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The Filling, Closing and Handling of Sacks

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Füllen, Verschließen und Handhaben von Säcken
Le Remplissage, la fermeture et la manutention des sacs
Llenado, cierre y transporte de sacos
大形袋への袋詰め、閉じ、およびその取扱い
袋的灌装、封口和装卸
تعبئة وغلق ومناولة الأكياس

Füllen, Verschließen und Handhaben von Säcken

Beschrieben werden die Überlegungen, die bei der Auswahl von Absackmaschinen angestellt werden müssen sowie die Grundlagen für den Betrieb der verschiedenen Gerätetypen. Ein Ausblick auf die zukünftige Entwicklung wird gegeben.

Le remplissage, la fermeture et la manutention des sacs

Examen des considérations affectant le choix de l'equipement de mise en sacs et exposé des principes de fonctionnement des divers types d'ensacheurs á vanne et de leurs applications. Comparaison entre les systèmes grand ouvert et d'ensacheur á vanne et référence aux développements futurs.

Llenado, cierre y transporte de sacos

Se examinan las consideraciones que afectan a la elección de los equipos para ensacar y se explican los principios del funcionamiento de los diversos tipos de ensacadores de válvula y sus aplicaciones. Se hacen comparaciones entre los sistemas de ensacado be boca abierta y de válvula haciendo alusión breve de los posibles desarrollos futuros.

Summary

Following a reference to the types of sacks available, the considerations affecting the choice of sack packaging equipment are examined.

Descriptions of basic open mouth and valve sack packing installations are given. The principles of operation of the various types of packers and their applications are explained.

Some comparisons are made between open mouth and valve sack systems. A brief reference is made to future developments.

1. Introduction

With the advent of multiwall paper sacks, a rapid development of filling, closing and handling techniques took place. This covered the introduction of purpose-built weighing and filling installations, heavy duty sewing machines and a range of valve packing machines.

When plastic film became available, particularly polyethylene, it was either incorporated to form an additional barrier among plies of paper or, in a much heavier gauge, it was made into sacks. More recently, woven plastic sacks, and multilayer films, have increased the variety of sacks which have to be accommodated by the packaging machinery industry.

Much of the equipment originally designed for paper sacks can equally well be used with woven and film sacks. The notable additional technique required has been the heat sealing of film sacks and of the film ply or coating of composite sacks.

In the section which follows, it is assumed that the type of sack has been established before the packaging equipment is selected. In some cases the suitability of a particular type of packing machine will determine the type of sack to be used.

In general terms, fine powders impose more stringent requirements, not only in the sack construction, but also on the filling and closing techniques, than coarse products.

2. Selection of Sack Packaging Equipment

In choosing sack packaging equipment each of the following factors must be taken into account: type of sack, construction of material of sack, nature of product(s), packing rate, unit weight(s), source of product, disposal of filled sacks, space available, services available, capital cost, operating cost, maintenance costs, skills available, health and safety, future expansion plans.

Type of sack: The selection of *open mouth* or *valve sacks* determines the basic range of equipment to be considered.

With open mouth sacks, special constructions (e.g. Step Seal or heat sealable liners) will dictate the need for a specific closing unit.

With valve sacks, the use of external sleeves will require additional facilities on the packing machine.

Construction material of sack: The material from which the sack is made will influence the methods of closing and handling, particularly in the case of film sacks.

Nature of product: The nature of the product has a prime influence on the choice of equipment, as well as on the type of sack. Its physical properties will determine the type of weighing, hopper design and, if appropriate, the type of valve

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packer. Its chemical properties may impose restrictions on construction material and the protection of electrical gear.

Product Properties to be considered are:

— Bulk Density
— Packing Density
— Angle of Repose
— Moisture Content
— Temperature
— Corrosive
— Abrasive
— Explosive
— Hygroscopic.

Typical product desciptions with examples are:

Clean free-flowing granules	Plastic Pellets
Fine free-flowing granules	Dried Vacuum Salt
Granules with some fines	Granular Fertiliser
Lumpy, irregular with some fines	Solid Fuels
Very fine sticky powder	Pigments
Aerated fine powder	Titanium Oxide
Sticky granules	Resins

The packing rate, unit weight, source of product, disposal of the filled sacks and the space available are considerations which are very much interrelated.

