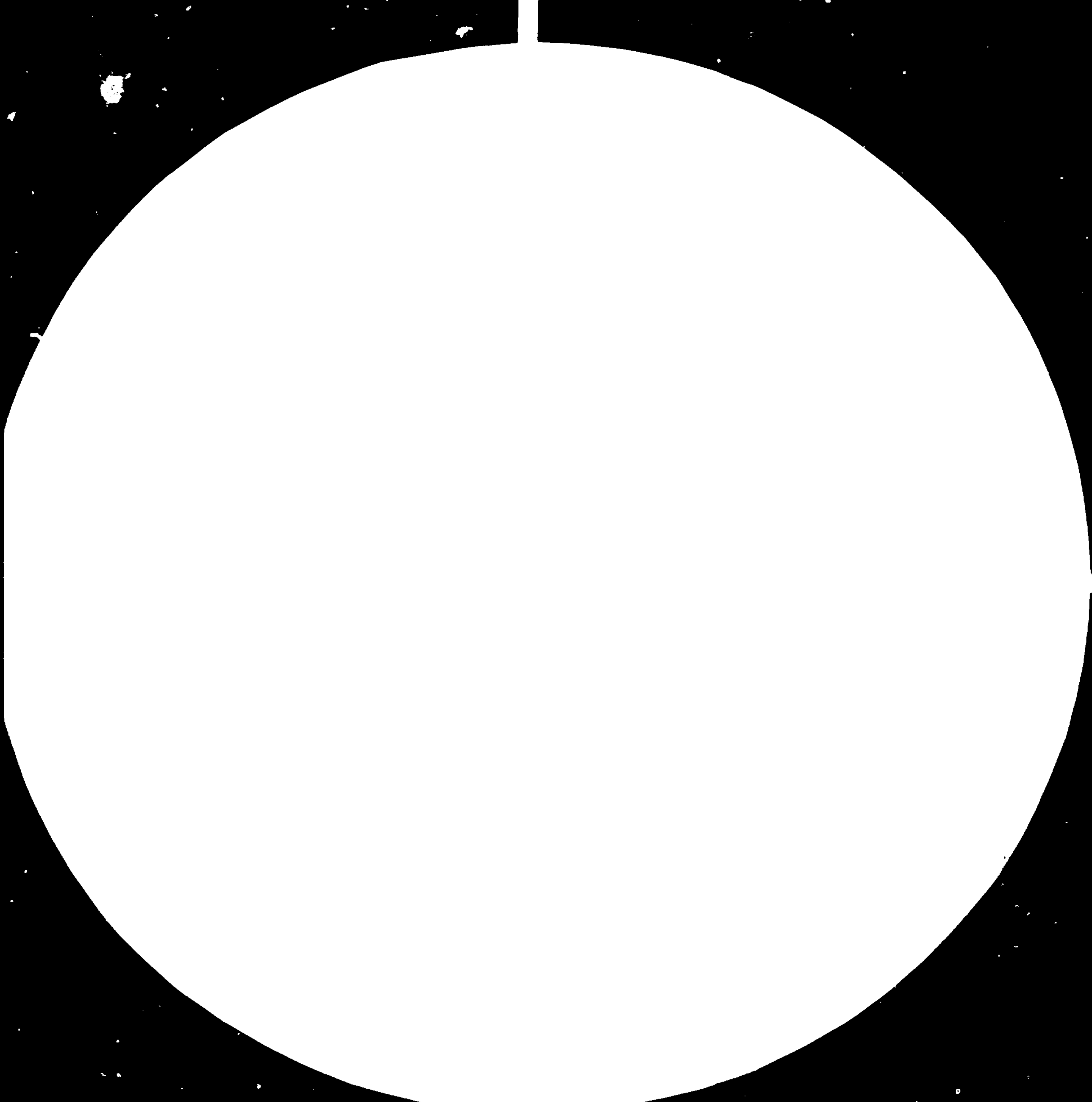

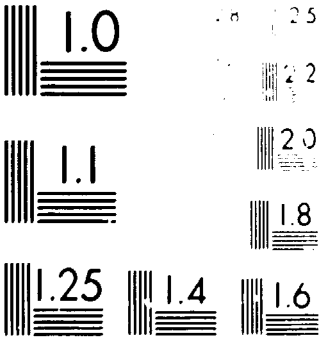

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THE MODERNIZATION OF PACKING PLANTS WITH
AUTOMATIC TRUCK LOADING EQUIPMENT AND
PALLETLESS SHRINK WRAPPING LINES *

by

Gernot Heinrich Schaefer **

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** Managing Director, BEUMER MASCHINENFABRIK KG, Federal Republic of Germany

V.82-30912

1. The Modernization of Packing and Loading Installations - General

After the building materials industry -- that is, the producers of cement, lime, gypsum, etc. -- concentrated its efforts in the past overwhelmingly on the more efficient and economic planning of its production capacity -- this resulting in the building of larger and larger production units -- the opportunities remaining today in these fields for improving efficiency are largely exhausted. Due to the enlargement of production units and the automation of the control and monitoring processes, the personnel required in the production area could be notably reduced with an equally notable rise in specific production capacity. The situation arose, then, in which often more personnel had to be employed in the packing and loading areas than in all other production departments combined, not counting maintenance and repair personnel. In addition, a certain dependence on the packing and loading personnel was forced on the plant -- and this in view of the willingness and capability of this personnel.

An additional task faced the management of certain plants to find a more economical shipping method than individual bag shipment, for example, as a result of a desire to export or due to the necessity of shifting the bagged product often during transport.

It was only a question of time, then, before modernization was undertaken in the packing and loading departments as well, with the departure from conventional machinery to some extent and the gradual introduction of more efficient systems.

