than ¼" variation from the top layer to the bottom layer (over a standard 64" load height).

In the real world, some variation in the pallet surface is to be expected. Also, cases will probably have the major flaps slightly out of alignment after sealing (typically ⅛") creating a slight parallelogram. These two factors combine to reduce the repeatability and accuracy in load stacking. Yet, a palletizer equipped with front and side retainers will maintain an accuracy of plus or minus ⅜" from the bottom layer to the top layer (over a standard 64" load height).

Case Patterns

The number of case patterns that can be programmed into a fully automatic palletizer is virtually limitless, using today's range of programmable controllers and software. However, in some cases, mechanical stops are needed to separate cases during pattern forming (Figs. 60 and 61).

The stops use cylinders and pneumatic valves to operate, together with software to determine which stops are required for which pattern. Should a very large number of case pattern sequences be required (20 to 40 patterns for example), it is advisable to place a case stop in all of the available locations. In other words, put a stop between every roll (approximately12) in the pattern forming area. Then pattern changes become simple software commands with no hardware needed.

It is unusual to physically move a stop in an automatic palletizer unless a pattern has been discontinued and that stop location will not be used for any current pattern.

Fig. 60 Case Stop in the Pattern Forming Area, UP

Fig. 61 Case Stop in the Pattern Forming Area, DOWN

Automatic palletizers do not handle square cases as well as rectangular ones. Square cases can only be column stacked, no pattern interlock is possible (Fig. 62). Rectangular cases enable the machine to form a load with each layer rotating 180 degrees for interlocking purposes. This type of load is very stable (Fig. 63).

Some case sizes do not allow patterns to be configured without gaps in the pattern either side-to-side (Fig. 64) or front-to-back (Fig. 65). However, the palletizer has the ability to form the pattern with these gaps in both directions.

Side-to-side gaps are created with stops located in the pusher section of the palletizer as shown in Fig. 60. However, to hold gaps front to back the process is a little more complicated. These are created using pusher gates mounted in the gate of a floor level machine (Fig. 66).

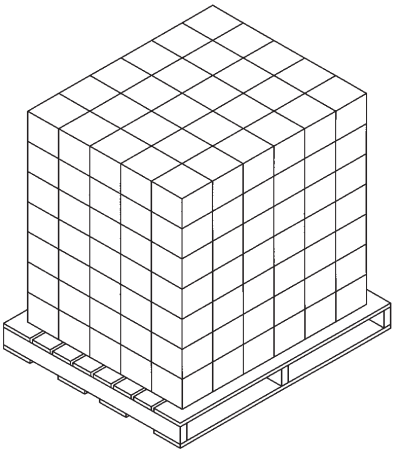


Fig. 62 Square Cases Column Stacked

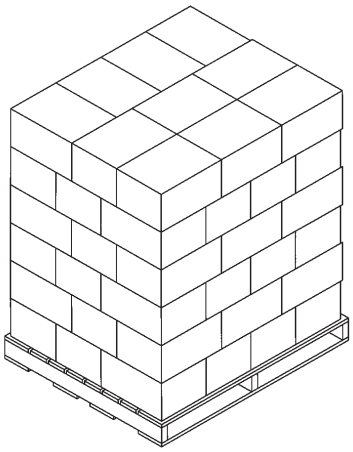


Fig. 63 Rectangular Cases Interlocked

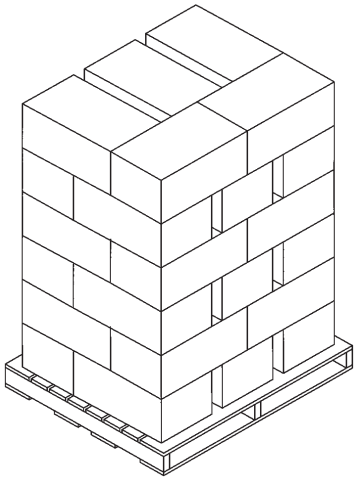


Fig. 64 Interlocked Load with Gaps Side-To-Side

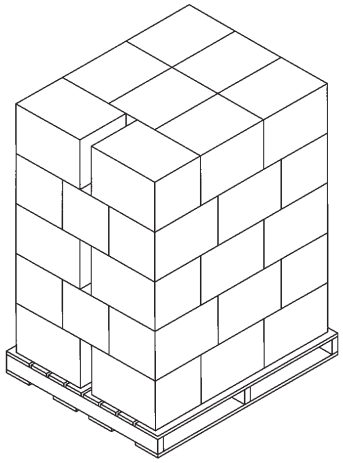


Fig. 65 Interlocked Load with Gaps Front-To-Back

Pusher Gate Operation Steps

The stripper plate carries the layer forward over the pallet. When it is fully forward the gate comes down.

(A) As soon as the gate is down fully, one of the pusher gates extends to line up the front of the layer evenly.

(B) The stripper plate then retracts to place the cases on the pallet.

(C) When the stripper plate gets half-way back, the pusher gate retracts causing a gap to form in the layer.

(D) The stripper plate continues toward its back position.

The size of the gap is determined by the stroke of the pusher gate cylinder.

This process is repeated on the second interlocking layer but with the other pusher gate creating the gap. This continues until the full load has been built, with the left pusher gate creating gaps in the odd layers and the right pusher gate creating the gaps in the even layers.

If a palletizer is required to form many patterns, each with front-to-back gaps and each gap a different size, it is easy to see the complexity of trying to fit many different-sized cylinders onto the gate. Two to three patterns with different sized gaps are about the most that can be accommodated on a single palletizer.

When fresh fruit or produce is palletized, gaps are often required around each case to allow cooling in refrigerated storage. These are created in a similar fashion except that a pusher bar is used with multiple back-to-back cylinders (Fig. 67).

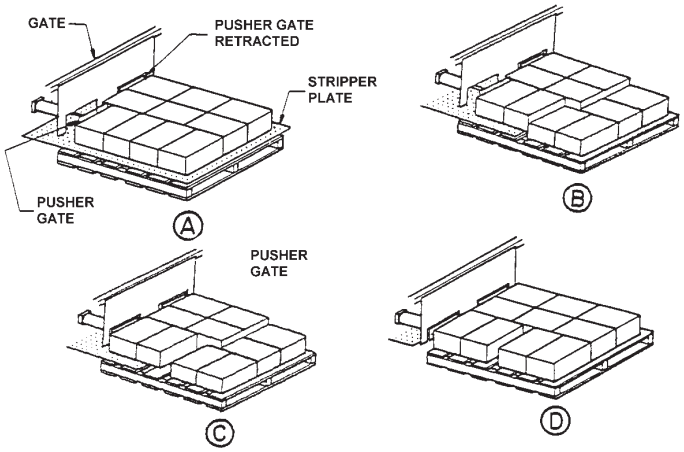


Fig. 66 Pusher Gate Operation

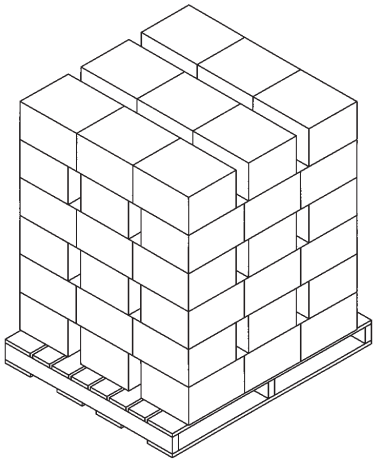


Fig. 67 Gaps Created in a Pattern Using a Pusher Bar

A rectangular case with equal height and width is ideal for palletizing. A case with a height 1½ times the width of the case or greater is called a high center of gravity case, or High CG (Fig. 68). In some instances, special attention is needed to avoid tipping this case over during pattern forming. This may involve using extra high case stops in the pattern forming area and layer retainers to hold the layer while it is stripped onto the pallet or the load.

Sometimes special loads require a specific case count which does not have the same number of cases in each layer. Under these circumstances, the palletizer is programmed to stack the incomplete layer on top of the load.