Packing rate: It is important to distinguish between the average long-term plant output and the maximum output required over a short period. The latter figure will determine the necessary packing line capacity. To achieve this the choice may be between a single high speed installation and several simpler low speed lines.

Unit weight: If a wide variation in unit weights is required, separate lines may be better than a more complex single machine, which frequently has to be re-set.

Smaller unit weights normally involve higher operating speeds.

Source of product: If there is adequate intermediate storage between the source of the product and the packing line, the performance of the filling equipment is not critical. If packing is direct from a continuous production plant or batch process, the provision of stand-by units is essential.

Disposal of filled sacks: Packing sacks for direct loading onto transport vehicles also calls for high speed equipment and spare capacity, which may not be required, however, if filled sacks are palletised or stacked for warehouse storage.

Space available: The space available for sack packaging may be a deciding factor, particularly on older plants. Installations using nett weighers require more headroom than those with gross weighers. Valve packers take up less floor space than open mouth lines.

Services available: Sack packaging equipment usually requires an industrial electrical supply (380/415 V, 3 phase, 50 Hz). The majority of scales and more advanced automatic sack filling and closing machines also require clean dry compressed air at 5.5 bars.

Capital, operating and maintenance costs: The three cost factors, capital outlay, operating (i.e. labour) and maintenance costs are inter-related. For a given output requirement the choice may be between a small number of high value advanced machines and a larger number of simple machines. While the advanced units will reduce the cost of operating labour, they will probably require greater expenditure on maintenance.

Skills available: It would be unwise to install complex equipment unless there was an adequate standard of operating and maintenance personnel.

Health and safety: The advent of automatic sack packaging equipment has reduced the exposure of operators to hazardous products.

Future expansion plans: Both open mouth and valve sack packaging installations lend themselves to augmentation of capacity. For example a simple sewing machine can be converted to higher speed with the addition of automatic control gear. Automatic cycle initiation and sack discharge can be added to a basic valve packer.

3. Open Mouth Sack Packing

The basic installation (Fig. 1) comprises:

— Weighing machine
— Filling spout
— Sack sewing machine and conveyor or
— Heat sealing machine and conveyor.

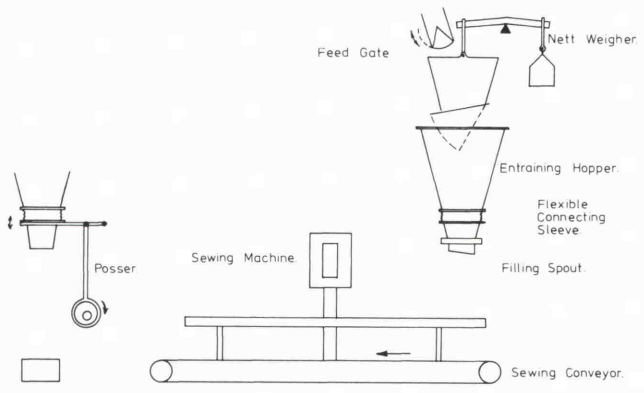

Fig. 1: Basic open mouth sack packing line

The nature of the product will determine the method of feeding the weighing machine. The packing rate influences the choice between gross and nett weighing, also the speed of the sewing or heat sealing equipment, which will vary from 6 m/min to 15 m/min (Table I).

For low outputs, gross weighing is used, in which the product is weighed directly into the sack and cut off manually or automatically when the correct weight is reached. For high outputs an automatic nett weigher is used. The product is fed into a scale pan until the correct weight is attained. The charge is then released through a filling spout into the sack. During this operation, the next charge is being weighed.

All open mouth sacks of standard multiwall paper, composite and woven constructions are normally closed by sewing, of which several varieties are available, with or without the addition of crepe tape. The heavy duty sewing heads are automatically operated by the passage of each sack, including the cutting of the thread or tape.

Film sacks are usually heat sealed. For very low outputs a static jaw type sealer is used. The majority of film sacks are closed by continuous band sealers, in which the sack top is carried by a pair of moving steel bands, matching the conveyor speed, first between heating bars, then between cooling bars. Film sacks can be closed by sewing (Fig. 2).