The breakthrough in the modernization of packing plants was brought about in principle by three machine systems which were developed jointly between the machinery industry and the cement manufacturers in the past decade. These were the development of automatic bag placing systems for high capacity rotary packers (Illustration 1), the development of machinery for loading bags onto trucks (Illustration 2) and the further development of palletizing technology in conjunction with palletless shrink wrapping for producing large packages without wooden pallets (Illustration 3).

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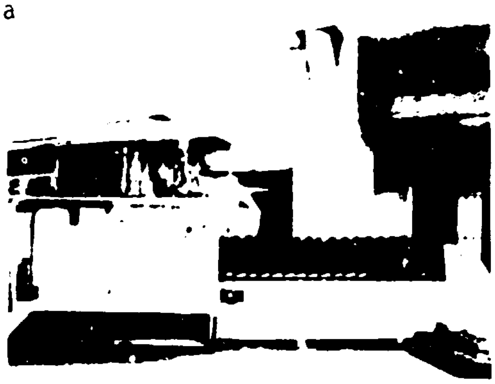

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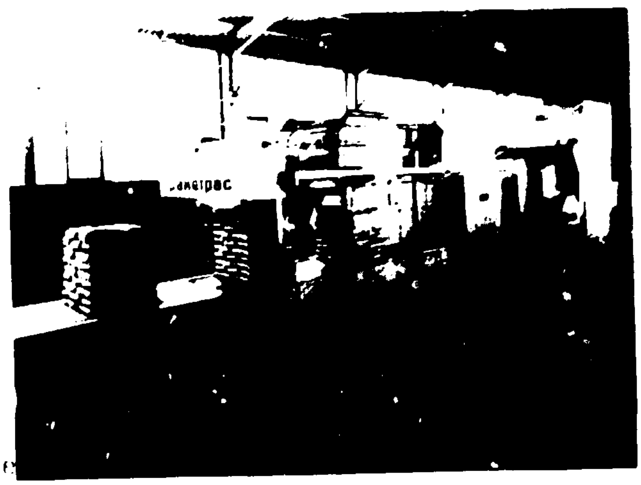
Ill. 1: Automatic empty bag placer
a & b for high capacity rotating packers

Ill. 2: Automatic bag loading onto open trucks with Beumer Autopac(R) II



Ill. 3: Palletless shrink wrapping of palletized bag stacks with Beumer Paketpac(R) line

Both of the above loading systems, that is, the direct loading of trucks and the production of large palletless packages through shrink film wrapping, have to fulfill the same basic requirements, namely:

-- work fully automatically, but still

-- have a relatively simple technical design to ensure high operating reliability in addition to keeping maintenance expenses to a minimum;

-- the loading equipment has to have a capacity corresponding to that of modern rotating packers, as the machines work in direct conjunction with the bagging equipment;

-- the bag stacks or wrapped packages formed by the equipment must be extremely stable;

-- the systems must be able to work without pallets, as the purchase and exchange of wooden pallets is often extremely expensive;

-- finally, the mechanized loading process must not place any additional demands on the bag quality, in fact, one purpose of such systems should be to significantly reduce the material loss due to bag breakage.

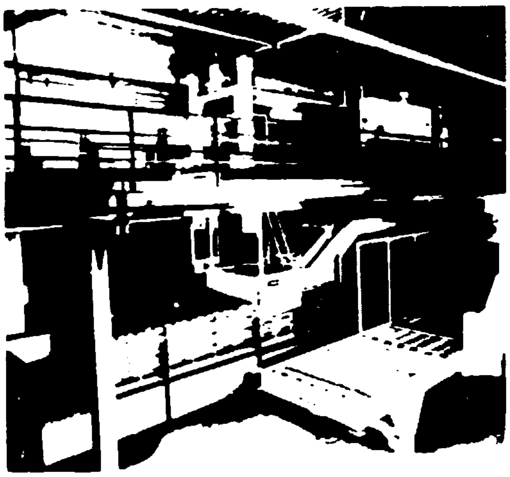
An additional demand of the plant management, in this case not in relation to the machines themselves but concerning the service function of the manufacturer, should be that the manufacturer instruct the plant personnel at the plant in questions of the mechanical design of the equipment, the electrical or electronic machine controls, operation of the equipment, maintenance and correction of malfunctions. It must be clear that, with the introduction of automatic equipment in the packing and loading departments to replace manual labor, there is still a certain degree of operating experience and preventive maintenance required even when every effort has been made in the area of simple and low-maintenance technology. When this has been recognized and accepted, the following systems can be introduced successfully.

2. Automatic Bag Palletizing onto Trucks

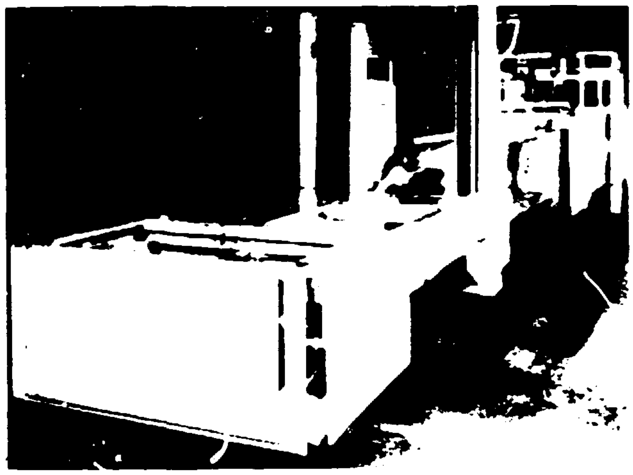
The automatic bag loading machines which palletize onto vehicles were developed 10 years ago and soon used for the first time in some European countries, particularly in West Germany, England, Spain and Italy. In the meantime, loading machines have come to be regarded almost as standard equipment in new plants, and numerous older European plants have changed from conventional bag loading machinery to automatic loading equipment. At the beginning of 1982, around 120 of the Autopac(R) type machines were in operation or ready for shipment or commissioning in Europe (West Germany, England, Italy, Spain, Finland, Greece, Netherlands, Soviet Union), in the Middle East (Saudi Arabia, Iraq, Turkey), North America (Canada), Central America (Mexico), South America (Venezuela, Brazil, Colombia) and North Africa (Libya, Egypt).