Other special loads can include stacking different-sized cases in one load (Fig. 69) or stacking the load in columns (Fig. 70) with different colors (in the case of tissue) or flavors (in the case of food). These loads are usually for end-of-aisle displays in club stores. While a conventional palletizer can handle these special loads, a robotic palletizer can be far more effective. This will be covered later.

Fig. 68 High C.G. and Ideal Cases

Fig. 69 Different Size Cases in One Load

Fig. 70 Columns of Different Color or Flavor

Robotic Palletizers

Robotic palletizers are currently used in industries where conventional palletizers have traditionally dominated, industries such as food, beverage, pharmaceutical, paper, automotive, chemical and consumer products.

Some robot producers, especially those that manufacture "articulating arm" styles have branched out into palletizing after finding their existing markets for painting or welding robots saturated or at least reduced to commodity-item status.

Robots were introduced to palletizing back in the late 1970s and early 1980s. However, they were not widely accepted due to programming complexity, lack of status and fault-diagnostic help, and general lack of safety circuitry to protect the robot in the event of a crash. If a problem occurred in the robot program, the result was not only crushed product but damage to the robot arm and "end effector."

Consequently, many robots installed during this time period were removed and replaced by conventional palletizers. Companies that had bad experiences were reluctant to try robotic palletizers for many years.

Today's palletizing robots are much more user friendly. Many use Windows-based software similar to desktop computer programs and familiar to most engineers.

Robot Conventions and Terminology

Just as with conventional palletizers, there is no industry-standard terminology relating to robot components. Figs. 71, 72, 73 and 74 show the four major types of robots and the axes through which they operate.

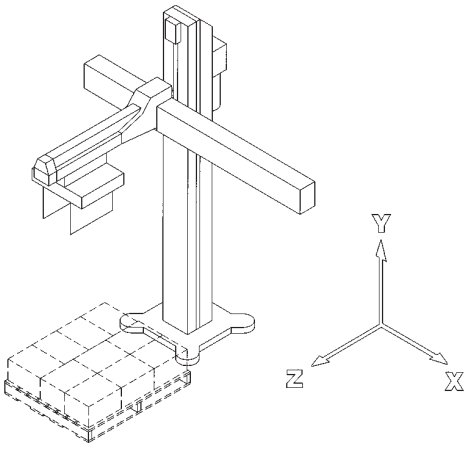


Fig. 71 Cartesian Robot

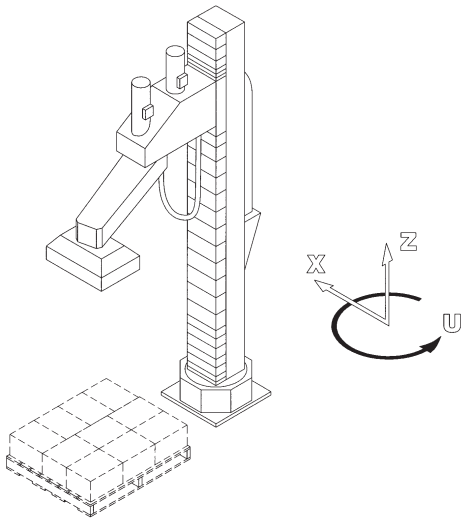


Fig. 72 Scara Robot

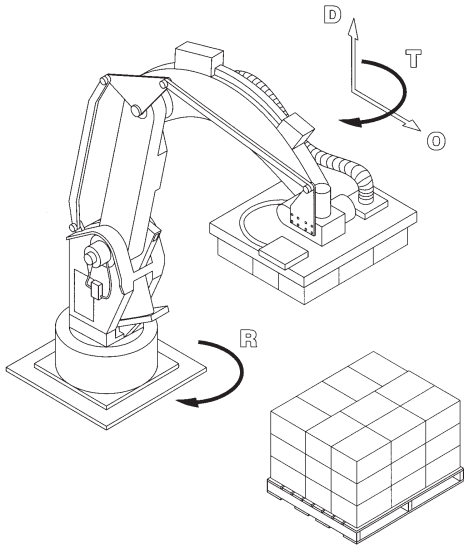


Fig. 73 Articulating Arm Robot

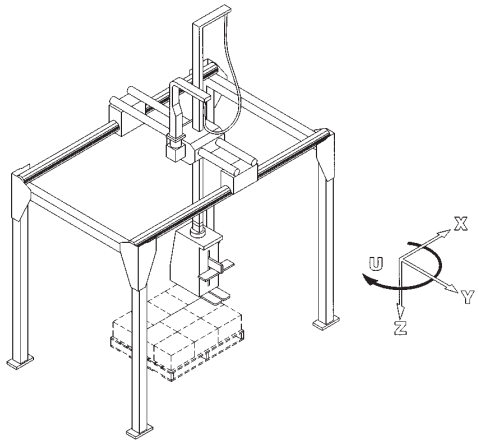


Fig. 74 Gantry Robot

Production vs. Distribution

Conventional palletizers are generally used in a production environment where the product is made and packaged. The palletizer may be located in the packaging area or in an adjacent warehouse. Although palletizers have the capability of stacking products from several production lines simultaneously, each load generally contains one particular product.

Robots, on the other hand, are more versatile and can be found not only in the production environment, but the distribution center. These centers are generally warehouses that receive full pallet loads of specific products, none of which contain mixed products in the same load. Each pallet load is stored in a designated location until a pick list is received which calls for a specific mix of products from several loads.

This mix of products may involve the re-palletizing of the different products onto a single pallet or several pallets and invariably involves different sizes of cases and/or bags. This is not something a conventional palletizer can handle and robots are increasingly being used for such tasks.

In the case of the cartesian, scara and articulating arm robots, products are fed to the robot in the order they are to be stacked, with the stacking program downloaded to the robot from a host computer. The gantry style robot travels to the loads to pick up the required cases for the random pallet load. In either case, random pallet load stacking is extremely slow when compared to the stacking speed required in the production environment.

Types of Robots

Figs. 75 through 78 are four types of robots involved in palletizing.

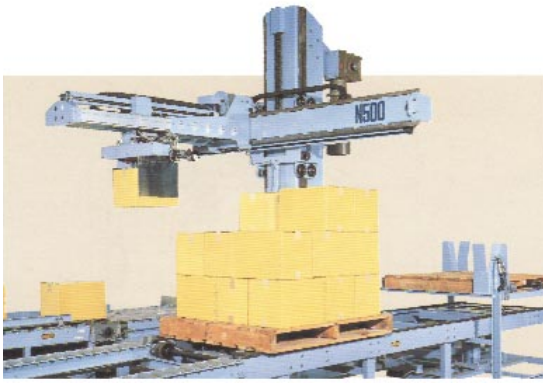


Fig. 75 Cartesian Robot (Columbia/Okura)

Fig. 76 Scara Robot (Costi Robots)

Fig. 77 Articulating Arm Robot (Columbia/Okura)

Fig. 78 Gantry Robot (Costi Robots)

There are vast differences in speed, function and price between the four types of robots:

Cartesian

This type is used in the production environment and is slow and somewhat limited in the size and weight of the products can handle. However, it carries a low price tag.

The cartesian moves through 3 axes; x, y and z. Load height or product type affect the y axis while weight affects the z axis. This sometimes causes the robot arm to bounce when fully extended with a heavy carton or bag. It's ideally suited for palletizing from a single production line at speeds up to 10 cases per minute and handles product weight up to 20 lbs.

Scara

Used in the production environment, the scara is generally faster than the cartesian robot and has a higher price tag. But it suffers from some of the same problems as the cartesian, namely bounce when heavy products are used with the arm fully extended.

The scara handles product weight up to 40 lbs. and is ideally suited for palletizing from one to three production lines at a total case rate of 20 cases per minute.

Articulating arm

This is the most versatile robot in the production environment. It's faster and comes with a variety of end effectors to pick up multiple cases or bags in a single pick. Then it can place them individually, if needed, to build the required pallet load (details of multi-pick and multi-place are covered later).