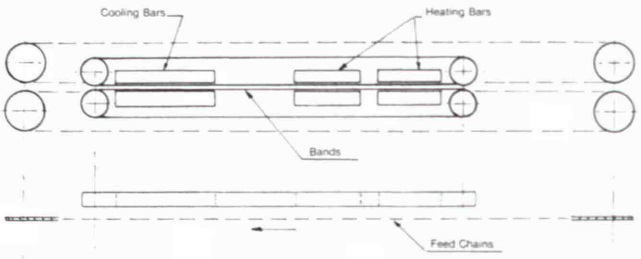

Fig. 2: Continuous band heat sealer

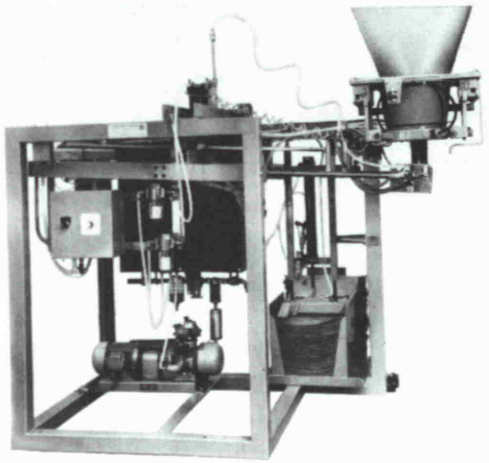

Fig. 3: Open mouth sack applicator

Refinements to the basic open mouth packing line include:

Posser: A machine which oscillates the spout to settle the contents of the sack during filling.

Automatic spout: Automatically clamps each sack presented to it, signals the scale discharge and, after a pre-set interval, releases the filled sack.

Automatic sack applicator: A machine which takes empty sacks from a magazine and places them on the filling spout (Fig. 3).

Automatic sewing unit: A number of machines are available which present filled sacks to the sewing head and close them without manual intervention. These either form the sack mouth by spreader arms and creasing bars or by a system of converging belts and rollers (Fig. 4).

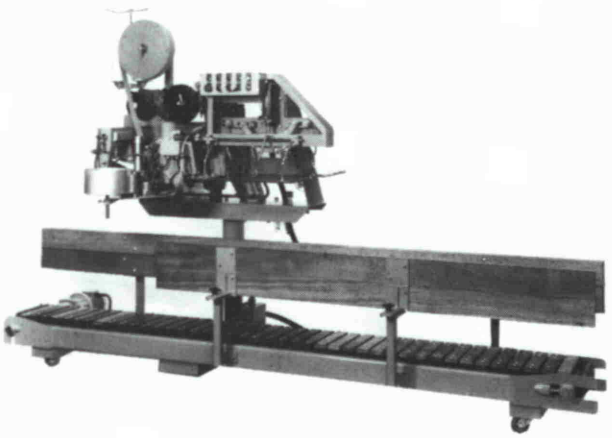

Fig. 4: Automatic sack sewing machine and conveyor

Table 1:
Open mouth sack filling and sewing

Type of equipment			Sacks per minute with number of operators		
Scale	Filling	Sewing	1 operator	2 operators	3 operators
Platform	Hand spout	Portable	1—2		
Semi-auto gross	Hand spout	Pillar and bogie	2—3		
Automatic gross	Hand spout	Pillar and conveyor (low speed)	3—4		
Standard nett	Auto spout	Pillar and conveyor (low speed)	4—6	8—10	
High speed nett	Auto spout	Pillar and conveyor (high speed)	5—8	10—15	
Twin nett	Auto spout	Pillar and conveyor (high speed)		12—16	18—24
High speed nett	Auto spout	Automatic	8—14		
High speed nett	Auto sack placer and spout	Pillar and conveyor (high speed)	8—14		
High speed nett	Auto sack placer and spout	Automatic	8—14[1]		
High speed nett	Integrated auto filling and sewing machine		8—14[1]		

The figures quoted are based on the assumption that adequate weighing and filling equipment is provided.

[1] one operator in attendance but free to perform other duties in vicinity

Ticket dispensers: Feed tickets from a reel or a magazine into the sewing line.