The patented Autopac(R) loading machine series (patented in the Federal Republic of Germany and numerous other countries) is available in three models:

Autopac II	for loading open vehicles from above (Illustration 4)
Autopac III	for loading closed vehicles and containers from the rear (Illustration 5)
Autopac V	for loading closed vehicles with laterally collapsible walls from the side (Illustration 6)



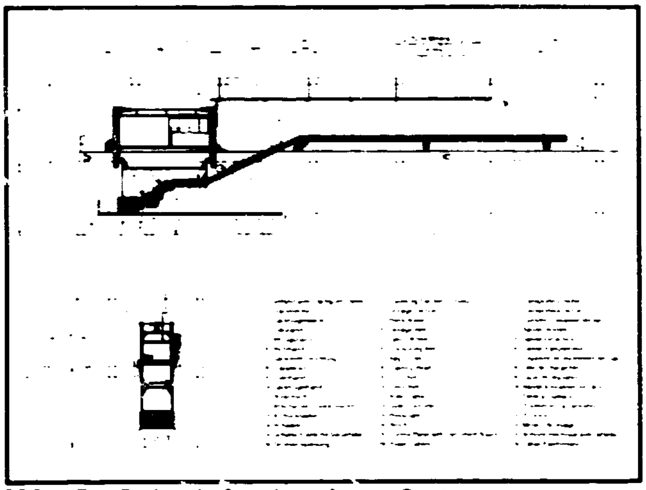
Ill. 4: Beumer Autopac$^{(R)}$ II for loading open vehicles automatically



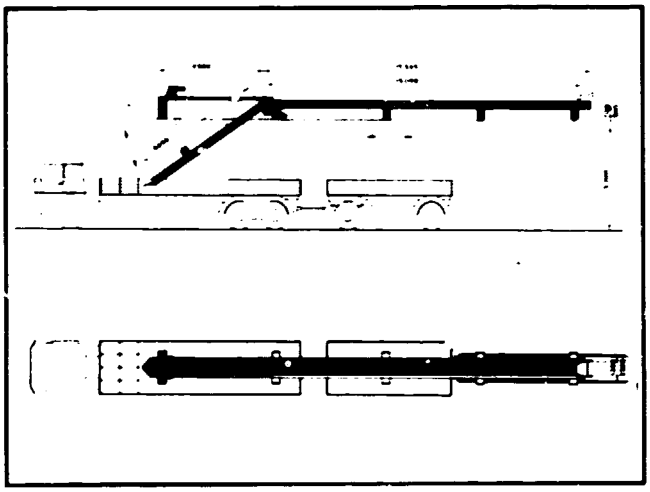
Ill. 5: Beumer Autopac$^{(R)}$ III for automatic palletizing in closed vehicles and containers from the rear

Ill. 6: Beumer Autopac$^{(R)}$ V for the automatic loading of closed vehicles from the side

In the great majority of projects -- and here especially outside of Western Europe and North America -- open trucks have to be loaded. For this reason, the following remarks will concentrate on the Autopac$^{(R)}$ II. The Autopac$^{(R)}$ III and Autopac$^{(R)}$ V should be regarded here as equipment for special requirements.



Ill. 7: Principle drawing of the Beumer Autopac(R) II for open vehicles

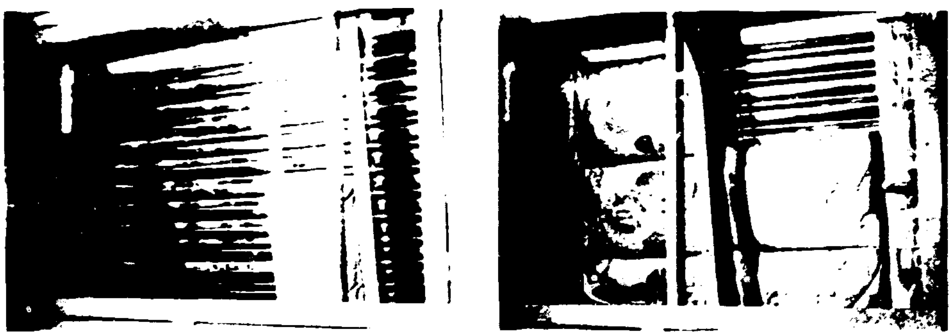


Ill. 8: Conventional bag loading onto open vehicles with the Beumer loading machine B 17

As mentioned, the Autopac(R) II was developed for loading open vehicles. Illustration 7 shows the Autopac(R) II with its major components. The entire unit comprising Positions 1 - 16 is mobile on wheels on the upper level of the loading building and loads the vehicle positioned in the loading dock through an opening in the ceiling. The principle, then, is similar to that used in conventional loading, when, for example, using conventional Beumer B 17 bag loading machines (Illustration 8). It is important to point out in this connection that, in cases in which automatic loading machines are possibly to be installed at a later date and conventional machines are to be used at first, that the conventional machines are equipped with the same gauge as the Autopac(R) (2300 mm) so that the ceiling opening is the proper size when later alterations are made. Positions 2 - 13, the descending storage section and the loading head with the positioning belt (6) and feed belt (9) are raised or lowered by the winch (14) during the loading operation and guided by four columns.