Articulating arm robots carry a higher price tag than either cartesian or scara, but can handle product weights up to 300 lbs. (including the end effector) and are capable of palletizing up to five loads at a time. On a single production line, the articulating arm robot can handle cases in the 50 to 60 lbs. range at 25 cycles per minute.

Gantry

The gantry is generally the slowest, but has the advantage of being able to palletize an infinite number of loads. It can also be manufactured to handle extremely heavy products. The gantry has a larger footprint than the other robots and, generally, a much higher price tag.

Robot Summary

Cartesian – Slow speed, generally handles one load at a time, low price.

Scara – Medium speed, generally handles one to three loads at a time, medium price.

Articulating arm – High speed, can handle from one to five loads simultaneously, higher price.

Gantry – Slow speed, can handle many loads at one time, expensive.

The articulating arm robot is currently the most popular for production palletizing and has been chosen for the following illustrations of end effectors.

End Effectors

The infinite variety of end effectors is what makes the robot such a versatile solution for palletizing.

With an end effector changeover, which can take from 15 to 30 minutes, the robot go from stacking cases to bags, pails, drums, plastic totes or bundles of loose products (books etc.). This versatility is not possible with a conventional palletizer.

End effectors can employ different methods of picking up products and placing them in the load. These methods include vacuum (fig. 79), clamp (fig. 80), finger (fig. 81), and combination (fig. 82).

End Effectors
(continued)

Fig. 79 Vacuum End Effector

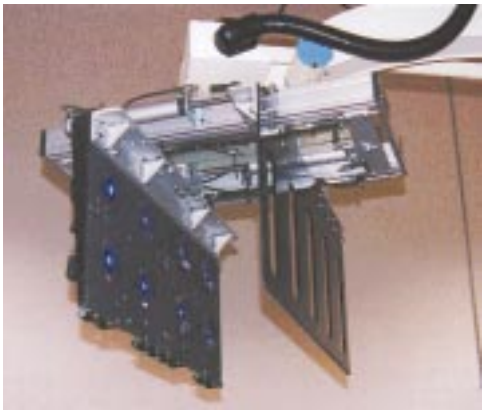


Fig. 80 Clamp End Effector

Fig. 81 Finger Style End Effector

Fig. 82 Combination End Effector

Vacuum

These end effectors can employ a single suction cup or multiple suction cups for either palletizing or depalletizing. Vacuum has limitations based on weight, speed and shape of product when used as the sole source of lifting and placing. For instance, a heavy product in a tall carton is not as easily moved as a heavy carton with a low profile.

If a heavy product in a tall carton needs to be handled at a fast rate, then a clamp style end effector or a combination of vacuum and clamp style is used. Vacuum is essential, however, for depalletizing individual products.

Clamp

These offer a very stable and reliable means of picking up and placing products. It has a pallet tool that accurately picks up and places pallets, then swings out of the way while handling product (Fig. 83).

Clamp and vacuum end effectors can be designed and programmed to pick up multiple products at a time, typically two or three cases (Fig. 84), and place them individually on the load. This can dramatically increase the robot speed.

For example, a robot with a rate of 25 cycles per minute can multi-pick and multi-place three cases at a time. This increases the palletizing rate from 25 cases per minute while handling one case to possibly 40 to 50 cases per minute while handling three, depending on the product and the stacking pattern. But a 25 cycles-per-minute robot handling three cases at a time cannot run at 75 cases per minute. Additional time is needed to individually place the cases on the load in the multi-place mode.

Fig. 83 Combination End Effector Using Carton Clamp and Pallet Tool

Fig. 84 Multi-Pick Multi-Place End Effector

Finger

This style of end effector is used mainly when handling bags. The fingers are spaced to fit between the rollers of the product conveyor. The end effector simply rises up to lift product and carry it to its position in the load (Fig. 85).

When high-speed bag handling is required, a combination of finger and clamp or finger and vacuum is used.

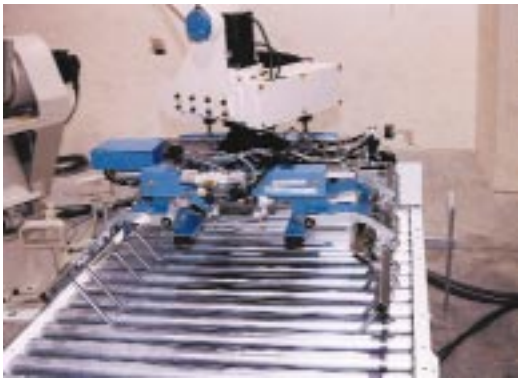


Fig. 85 Finger Style End Effector Showing the Individual Finger Spacing

Finger (continued)

The tremendous versatility possible with end effectors can also mean cost savings for additional equipment like pallet dispensers and sheet feeders. For instance, a single end effector can be equipped with clamps to pick up product, swing-out clamps to pick up and place pallets prior to loading, plus vacuum heads to pick up and place slip sheets, tie sheets or a cap sheets (Fig. 86).

While this combination end effector can save the cost of buying pallet dispensers or sheet feeders, it does so at the cost of overall speed.

Fig. 86 Combination End Effector That Can Handle Product, Pallets and Sheets

Hybrid Palletizing

Hybrid palletizing combines the proven techniques of conventional palletizing with the latest robotic technology. It enables an articulating arm robot to operate at speeds usually associated with conventional palletizers.

Hybrid palletizing involves forming a complete or partial layer of cases using conventional palletizing techniques and then using a high-speed robot to pick up this layer and stack it on the load in one cycle (Fig. 87 and 88).

In the example shown, the load building speed is raised to approximately 50 cases per minute. The only limitation is the weight of the layer to be handled. The cost also increases due to the need for layer forming equipment.

Fig. 87 Robot Stacking a Partial Layer in One Cycle

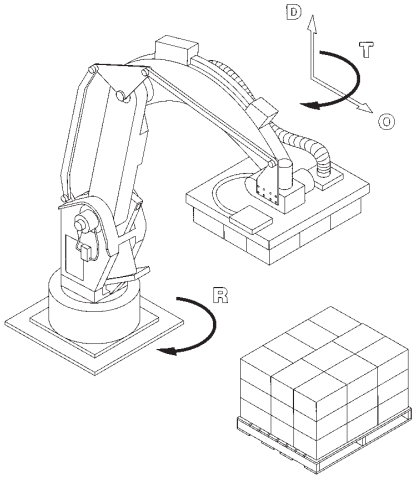


Fig. 88 Robot Stacking a Complete Layer in One Cycle

Mixed Products and End Of Aisle Displays

Most of us have been to the local club store where bulk products are placed in racks. On the end of each aisle there is often a pallet load of product in display cases or mixed by color or flavor (Fig. 89 and 90). While mixing products on the same pallet can be handled on a conventional palletizer, it is much easier to achieve using a robot.

The four lines feeding the robot as shown in figure 91 could be fed from four different production operations, each producing a different color of toilet tissue, a different flavor of potato chips, etc.