Sack mouth cleaning: Prior to heat sealing a film sack containing some dusty products, it is necessary to clean the surfaces to be joined by a lance with suction holes, a small revolving wire brush or other means.

Special Open Mouth Sack Closing Systems

Step-sealer: In this machine, hot air jets melt the pre-applied adhesive on the protruding lip of the sack mouth, which is folded over and passed through pressure rollers to give a tight strong seal.

Combined sewing and heat sealing: Units are available to close sacks with heat sealable inner liners, by successively sewing, sealing the liner just below the sewing line and finally applying a heat sensitive tape over the sewing. These machines are much longer than ordinary sewing units, requiring a conveyor about 6m long (Fig. 5).

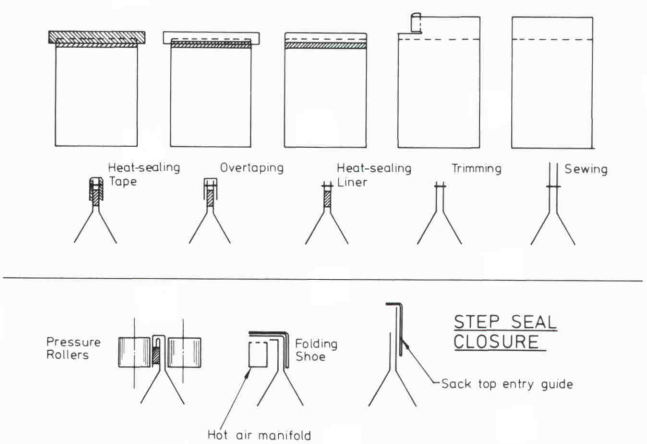

Fig. 5: Combined sewing, heat-sealing and overtaping

4. Valve Sack Packing

The function of all valve packers is to accelerate the product so that it will enter the relatively small filling aperture of the sack at high speed, to achieve an acceptable packing rate. The nature of the product determines the method by which this is done (Table 2).

Valve packing machines may also be divided into those with built-in mechanism to weigh the product directly into the sack and those which receive a pre-weighed charge from a separate nett weigher.

4.1 Types of Valve Packer

Groove Wheel (or belt): A flat belt runs in contact with part of the circumference of a wheel rim, recessed to form a rectangular section groove. The product enters the annular space so formed from a narrow vertical chute and is discharged horizontally through a filling spout into the sack (Fig. 6).

These machines normally operate with nett weighers and are suitable for free-flowing granular products (Fig. 7).

Impeller: An impeller running continuously in a housing accelerates the product and delivers it through a tangential outlet, connected by a short length of flexible tube to the filling spout. The spout and the sack supporting chair are carried on a weigh beam. When the correct weight is attained, the flexible tube is closed by a pinch valve (Fig. 8).

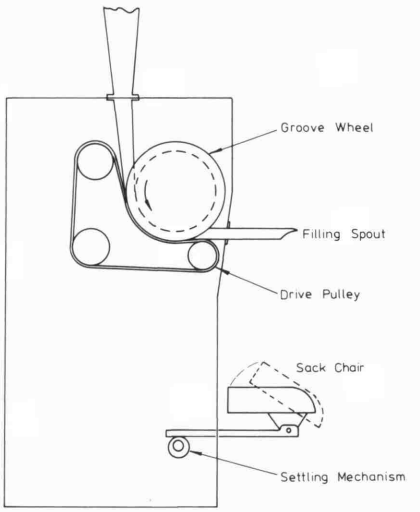

Fig. 6: Groove wheel (or belt) packer

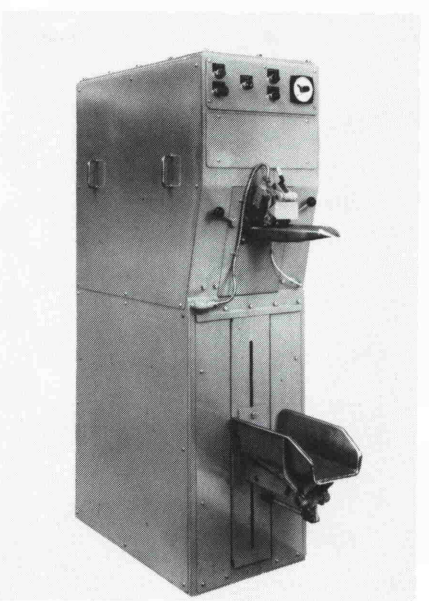

Fig. 7: Belt packer

Impeller Packers are used for products of the "ground rock" variety, including cement, china clay, ground limestone, hydrated lime etc.