The Autopac(R) forms two adjacent stacks simultaneously on the truck. The bag layers of the stacks consist of five bags each, and the stack is palletized in a double bonded interlocked packing pattern, in other words, the packing pattern alternates from layer to layer.

The loading operation functions as follows: the bags coming from the packer are deposited onto the travelling flat belt conveyor (1) in order to reach the palletizing head via the feed belt (9) after they have passed through the bag turner (7) via the storage section (2) -- for each double layer in 5-fold bonded pattern, six bags must be turned 90^0 and four are not turned at all. The palletizing head consists of the roller table (11) on which the bags are distributed to the left and right by a lateral push plate (Illustration 9). After ten bags have been formed into a layer, the roller table is retracted (Illustration 10) and the bag layer removed from the roller table by the pressplate (13).



Ill. 9: View into the palletizing head of the Beumer Autopac(R) II

Ill. 10: Placing of a bag layer by retracting the roller table in the Autopac(R) II

The bags fed in from the packer during the formation of the layer are kept in the storage section (2) until the roller table is closed again. After the roller table closes, the palletizing head is raised by one bag layer so that the next layer formed in the meantime can be deposited. This process is repeated until the double stack is completed. The Autopac(R) then automatically reverses by one stack width and forms the next double stack.

After the desired number of stacks is reached, the palletizing head is automatically raised into its rest position so that the loading dock is free, the loaded truck can leave and the next truck can be driven into loading position.

The Autopac(R) forms the stacks either directly onto the floor of the truck or onto pallets placed there.

It should be mentioned that the Autopac(R) consists solely of electromechanical components. Pneumatic, hydraulic or vacuum technology are not used in order to keep maintenance as simple as possible. The Autopac(R) is controlled by a memory-programmable electronic unit. For the hardware, several reputable suppliers (Siemens, BBC, AEG, etc.) may be chosen from. As a rule, the Siemens Siematik controls are used. Beumer itself supplies the software for controlling the machine. No mechanical switches, but rather proximity switches and gallium arsenide emitters are used for command signaling.

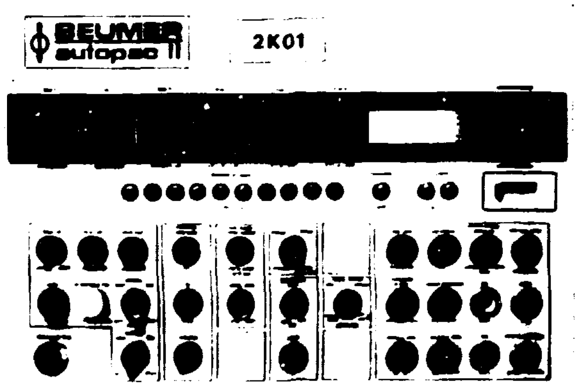
The guaranteed loading capacity of the newest Autopac(R) models is 2300 bags per hour, and, under very favorable conditions, the capacity can increase to up to 2500 bags/hr. To reach an effective loading capacity from the machine capacity, idle periods for changing trucks must be subtracted. With a packer capacity of 2000 bags/hr., an effective loading capacity of 1800 bags/hr. can be expected if there are no external interruptions. External interruptions in this sense would mean all influences which disturb the loading process which are not caused by the Autopac(R).

Significant technical data for the Autopac(R) II:

stacking program	double 5-fold bonded pattern with alternating layers
number of layers	1 - 9 can be selected
bag dimensions (standard)	600 x 400 x 120 mm (full bag dimensions)
bag weight (standard)	50 kg
guaranteed loading capacity	2300 bags/hr.
machine weight	12,5 tons
installed capacity	32 kW
nominal capacity	12 kWh
rail gauge	2300 mm
loading head width (standard)	1940/2000/2060 mm
height of rails over roadway (standard)	4000/4500/5000 mm
free passage heights (standard)	3200/3700/4000 mm
controls (standard)	Siematik S3 111

The operator must move the Autopac(R) out of rest position into the foremost loading position and lower the palletizing head onto the truck in manual operation and by sight. The palletizing head can be moved 250 mm to the side for centering it on the loading surface or between the truck walls. This centering is also done by the operator by sight in manual operation (automatic centering with trucks with side walls is possible with a special model).

After the palletizing head has been brought into starting position in this way, the operator at the instrument board (Illustration 11), which is integrated into the control panel (15), selects the desired number of double stacks and the number of layers per double stack and then switches on the automatic loading operation. Normally, the operator need do nothing further until loading of the next truck commences. In cases where malfunctions occur (for example a broken bag, or the palletizing head is brought too close to the side walls of the truck in the case of very narrow trucks), or for maintenance purposes, every function of the Autopac(R) can be carried out individually from the instrument board in manual operation. When, for one of the above reasons, it is necessary to switch from automatic to manual operation, the operator must complete the layer already begun in manual operation before he can switch back to automatic operation.



Ill. 11: Instrument board of the Beumer Autopac(R) II

The trucks must be at least 200 mm wider between their side walls over the entire length of the loading surface than the outer dimensions of the palletizing head. Taking full bag dimensions of 600 x 400 x approx. 120 mm, this would mean a minimum space between the side walls of 2200 mm.

The rear wall of the truck must be collapsible, the loading surface should be as even as possible and the loading area free of projecting objects. Trailers with a front wall of up to 1600 mm high do not have to be unhitched.

To complete the picture, it should be mentioned that, particularly for installing an Autopac(R) in existing plants, there are possibilities of fitting the equipment into limited spaces due to the various designs available for the travelling flat belt conveyor (1).