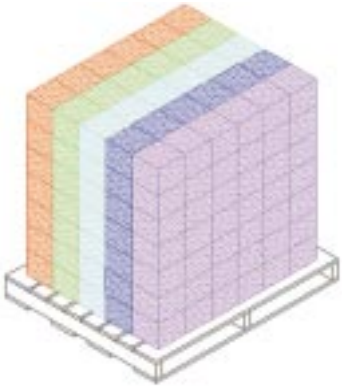


Fig. 89 Mixed Load By Color (Tissue)

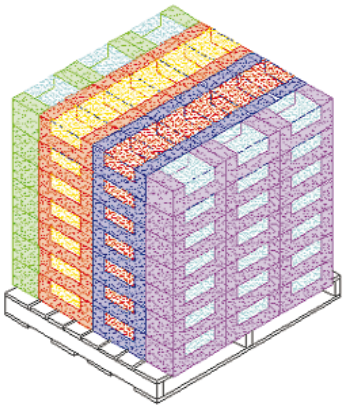
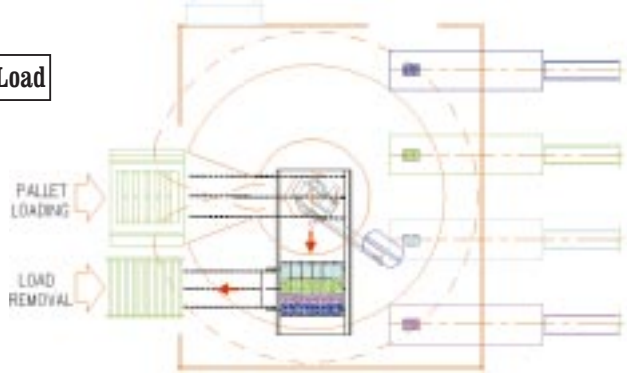


Fig. 90 Mixed Load By Flavor (Potato Chips)

Fig. 91 Building a Mixed Pallet Load



Channels of Distribution

Conventional palletizers are generally sold by direct salesmen or by independent sales representatives. Direct salesmen work for the company that manufactures the palletizers and are generally paid a salary plus a commission or bonus based on sales volume, profitability and other factors.

Independent sales representatives work for a company that is not affiliated with the equipment manufacturer. They have agreements allowing them to sell the equipment, usually exclusively in a specified territory. Independent sales representatives are paid a predetermined commission based on their involvement in securing the sale. For instance, a palletizer manufacturer may pay an independent-representative company a 2% to 3% finder's fee for simply bringing a project to the attention of the manufacturer.

Channels of Distribution (continued)

A typical full representative commission is 10%, which is paid for securing full-project information. This includes:

A. Measuring the space the equipment will occupy, including any obstructions such as columns, etc.

B. Product information including case weight, stacking patterns, and dimensions and direction of travel – whether cases are travelling wide way leading or narrow way leading.

C. Pallet style, size and direction of travel; pallet dispenser loading procedure; and full unloading requirements from the palletizer outfeed conveyor.

Other information can also include type of PLC controller, photocells and proximity switches necessary, and whether slip sheets, tie sheets or cap sheets are required. The representative also must gather any other relevant information required by the palletizer manufacturer.

A commission is paid only when a sale is made. Independent sales representatives usually have a range of products to sell, such as fillers, case packers, conveyors, palletizers and stretchwrappers.

Distributors rarely buy standard, conventional palletizers and then integrate them into complete palletizing systems for customers. This is usually done by the palletizer manufacturer, the customer or a consulting engineering company.

Some robotic palletizer manufacturers sell to distributors and integrators in addition to direct sales people and independent sales representatives. Distributors and integrators integrate the robot into a material handling/palletizing solution that they design, engineer, program and install. This can be advantageous to a customer in some cases, especially if the integrator has a wide range of equipment with which he is familiar and has the capability of offering a total installed package. But there can be certain drawbacks.

Some distributors and integrators are not bound by geographic boundaries and could find themselves competing with others who may offer the same customer a very different overall material handling solution. Worse yet, a distributor or integrator may find himself competing directly with the robot manufacturer. In either case the customer can be left dazed and confused.

Robotic palletizer manufacturers will usually set up the robot at their factory and invite customers to observe the robot's performance prior to shipment. In this way, customers can be certain the robot can do all that is expected.

While some integrators have this capability, it is uncommon. It's more likely that a customer will receive all of the pieces at his facility and integration will take place there. Integration takes a lot less time at the manufacturer's facility because experienced engineers and assemblers are available to make program changes and adjustments to the robots, servo drives, or conveying systems very quickly.

This integration involves the robot and the systems immediately surrounding it, including case pick-up conveyors, pallet feeders, sheet feeders, load discharge conveyors, controls and programs. If the robot is to be fed by case conveyors that are longer than 50 feet, only the sections adjacent to the robot would be set up at the manufacturer's plant. The long lengths of simple delivery case conveyor would be set up directly at the customer's facility.

Factory Test

A conventional or robotic palletizer manufacturer will have a standard factory test procedure where the customer is invited to observe his machine performing in accordance with the purchase order requirements.

The following is an outline of what the customer can expect, together with approximate timelines:

Approximately six weeks prior to machine shipment, the manufacturer will ask the customer for test product to be run on the palletizer.

This product should be extremely well protected for shipment to the palletizer builder. If the product is damaged it may be difficult for the conventional or robotic palletizer to stack accurately.

Approximately one week to 10 days prior to shipment, the customer will be invited to send a representative, usually an engineer or maintenance supervisor, to witness the test. Some customers send a team of individuals if the installation is expected to be complex or has to be carried out in a fixed timeframe.

This test involves running the system at required speeds and checking it against the specifications.

When the customer's representatives are satisfied, they may observe the dismantling of the equipment, noting connection points and methods of connection.

The representatives are usually invited to meet with the engineers to discuss weights of the various sections and the best ways to handle them, or any other question regarding electrical systems, programming, etc. This also is an ideal time to go over safety features.

Representatives will have opportunities to go over the operating manual, discuss spare parts requirements and meet with the service manager to discuss commissioning and training.

When the customer's representatives leave the manufacturer's facility, they should be armed with all the information required to install the equipment in their own production facility even before contacting the service manager to arrange for commissioning and training.

Most customers use their own contractors to install small to medium size palletizing operations. These are local contractors who are aware of permits and code requirements.

However, some customers ask the manufacturer to carry out installation and commissioning of the small to medium machines.

Post Sale Support

Since many conventional palletizers are still in operation after 20 or 30 years, it is very important to ensure that manufacturers of both conventional and robotic palletizers are financially sound and in the material handling business for the long haul.

Many companies that start out manufacturing palletizers with good intentions get bought out or taken over by other companies. Once combined with other material handling equipment, they often lose their palletizing focus and expertise. This makes it extremely important to carefully examine the potential manufacturers or suppliers before making a commitment.

In the material handling industry, original cost of equipment is often quite small compared with the cost of downtime over the life of the equipment. The engineer should also look for a manufacturer who carries an adequate supply of spare parts, will provide lifetime support for his equipment even if it is 30 years old, and has a well trained service staff ready to go at a moment's notice.

Systems

Before defining a material handling system, it's important to determine where the packaging ends and the material handling begins.

In a typical bottle-filling packaging line, where bottles are received in cases with open flaps, the cases are depalletized then fed through an uncaser. The bottles are then washed or rinsed, filled, crowned, labeled and put back into a carton or case, which is then sealed. This case sealer represents the end of the packaging line.

The material handling system begins with a filled, sealed case and may comprise some or all of the equipment shown in figure 92. This shows seven case sealers, each feeding a different product onto a common transport conveyor. As the cases leave the sealer they are bar-code labeled.

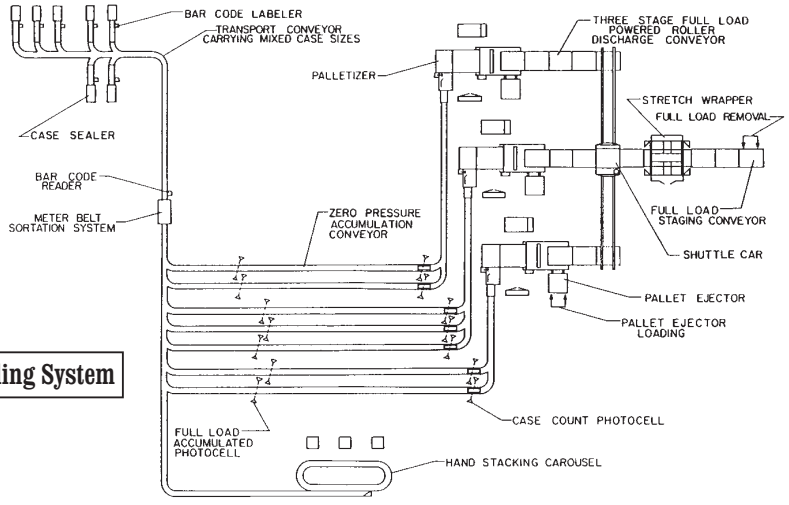


Fig. 92 Typical Material Handling System

Therefore, we consider the material handling system to involve some or all of the following:

- Labelers
- Accumulating conveyors
- Bar-code readers
- Sorting systems with various types of diverters
- Full pallet load accumulating conveyors with multi-line conveyor controls and motor control centers
- Palletizer discharge conveyors, including full load and right angle styles
- Transfers and turntables
- Stretch wrap machines
- Shuttle cars
- Automatic guided vehicles (AGVs)

Although often insisting on choice of manufacturer, many end users are not prepared to purchase palletizers, conveyors, stretchwrappers, and bar-code readers from four separate companies. Determining component compatibility can be too time consuming. As an alternative, the end user can select one supplier with experience and a proven track record of putting together complete systems.