Fluidising: The product is fluidised by the admission of low pressure air through a porous pad in the base of a chamber. The fluidised material flows by gravity through a flexible connection to the filling spout. The packing rate may be increased by applying air pressure above the product in the chamber (Fig. 9).

The weighing mechanism is as described under the Impeller Packer (Fig. 10).

Fluidising Packers are particularly suitable for fine powders with difficult handling characteristics, but they can pack a wider range of materials than any other valve packer.

Gravity: Machines relying solely on gravity take the form of a steeply inclined or vertical chute terminating in a filling spout. Low output machines, mounted on platform scales, employ gross weighing; for high outputs the "free-fall" vertical chute packers operate with pre-weigh scales.

Gravity Packers are suitable for free-flowing granular materials.

Screw: The material is delivered from a small hopper with an agitator through a high speed screw or auger in the filling tube. For gross weighing, the complete unit is mounted on a platform scale; alternatively, it may be supplied from a pre-weigh scale.

Screw Packers are used for powder products which do not flow freely.

Table 2:
Valve packing

Type of packer	Products		Unit Weight kg/lb	Output sacks/min with one operator			
	General description	Typical examples		1 Spout	2 Spout	3 Spout	4 Spout
Gravity on platform scale (Semi-automatic weighing)	Granular free-flowing	Plastic pellets	25/56	2	4	—	—
		Dry sand	50/112	2	4	—	—
Gravity free fall with pre-weigh scale	Granular free-flowing	Plastic pellets	25/56	5—6	12—14	—	—
		Granular fertiliser	50/112	6	12—16		
Belt (grooved wheel) with pre-weigh scale	Granular free-flowing	Granular fertiliser	50/112	6—7	14—15	20	20
		Granular sugar[1]	50/112	4—5	8—10	—	—
		Plastic pellets	25/56	6—7	14—15	20	20
		Provender pellets	25/56	6—7	14—15	20	20
		Grain	50/112	5	10	15	20
		D.V. salt	50/112	6—7	14—15	20	20
Belt (grooved wheel) with pre-weigh scale and belt feeder	Large cubes	Beet pulp nuts	50/112	3	6	9	12
		Cattle cubes	25/56	4—5	10	15	20
	Light fine flake	Provender meals	25/56	4—5	8—10	12—15	16—20
		Soya meal	50/112	4	8	12	16
		Shredded beet pulp	40/88	2 1/2	5	7 1/2	10
Impeller on platform scale (hand controll)	Pure ground rock	Portland cement	50/112	2—3			
		Gypsum	50/112	2			
		Hydrated lime	25/56	1—2			
		China clay	25/56	1—2			
		Fly ash	25/56	2			
Impeller with automatic weighing and sack discharge	Pure ground rock	Portland cement	50/112	5—6	10—12	15—18	20—24
		Gypsum	50/112	3—4	7	10	14
		Hydrated lime	25/56	3	6	10	14
		China clay	25/56	3	6	9	12
		Fly ash	25/56	4—5	8—10	12—15	16—20
Fluidising, pressure flow	Powders, Powder/fine granule mixtures	PVC resin	25/56	5—6	12		
		Carbon black	25/56	3—5	8—10		
		Starch	50/112	4—5	8—10		
		Refractory powders	50/112	5—6	12		
		Flour	50/112	4—5	8—10		
Screw with screw feeder, mounted on platform scale (hand control)	Fine and very fine non-free flowing powders	Resin powder	25/56	1			
		Starch	50/112	1			
Screw with pre-weigh scale	Fine and very fine non-free flowing powders	Resin powder	25/56	2	4		
		Starch	50/112	1 1/2	3		
		Flour	50/112	1 1/2—2	4—5		
		Provender meal	25/56	2—3	4—6		

1 Tuck-in sleeve valves.

If sacks with tuck-in sleeves are used with valve packers having automatic discharge, an arresting device may be provided to hold the sack temporarily at a convenient angle.