The following illustrations 12 - 15 show project sketches for some completed installations at Derna/Libya, Tabbin/Egypt, Sinjar/Iraq and Zliten/Libya.

Completed projects with the Beumer Autopac(R) II:

Illustration 12: Derna/Libya

Illustration 13: Tabbin/Egypt

Illustration 14: Sinjar/Iraq

Illustration 15: Zliten/Libya

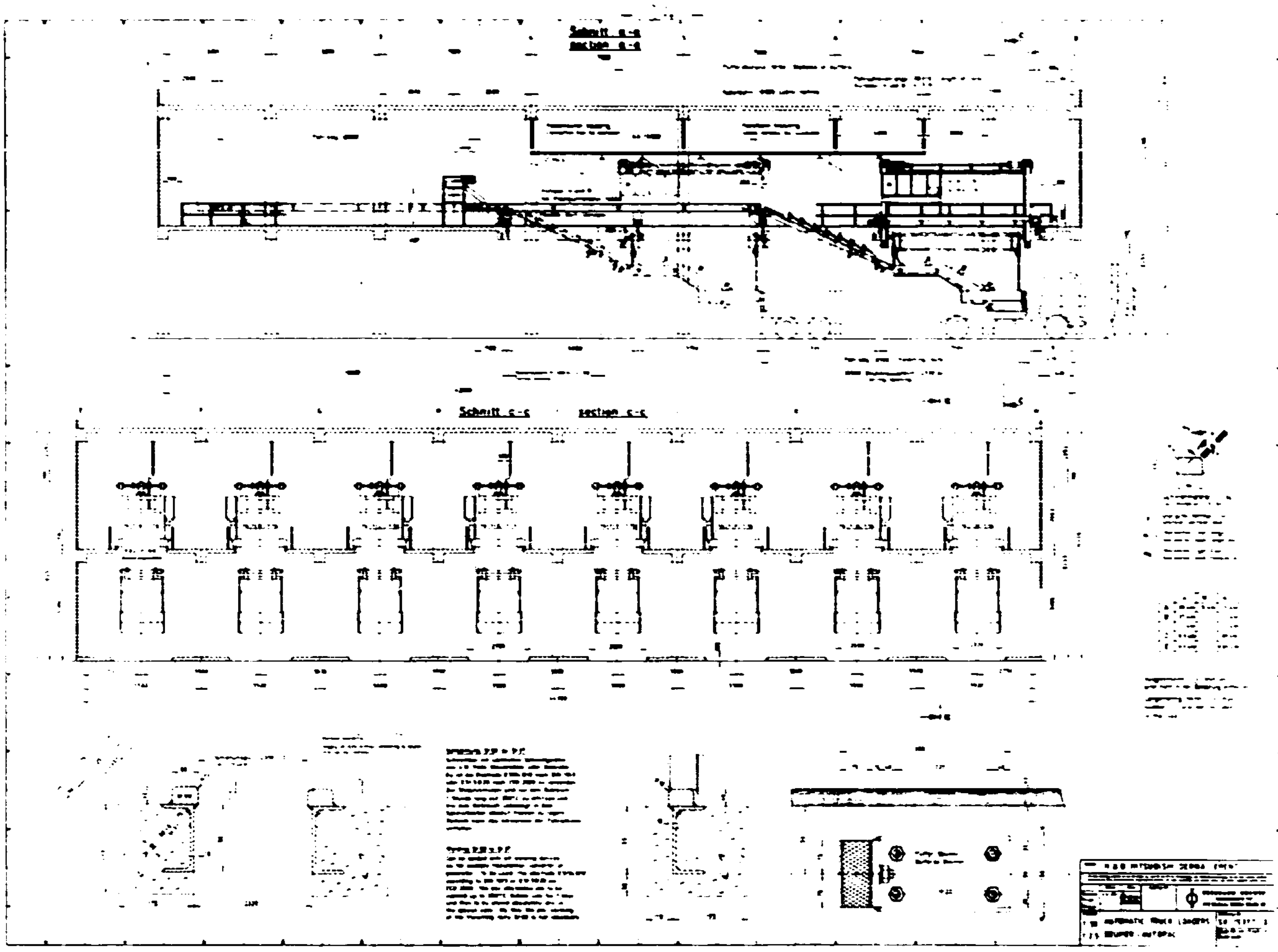


Illustration 12: Derna/Libya