The sophisticated end user in today's marketplace expects one supplier to furnish all of the necessary equipment and interface the complete system, both electrically and mechanically. This may include installation and guarantee of rated throughput for production.

The benefits to the end user are that system suppliers are familiar with the operation of many different types of conveyors, stretchwrappers, etc., and has a working relationship with the various suppliers. This gives the end user the widest possible choice of equipment for his unique system.

Material Handling System

The transport conveyor with the mixed product may be several hundred feet long, conveying the cases from the production area to a warehouse. A bar-code reader located at the entry of the sorting system selects the appropriate accumulation conveyor for the cases, and the meter belt provides the gap required between cases as they are diverted onto the accumulation lanes. Should the bar-code reader fail to recognize the code on a case entering the system, the case will be directed to the hand-stacking carousel.

The cases are gathered behind a meter belt on each accumulation conveyor and a photocell positioned there detects when a full pallet load has accumulated. The conveyor control system releases each line on a first-come, first-served or designated priority basis. The meter belt at the end of the accumulation conveyor starts and each case is counted until a full load is released to the palletizer.

The conveyor control system also instructs the palletizer on what pattern to form and how many layers high. The full loads are discharged and conveyed to the stretchwrapper by a shuttle car. This runs on a track buried in the floor, thereby allowing the fork truck access for placing pallet stacks into the hopper of the center palletizer. The stretchwrapped loads are discharged onto the full load staging conveyor and are either removed by fork truck or automatic guided vehicle (AGV).

Material Handling System (continued)

A recirculation line can be used to accumulate product that did not get sorted to the proper accumulation conveyor . This product is then transported back to the main delivery conveyor above the bar-code reader. Even though labels can be misread by the bar-code reader, it is a good idea to reintroduce good product to the proper accumulation line rather than to a hand stack area, where the work is more labor intensive. The bar codes may be read properly the second try and this method may help increase system efficiency.

Dedicated hand stack areas require a great deal of space for partial pallets, or require a great deal of time to get product back in the system. Hand stack response time also should be considered with perishable products.

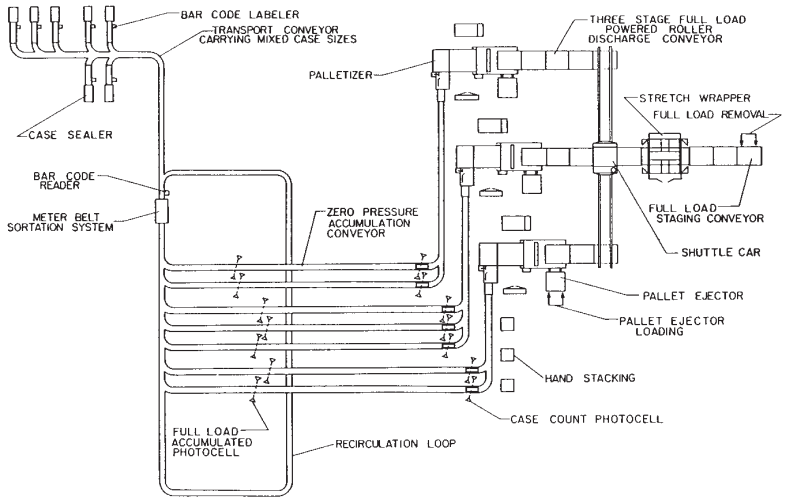


Fig. 93 Typical Material Handling System Showing Recirculation Line Used with Conveyor Sorting

Reasons Product is Diverted to Recirculation or Hand Stack Lines

Bar-code or bar-code reader

a) Misreads (product may be reintroduced)

b) Case not aligned properly with bar-code reader

c) Bar-code reader needs adjustment

d) Power or unit failure

Accumulation line overflow

a) Accumulation line is full and awaiting transfer to the palletizer (rather than stopping the main delivery conveyor, which stops production, recirculate that line's product)

b) Product is read but not selected to an accumulation line (recirculate)

c) Proper accumulation line has not been turned on.

Missed during sorting

a) Diverters miss product due to mechanical malfunction or air starvation, or a case hangs up and causes a timing error.

Selectable Control Modes of the Recirculation Line

1. Constant recirculation of the product with priority given to the main delivery conveyor. If the recirculation line backs up the operator is signaled.
2. Accumulate product on the recirculating line. When the recirculating line backs up the operator is signaled.

When the operator is signaled, he can stop the main delivery line and divert all products onto the recirculation line, or manually divert all products to keep production flowing using a pushbutton station. This pushbutton station is extremely important if bad bar codes get through production, if the bar-code reader fails and is not immediately replaceable, or if perishable products are being handled.

Bar Codes and Labels

If the cases are to be coded and read at another location in the system, whether for sorting, production reports, etc., accuracy of the printed code or label is critical.

Consider a sorting system where a bar-code reader identifies a specific code and diverts recognized cases to a palletizer with the unrecognized cases going to a hand stack area. A 1% error rate times 30 cases per minute, times 60 minutes per hour, times 8 hours per shift equals 144 misread cases. If a palletizer is stacking these cases eight per layer, five layers high, then this 1% code reading error represents over three full pallet loads. It's obvious that bar-code reading must be far more accurate to make the system workable.

This is not a significant problem with the right equipment. Many of today's the bar-code readers have no-read or misread rates of less than 0.0001% (or, in the example above, about one case per shift or less).

There are many different bar codes that can be placed on cartons, each being unique and meeting a specific requirement. Codes include: Interleaved 2 of 5, Code 128, Code 39, UPC-A/EAN-13, etc. (Fig. 94).

Fig. 94 Typical Pre-Printed Bar-Code Labels

Bar Codes and Labels
(continued)

There are various methods of placing bar codes on cases including :

The carton manufacturer can print the bar code on the carton at the same time carton graphics are applied. This is very cost effective where large volumes of a single product are being produced. However, the bar code cannot supply data such as the date product was made, batch number, etc. (Fig. 95).

The bar code can be printed on the carton as it leaves the case packer. This method can be very accurate and cost effective. However, strict attention must be paid to the print density and the porosity of the carton. One of the leading manufacturers of ink jet printers for this process is Marsh Co., who guarantees a read rate of 99.9% for their high-resolution generated bar codes (Fig. 96).

A pre-printed label may be applied to the carton as it leaves the case packer. This method offers a very accurate solution since the computer generated labels can be checked for quality prior to loading into the label applicator. It is also the most expensive.

Fig. 95 Cartons with Preprinted Bar-Codes

Fig. 96 Ink Jet Printing Directly onto the Carton. (Marsh Co.)

Bar-Code Reading

There are many manufacturers of bar-code readers. Some of these are very simple units that identify basic bar codes. Some have additional features, such as abilities to read even when the carton is skewed or a long distance (3 to 4 feet) from the reader, or even recognize color symbols (Fig. 97 & 98).