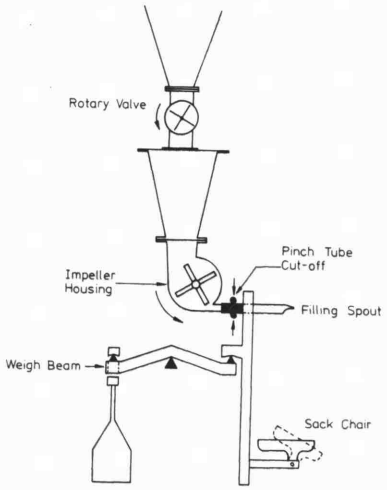

Fig. 8: Impeller packer

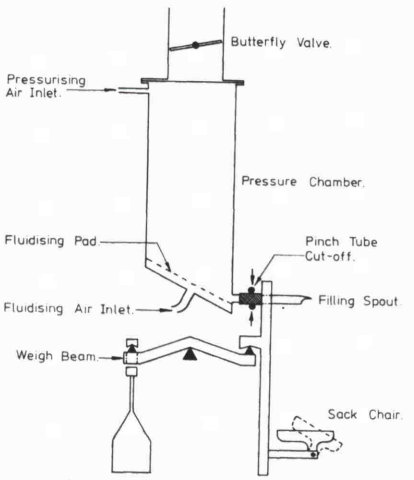

Fig. 9: Pressure flow packer

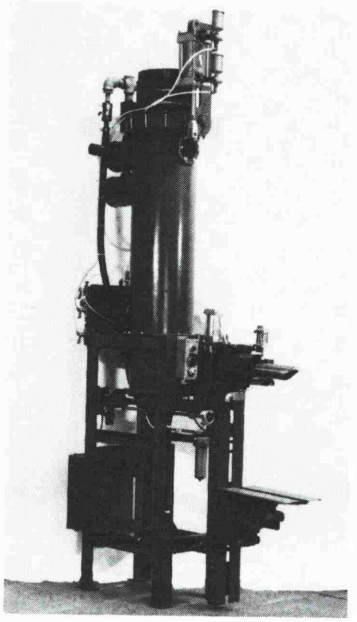

Fig. 10: Pressure flow valve packer

4.2 Multi-Spout Valve Packing Installations

Belt Packers are avialable as single or twin spout machines, Impeller Packers can have up to four spouts. Other types, though supplied as single units, may be grouped together for economical operation by one man.

4.3 Valve Sack Applicators

These machines withdraw sacks from a magazine, open the valve, and place them on the packing machine filling spout. They may not be used with external sleeve sacks (Fig. 11).

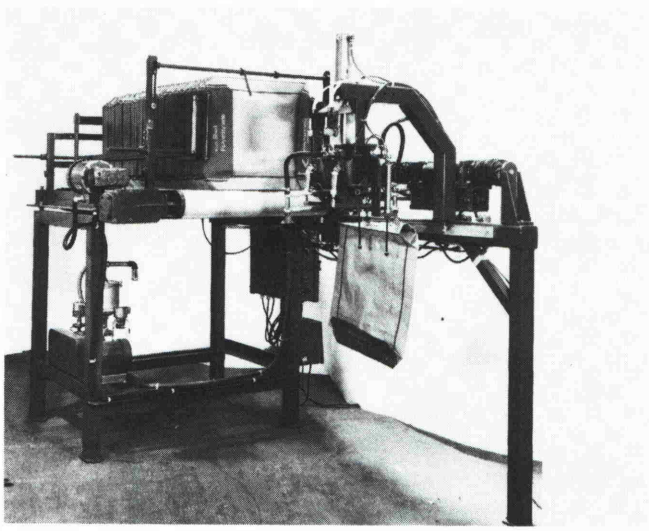

Fig. 11: Valve sack applicator

5. Rotary Packers

These consist of a number of individual packing units mounted on a slowly rotating structure. Empty sacks are manually placed on each of the filling spouts at one point; filling takes place as they travel round until they reach the point at which the filled sacks are discharged. The output is no longer governed by the time taken to complete each weighment and fill each sack, therefore constant high packing rates can be achieved.