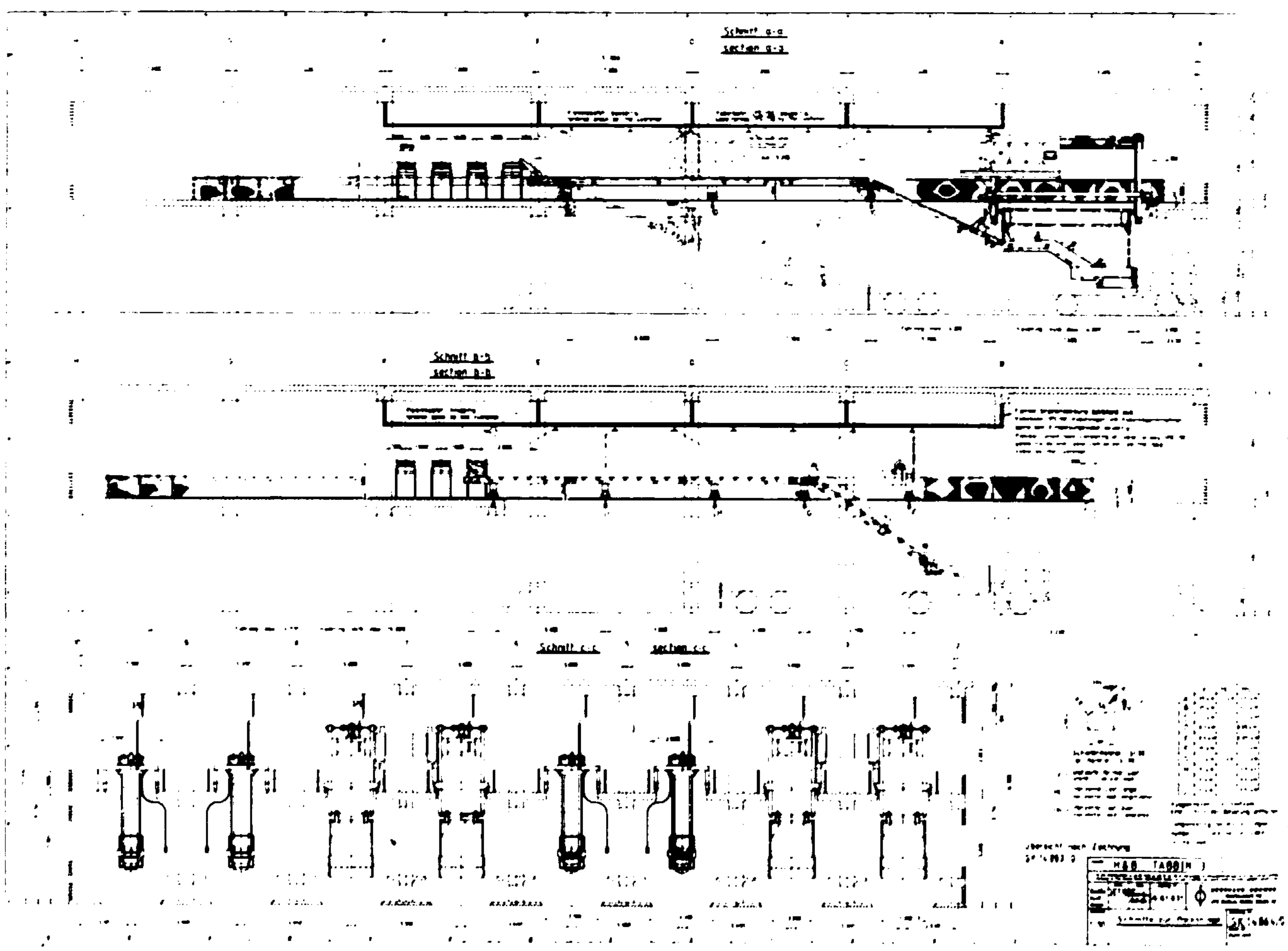


Illustration 13: Tabbin/Egypt

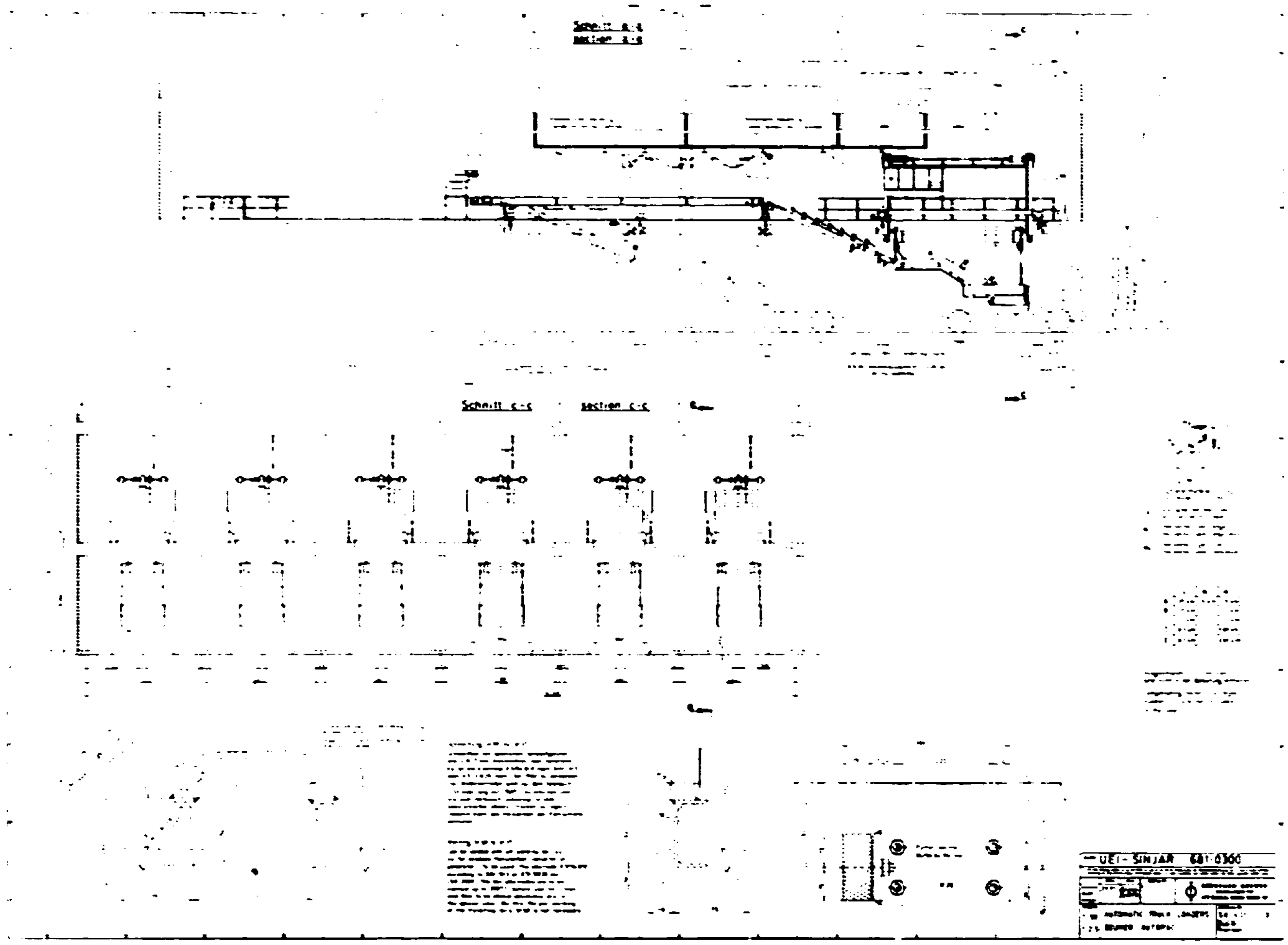


Illustration 14: Sinjar/Iraq

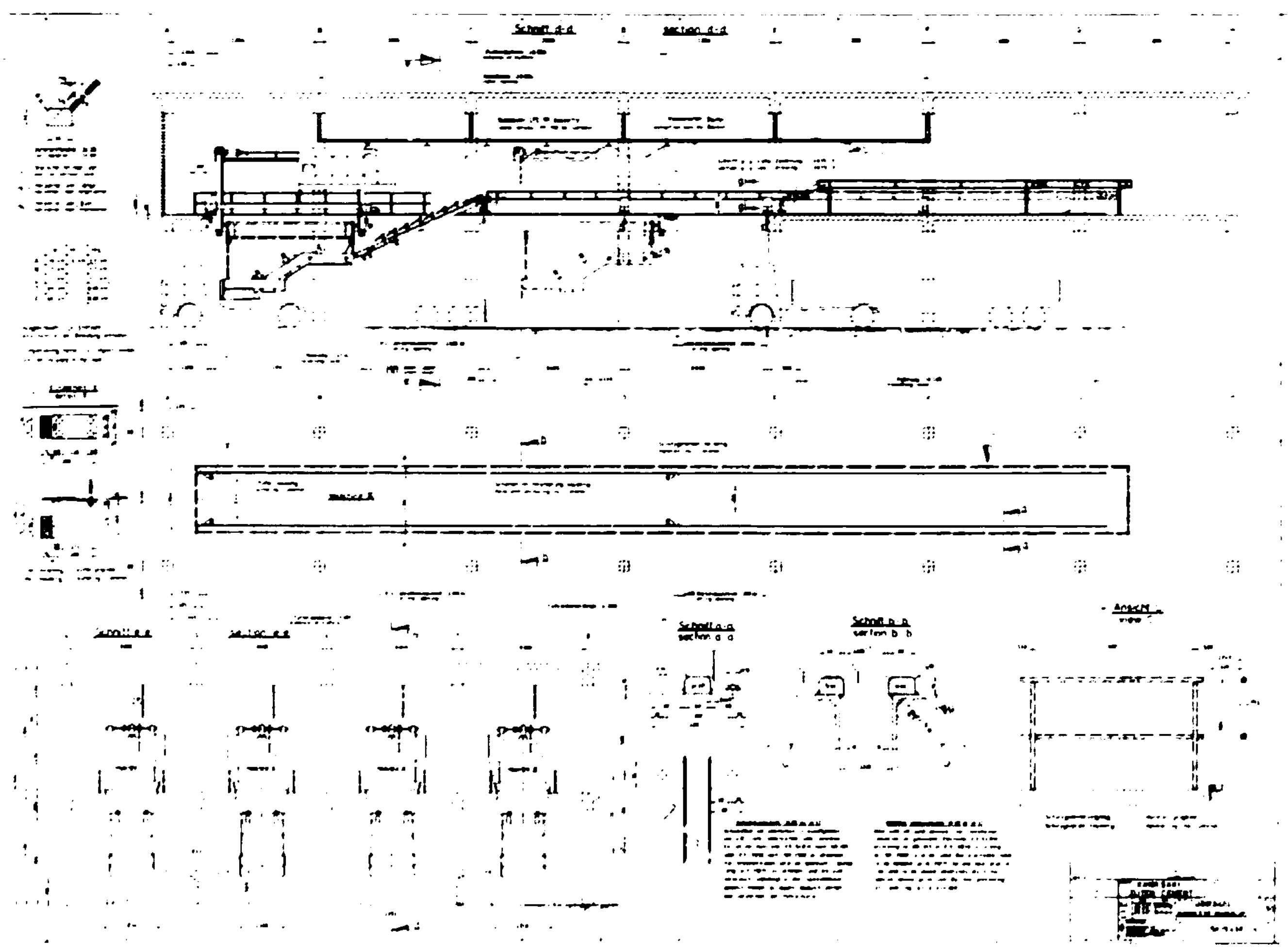
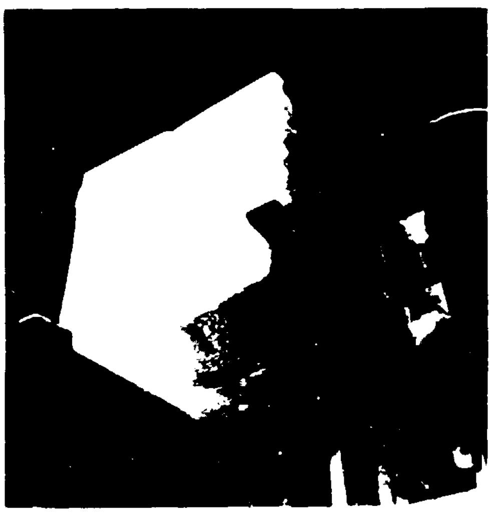