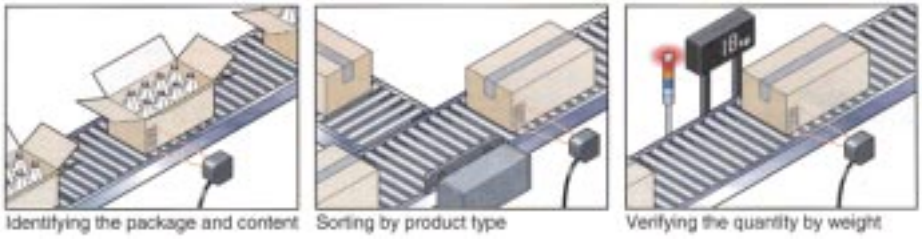


Fig. 97 Bar-Code Reading (Keyence Corporation of America)

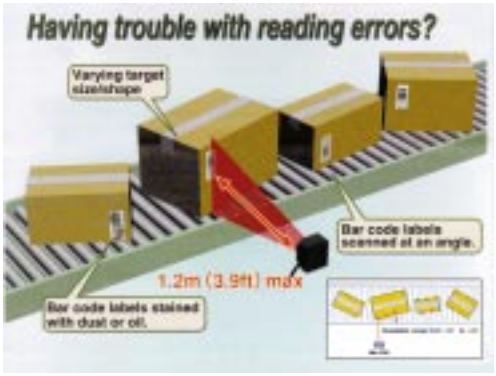


Fig. 98 Long Distance Bar-Code Reading (Keyence Corporation of America)

Applying Bar-Code Labels to Full Pallet Loads

Another use of bar codes is to apply them on the full pallet loads to provide time, date and product information. This is more complicated than placing labels on a single carton since palletizers can stack different products with different case heights.

If the palletizer stacks cases that are 6" tall and, later in the day, stacks cases that are 7" tall, a label applicator with only a single position may place labels between two layers. In other words, part of the label is on one case and part of the label on the case below. Also, if the palletizer fails to stack the load perfectly the label may not stick (Fig. 99).

There are print/apply pallet load labeling systems available that can adjust label height position automatically. When a palletizer pattern is selected the information is also fed to the labeler, which adjusts the label location automatically. These systems are available from Kolinahr Systems, Inc.

Fig. 99 Automatic Print/Apply Pallet Labeling System (Kolinahr Systems Inc.)

Case Conveyors and Diverters

Many types of case conveyors are available for material handling systems. Determining which type to use varies with the application based on size, shape, weight and other factors.

To accumulate cases on a conveyor, it is important to relieve the back pressure on the cases and many different solutions for this are available. The automatic pressure conveyor (APC) from Rapistan was the first power model to allow accumulation of material along a line without pressure buildup. APC conveyors are used wherever there is a need to stop, hold and release cartons. This need is common in both manufacturing and warehouse material handling systems.

Air-operated, padded chain conveyors with a single drive unit can power up to 300 feet of accumulating conveyor. During operation the pads drive the rollers. When a case stops, an air-powered mechanism drops the chain from the rollers in that section to stop flow, resulting in zero drive pressure on the accumulated cases (Fig. 100).

Under ideal conditions, the back pressure on accumulated cartons should be zero. There are many conveyor manufacturers that offer zero pressure conveyors. But in many instances, a low back pressure of 2% is adequate and can often save money when compared to zero pressure conveyors (Fig. 101).

Fig. 100 Air-Operated, Padded-Chain, Zero-Pressure Accumulating Conveyor Shown in a Distribution Warehouse Application (Rapistan)

Fig. 101 Two Percent, Back-Pressure Accumulating Conveyor (Hytrol Model 190 – ACZ)

Lineshaft is another popular type of accumulating conveyor. This was originally developed by Ermanco (Xenorol), but is currently available from several manufacturers (Fig. 102 & 103). Lineshaft conveyors are powered by a longitudinal shaft running under the carrier rollers. This shaft runs continuously, can be "bent" around curves and used to slave drive auxiliary components.

Molded spools are positioned on the lineshaft to transmit power to the rollers by means of polyurethane belts. The friction between the lineshaft and the spool is enough to drive the roller, but low enough to allow the lineshaft to slip inside the spool. This is an extremely important consideration in the prevention of injury or product damage (Fig. 104 & 105).

Standard lineshaft conveyors offer different degrees of low-pressure accumulation capability, and a true zero pressure version is also available.

Fig. 102 Ermanco's Xenorol

Fig. 103 Accumulating Conveyor (Ermanco)

Fig. 104 Lineshaft Conveyor (Rapistan)

Fig. 105 Curved Lineshaft Conveyor (Rapistan)

Case Conveyors and Diverters (continued)

Inclines and declines in conveyor elevation are usually accomplished using belt conveyors (Fig. 106 & 107). However, there are a number of alternatives such as case elevators and de-elevators, which are often used when there are space limitations.

Fig. 106 Decline Belt Conveyor (Rapistan)

Fig. 107 Incline Belt Conveyor (Rapistan)

Sorting Merges and Diverters

When cases of different products exit their case packers or sealers to be conveyed to a single palletizer, they might travel on a single conveyor to a warehouse and then be sorted into discrete lines of single products.

Most conveyor manufacturers also make merges and diverters. Diverters range from simple, slow-speed pusher units to the more complex shoe sorters, which are more expensive (Figs. 108, 109, 110, 111 & 112).

The high-speed pusher shown in Fig. 108 automatically diverts cases onto another conveyor. A special two-valve pneumatic control system provides smooth operation at speeds up to 45 cases per minute. It can handle weights up to 75 lbs.

Fig. 108 Air Operated Pusher (Hytrol)

The air-operated pusher (Fig. 109) diverts cases at right angles and consists of a powered pusher arm with an anti–skid face.

Ideal for moderate-rate sorting, the pop-up wheel sorter (Fig. 110) consists of a high-speed belt conveyor with two rows of skewed wheels installed at divert points. Depending on sort speed and carton weight, one or both sets of wheels may be powered.

Fig. 109 Air Operated Pusher (Rapistan)

Fig. 110 Pop-Up Wheel Sorter (Rapistan)

Sorting Merges and Diverters (continued)

For high speed sorting, the steerable roller sorter (Fig. 111) offers a number of advantages over other types, including ability to carry out bi-directional sorting, which is a useful when space is limited.

One of the most versatile is the sliding shoe sorter (Fig. 112), which can gently handle irregularly shaped cases. It accomplishes the most positive divert and can handle a very wide range of products.

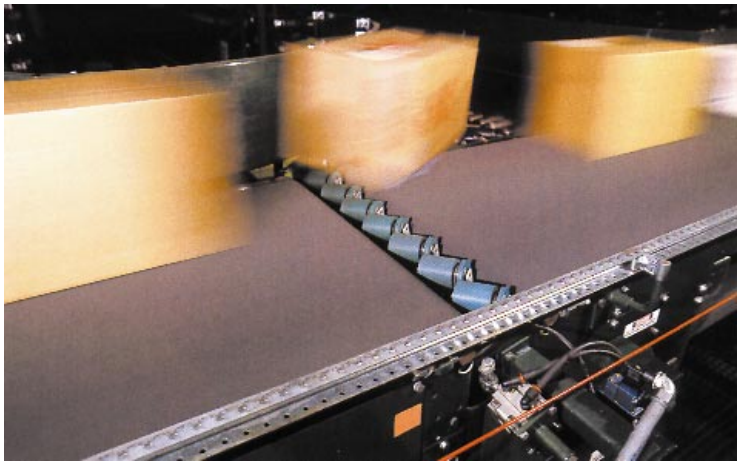


Fig. 111 Steerable Roller Sorter (Rapistan)

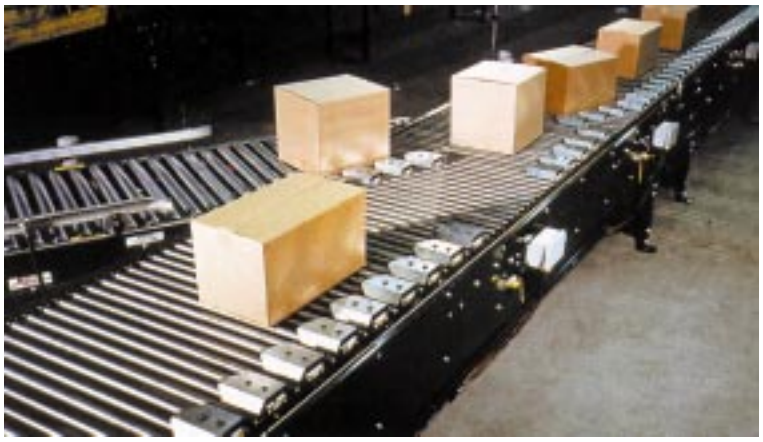


Fig. 112 Sliding Shoe Sorter (Rapistan)

Discharge Conveyors

Most palletizer manufacturers offer machines capable of handling 3000 lb. loads. However, some customers have loads that are in the 5000 to 6000 lb. range. These require heavy-duty conveyors that can stand up to fork truck abuse when loads are removed.