Rotary Packers are available for both valve and open mouth sacks, but they are mainly used for filling cement into valve sacks at rates of up to 120 tonnes per hour.

6. Comparisons Between Open Mouth and Valve Sack Packaging Equipment

6.1 Open Mouth

Advantages:

— Flexibility to handle a range of products.
— Variety of secure closures available.
— Variations in product density can be accommodated.
— Tickets can be securely attached to sacks.
— Mobile closing units can serve several outlets.
— Capacity can easily be increased.

Disadvantages:

— Sewing machines can be troublesome and require skilled maintenance.
— Some operating skill is required.
— Extra labour is required for high speed packing.

6.2 Valve Packers

Advantages:

— Machines are robust and no special skills are required for maintenace.
— No operating skill is required.
— There is no separate sealing operation.
— Less packing line labour is required.
— Less floor space is required.

Disadvantages:

— Variations in product density cannot be accommodated.
— Several types of machine may be required to cover product range.
— Liable to product hold-up and weight variation.
— May cause degradation of product.

The above considerations purely relate to the equipment: other factors, such as sack costs, the handling characteristics of the filled sacks, customer preference etc., are more likely to have a decisive influence on the type of packing equipment to be selected.

7. Filling Aerated Products

Many products are aerated on entering the sack, either as a result of previous handling or by the packing machine. To remove the air and obtain tight packs the sacks can be posed or subjected to vibration during filling. A system of direct suction using probes with a porous plastic filter medium is also used. This problem is of the greatest significance when using film sacks or sacks with impervious barriers which are to be heat sealed.

8. Handling Filled Sacks

Multiwall paper sacks lend themselves particularly well to mechanical handling by belt conveyors, roller conveyors, elevators and chutes. With film plastic sacks, particularly those containing granular or lumpy products, chutes should be avoided, since friction can cause puncturing.

Prior to stacking, palletising or loading onto vehicles, sacks may often with advantage be flattened. This is done by passing them between rollers, compression belts or vibrating plates. Care is required when highly aerated products are packed in film sacks or composite sacks with impervious linings and fully sealed closures.

Semi-automatic and fully automatic palletisers have been developed specifically to handle filled sacks. In semi-automatic machines, each layer is arranged manually after which it is mechanically transferred to the pallet. After each layer is deposited, the pallet lowers in readiness for the next. Fully automatic palletisers have means of turning each incoming sack through 90° or 180° according to a pre-set programme, before passing it to the layer forming table. From there on the pallet loading is as previously described.

9. Future Developments in Sack Packaging Equipment

Increased interest is being shown in the "Step Seal" or pinch closed sack. This type of sack must be entered very accurately into the closing unit, which cannot therefore be linked to the types of automatic feeder previously discussed. A system in which the sack top is continuously and accurately controlled will be necessary.

In the USA there is a growing requirement to seal valve sacks positively, which can be done by heat sealing an external polythene sleeve. Another development includes the use of a water-soluble plastic sleeve which is moistened by a water mist injection device in the packing machine spout.

A system of storing up to 3,000 individual sacks on a reel, held in place by bands, has been developed in Germany. As the reel is unwound each sack is delivered to an automatic placing device.

Form-fill-seal machines using layflat tube polythene film from a reel have been in use for some time for high speed packing of fertilizer in 50 kg units. The sacks are cut and the bottom seal is made in one operation. They are then transferred to the filling station and, after filling, the top is heat sealed in a band sealer.

The need for higher packing rates and reduced manual labour will continue to influence the development of sack packaging machinery. While the great merit of the sack as a container for free-flowing materials lies in its flexibility, this property causes problems, not encountered with rigid containers, throughout the packing cycle.

Further progress will be made with automatic sack application to open mouth and valve packer filling spouts, also with the automatic closing of open mouth sacks. The ultimate goal will be packing lines with built-in fault detection and correction. Until this is attained, it must be accepted that some supervision of even the most advanced equipment is necessary, though the manual labour hitherto associated with sack packaging can largely be eliminated.