A chain-driven live roller conveyor, or a two or three strand chain conveyor is the preferred solution to handling these heavy loads, depending on the direction of the pallet bottom boards. If the load must travel with the bottom boards running parallel to pallet flow, then a roller conveyor can be used (Fig. 113). Otherwise, the load will bounce along the conveyor and can be shaken apart. If the load must travel with the bottom boards running perpendicular to pallet flow, then a chain conveyor is normally used (Fig. 114).

Also, if the pallet is travelling on the discharge conveyor with the fork truck openings inaccessible for pick up, there are various ways of turning the pallet to aid fork truck access, including right angle transfers (Fig. 115) and turntables (Fig. 116).

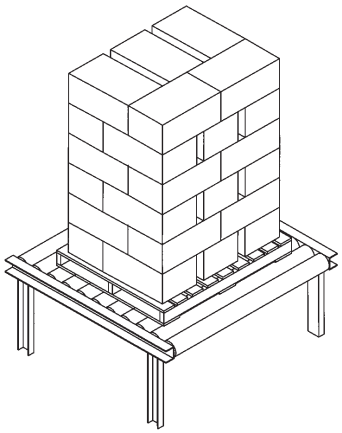


Fig. 113 Pallet Bottom Boards Running Parallel to Pallet Flow

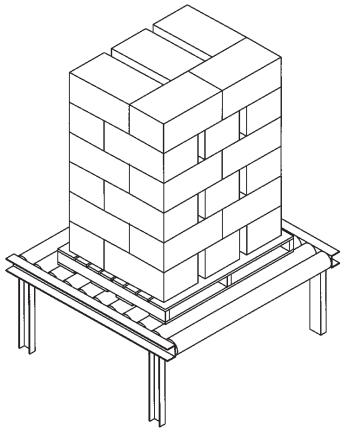


Fig. 114 Pallet Bottom Boards Running Perpendicular to Pallet Flow

Fig. 115 Right Angle Transfer (Rapistan)

Fig. 116 Full Load Turntable (Hytrol)

Stretch-wrappers

A wide range of semi-automatic and fully automatic stretchwrappers are available, ranging from low speed (around 30 loads per hour) up to high speeds (around 100+ loads per hour).

Manually loaded stretchwrappers are available with many of the features offered on the more expensive, fully-automatic, high speed units. These can include variable speed turntables with soft start and stop, and adjustable stretchwrap tension controls (Fig. 117).

Fully-automatic turntable models are available that can run at speeds of 65 loads per hour. These speeds, however, require a very stable load since it is rotating on the turntable (Fig. 118).

Fig. 117 Manually Loaded Stretchwrapper (ITW Mima)

Fig. 119 Stretchwrapper where the Film Web Rotates Around a Stationary Load (ITW Mima)

Even the most difficult loads may be automatically stretchwrapped at higher speeds with a special machine that allows the load to remain stationary while the film web spins around it (Fig. 119). The powered pre-stretch film delivery system can elongate the film up to a maximum of 300%, providing cost-effective stability.

One optional feature available is an automatic corner post placer. This allows stretchwrapping of soft loads such as polywrapped bundles of tissue, towel products and bagged products (Fig. 120). These corner posts give loads added stacking strength and more stability.

Fig. 118 Automatic Turntable Style Stretchwrapper (ITW Mima)

Fig. 120 Corner Post Placer (ITW Mima)

Double Stacked Loads

Some customers require loads between three and four feet in height. This is because the loads are extra heavy or, more likely, they are built to be end-of-aisle displays. Rather than add the expense of a full load double stacker, it is often possible to have the palletizer stack the two loads in the machine (Fig. 121).

Fig. 121 Full Load Double Stacking Done by the Palletizer

Personal Computers vs. Programmable Logic Controllers

At the time of preparing this revision of "The Science Of Palletizing" (April 1999), the industry standard for machinery controls is clearly programmable logic controllers (PLCs). However, now that engineers and plant maintenance people are comfortable using personal computers (PCs) we are seeing them being used more frequently.

Some 25 years ago, when the material handling industry was introduced to PLCs, the transition from mechanical stepper switches and relays was slow. It took between four to five years before PLCs began to dominate machinery controls. This time, it's apparent that the transition from PLCs to PCs will take less time, possibly two to three more years.

A concern for companies considering this changeover is the programming format. Since virtually all plant maintenance personnel are familiar with ladder diagram logic, the ideal transition would maintain this format. Fortunately, the few companies currently offering PC controls have done just that.

Why Change from PLC Controls to PC Controls?

Some benefits of PC controls over PLC controls include:

1. The ability to have fault diagnostics incorporated into the standard package, while including operator and customer training, preventive maintenance instructions, operating procedures, parts data, safety information, and real time reporting.
2. On-line training video which can be incorporated into a hard drive or on a separate CD.
3. Programming on a disc, which can include all of the personality information for a specific machine, such as pattern configurations, timer, counter values, etc. This provides the ability to reload the program in the event of a computer system failure.
4. A complete graphics package which can include the location of all motors, photocells, proximity switches, lubrication points, adjustments, etc.
5. PC controls for upstream and downstream equipment, including conveying systems, bar-code reading, full-load discharge conveyors, and stretchwrap equipment.
6. Safety training which can include video showing all of the guards in place and the associated safety switches, plus safe start-up and shutdown procedures.

Many companies using material handling equipment use hybrid controls. Basic machine control is carried out by the PLC, with a separate graphical interface to display fault and status conditions. This also enables the operator to change timer and counter values. The use of a PC in this configuration provides real-time production reporting and production line efficiency, such as up-time and shut-down time status.

Safety

Please Note:
All palletizers, regardless of the manufacturer, can cause injury to personnel if the manufacturer's safety instructions are not strictly followed.

Some key points to remember when working around any palletizer:

Since the machine is automatic, any part may start at any time without warning. The machine may appear to be completely switched off when it is actually just waiting for product. As soon as it arrives, the machine can begin operation without warning.

Machinery guards have been designed to provide safe operation of the palletizer and reduce the possibility of personal injury and/or machine damage. It is essential to keep all shields, guards and safety devices in place before, during and after machine operation.

If a shield, guard or safety device has been removed for any purpose, or is damaged or missing, it should be repaired or replaced before the machine resumes operation.

Never clear product jams or attempt repair or maintenance on a machine while it has any form of power connected (air, hydraulic or electrical).

Never attempt to work on or under the hoist without the machine being locked out and the hoist safety pins securely in place.

Never allow an operator to get on or into the machine without the electrical power and air supply being "locked out." This means locking out the electrical disconnect switch and the air supply using padlocks, with the key being kept by the person who needs to get on or into the machine.

Never attempt to clear a pallet jam without first switching off the machine and locking it out.

Never attempt to remove a full load from the palletizer until it has come to a complete stop on the discharge conveyor.

Never attempt to weld anything on the palletizer while the power is switched on. Always disconnect the PLC before any welding is carried out.

The palletizer will come with a number of warning decals, which are positioned on the machine to indicate specific areas of danger. These warnings must be followed.

Most palletizer manufacturers design their machines to very exacting standards, including accepted engineering standards, and applicable state and local codes. OSHA standards, however, apply to the location thereby becoming the responsibility of the equipment user and not the equipment manufacturer.

Finally, require all personnel working with the palletizer to read the instruction manual and the safety related material.

Summary

The following are considerations for the company contemplating purchasing and operating palletizers for the first time.

1. Visit the potential supplier to ensure he has the engineering capability, necessary parts backup and dedicated service organization required by your company. Look for an organization that can be reached at every division — whether it's Sales, Engineering, Service or Parts — to answer questions and resolve problems.
2. Obtain a list of customer references from the palletizer supplier. Ask for those with similar machines and applications as the one you are considering.
3. If more capacity is going to be required from the machine at a later date, ensure the machine is upgradable. Check out what is involved to upgrade; don't simply take the sellers' word for it.
4. Specifically check any limitations of the machine. For example, check whether patterns can be formed with gaps in either or both directions, and whether options can be added at a later date. These may include sheet feeders, glue systems, pallet dispensers and additional patterns.
5. Check to ensure that adequate documentation is available prior to completion of the palletizer. This would include operating and installation instructions, and a complete recommended spare-parts list. Make sure detailed electrical, pneumatic and hydraulic (if required) schematics, and cross-references are available for reproduction if necessary. Find out if training video tapes are available.
6. Select a palletizer manufacturer that has a long-standing reputation for dependability.
7. Insist on a performance guarantee and don't buy on **price** alone. Remember, the price of the machine is soon forgotten, but the **quality** is reflected in its **performance.**

Acknowledgements

The following products are shown in this book:

Allen Bradley Co.
Barton Brands.
BOLD is a product of the Procter and Gamble Co.
Bowater Paper Co.
Champion Paper Co.
CHEER is a product of the Procter and Gamble Co.
CHEP Pallets.
CLOROX 2 is a product of the Clorox Co.
Columbia Contech.
Columbia Machine Inc.
Columbia/Okura L.L.C.
COSTI Robots
Cutler Hammer Co.
DAWN is a product of the Procter and Gamble Co.
Ermanco Inc.
Gilster Mary Lee.
Hammermill Paper Co.
Hytrol Conveyor Co.
ITW Mima Co.
James River Paper Co.
Keebler Co.
Keyence Corp of America.
Kolinahr Systems Inc.
Kroger Co.
Lake County Pears
Leslie Salt Co.
LIQUID PLUMBER is a product of the Clorox Co.
Marsh Co.
MR. CLEAN is a product of the Procter and Gamble Co.
Murphy Phoenix Co.
Nass Foods Co.
OXYDOL is a product of the Procter and Gamble Co.
PUREX is a product of the Dial Corporation
Rapistan Systems.
Schmidt Brewing Co.
Seagrams
Shell Oil Co.
Snapple.
TACKLE is a product of the Clorox Co.
TIDE is a product of the Procter and Gamble Co.

These products are used in this book for illustrative purposes only. Their presence should not be construed as product endorsements by Columbia Machine Inc., or an endorsement of Columbia Machine Inc. by these companies.

"The Science of Palletizing"
Written by Robin A. Popple
Major Accounts Manager
Columbia Machine Inc.

Columbia Information Service

This service offers free brochures to help you choose the right palletizing system for your operation. Your palletizing needs are unique and Columbia Machine knows this. That's why our Information Service offers a wealth of information to help you plan and install a system custom designed and engineered to meet your specific requirements for years to come. Some of the helpful materials are described in the following pages.

For more information, just mail in the postage free card at the back of the book or call Robin Popple at Columbia Machine, 360-690-1380.

Bulletins, Brochures, Videos and CDs

Product Line Brochure

Covering most of Columbia's product line, this brochure includes information on our low-cost, FL and HL series of floor level and high level palletizers, our HD series of extra heavy duty machines and specialized machines like pail, drum and bag palletizers.

E Series Brochure

These economically priced, versatile floor level machines have a wide variety of footprints enabling them to fit into virtually any layout. The FL-100 is capable of speeds up to 20 cases per minute, while the FL-150 loads at up to 30 cases per minute.

HL Series Brochure

These high level workhorses are economically priced, versatile and offer a wide variety of footprints to fit any plant layout. The HL-4000 is capable of speeds up to 45 cases per minute and the HL-6000 runs at speeds up to 70 cases per minute.

PI Series Brochure

The extra heavy duty FL-200 and FL-500 machines are primarily used in the paper industry where they handle case weights of up to 200 pounds or more. They tackle cartons measuring up to 52" x 42" x 18" and provide labels out stacking. The FL-200 is capable of speeds up to 12 cases per minute and the FL-500 moves at speeds of up to 40 cases per minute.

Models 200, 500 and 510 Bulletins

These describe the features of our extra heavy-duty floor level palletizers, which handle very heavy cases of 200 pounds or more, and loads of 6,000 pounds or more. The model 200 is capable of speeds up to 20 cases per minute, the model 500 runs at up to 45 cases per minute and the model 510 loads at up to 55 cases per minute. These machines have life expectancies of 30 years or more. With over 3,000 currently in use worldwide, they represent the bulk of Columbia's production.

Stand Alone or Retrofitable Options Bulletins

These describe options such as pallet dispensers, sheet dispensers and palletizer infeeds. One infeed, the Turnado, is capable of turning cases 90, 180 or 270 degrees either clockwise or counterclockwise. It's used for labels-out stacking, which is ideal for display packs where the display side of the carton must face the outside of the load.

Retrofit options include an electrically operated flight bar pusher, which can be fitted to existing machines for increased speed.

A-730 and A1500 Brochures

The A-730 is a four-axis, articulating arm robot capable of handling cases, bags, pails, drums, totes and bundles. It works at a rate of 550 cycles per hour for cases and 700 cycles per hour for bags. Its payload capacity is 264 pounds minus the end effector weight.

The A-1500 is a four-axis articulating arm robot capable of handling cases, bags, pails, drums, totes and bundles at a rate of up to 1,500 cycles per hour. It has a payload capacity of 340 pounds minus the end effector weight.

Bulletins, Brochures, Videos and CDs (continued)

HL-8000 Brochure

Our most sophisticated palletizer, the HL-8000 runs at speeds of 100 cases per minute or faster, has a unique soft-handling turning mechanism and can accommodate case sizes from 6" x 6" up to 18" x 24". This high level design incorporates the very best case handling techniques developed during Columbia's 35 years of experience.

Industrial Control Systems and Engineering Brochure

This outlines the capabilities of Columbia's industrial controls group, Columbia Contech. This group is proficient with a wide variety of programmable controllers and PC controls, motor controls and complete material handling system design. Columbia Contech is one of the very few controls groups that can take a complete material handling project from concept to a fully functional system.

Videos and CDs

Columbia has a wide range of videos covering all of our machine models. We've also produced animated graphic CDs for each of our standard palletizers. These presentations include basic information on operation, safety, fault finding and preventive maintenance. They're invaluable tools for training new operators and helping to ensure peak palletizer operational capacity.

Columbia Technical Services

Columbia Technical Services offers literature on:

- Case, pail and drum palletizing
- Bag palletizing and depalletizing
- Total material handling systems

In addition, our sales representatives will be happy to show our videos and CDs at your location. Please call 1(360) 690-1380 for more details.

Free Seminars

We can provide educational seminars at your plant for groups of eight or more people. For groups of less than eight, we will host the seminar at Columbia.

Topics covered include:

- Palletizer interfacing upstream and downstream
- Conveyor systems and controls
- Discharge conveying systems.
- Interfacing with string tyers, strappers and stretchwrappers
- Programmable controller considerations
- Single-line and multi-line applications

COLUMBIA MACHINE, INC.
107 Grand Boulevard • P.O. Box 8950, Vancouver, WA 98668-8950
Phone (360) 694-1501• Fax (360) 690-4583
Email: pallinfo@colmac.com • www.colmac.com