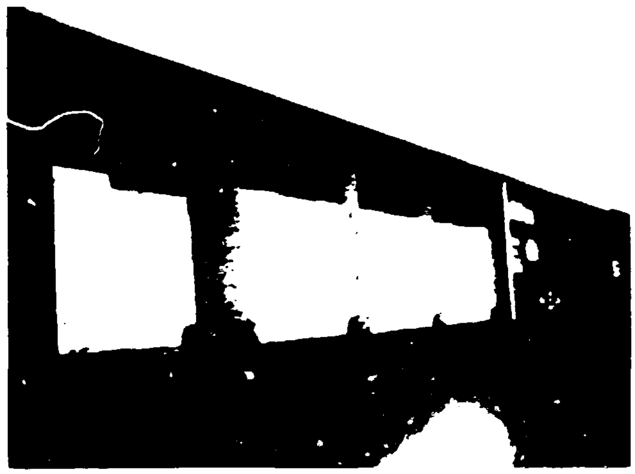
Illustration 15: Zliten/Libya

3. Palletless Shrink Wrapping of Bag Stacks

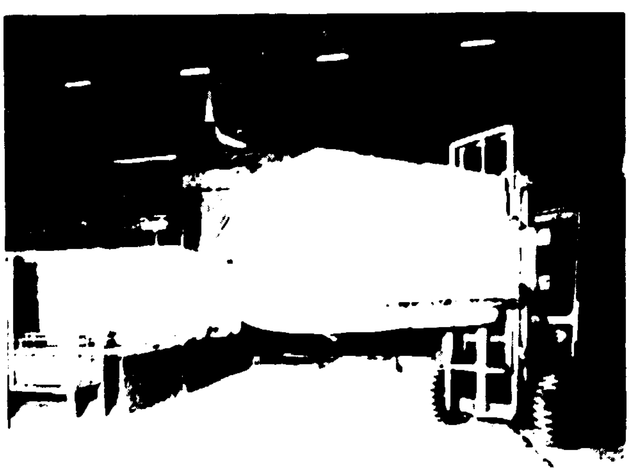
The purpose of palletless shrink wrapping of palletized bag stacks is to produce large packages (Illustration 16) which can be transported safely (for example with fork lifts, by ship and also by rail) (Illustrations 17 and 18), are capable of being stacked one on top of the other, are packed water-tight and can be stored outdoors (Illustration 19) and do not have the disadvantages associated with the use of pallets.



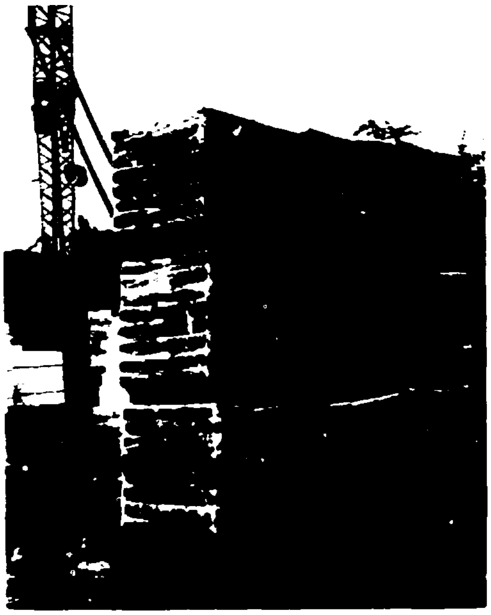
Ill. 16: Shrink wrapped stack transported by fork lift



Ill. 17: Rail transport of shrink wrapped bag stacks



Ill. 18: Transport of two shrink wrapped stacks from the Paketpac(R) installation to storage



Ill. 19: Storage of bag stacks wrapped in shrink film in the vicinity of a construction site

The films used for the palletless wrapping of bag stacks are thermal shrink films, i.e. special plastic films which shrink when warmed and subsequently cooled, thereby surrounding the packaged product securely and holding it together.

Thermal plastics are used to manufacture shrink films. Low density polyethylene, with the international designation LDPE, is especially well-suited. The particular advantages of polyethlyene over other thermal plastics are its great strength and tear resistance, very low water absorption, high resistance to chemicals, ease of handling and reasonable price, as it is a mass-produced plastic. For these reasons, PE-film can be regarded as t h e standard shrink film to use. Sometimes stabilizers against short-wave radiation, heat, and other climatic factors are added. It must be taken into account here that films stabilized against ultra-violet rays are 15 - 25% more expensive than unstabilized films. For special applications, PE-film can be provided with flame retardants. For printing on PE-film, the ink-repellant surface must be specially treated.

For the application discussed here, the film thickness would be around 150 - 200 my (6 - 8 mil), that is, in the area of heavy-duty packing film. In practice, one often begins with thicker films, working down to the thinner films through testing.

The following table shows the most significant chemo-physical values and German Industrial Standard designations for a standard PE-shrink film.

SPECIFICATIONS FOR A STANDARD PE-FILM FOR THE PALLETLESS SHRINK WRAPPING OF BAG STACKS

Characteristic	Dimension	Testing Method	Normal value
Thickness	mm	DIN 53370	0.15 - 0.20
Density	g/cm^3	DIN 53479	0.92 $\pm$ 0.002
Melting Index	g/10 min.	DIN 53735	0.1 - 0.3
Melting point	^{o}C	accd'g to Kofler	110^{o} C
Tear resistance	N/mm^2	DIN 53455	lengthwise: 15 crosswise: 14
Stretch allowance	%	DIN 53455	lengthwise: 250 crosswise: 400
Permeability - water vapor	g/24 h	DIN 53122	less than 1 at 200 my
Surface strength puncture resistance	Ohm	DIN 53482	10^{17}
Temperature tolerance	^{o}C	+)	- 30 to + 60
Light tolerance	h	+)	unstabilized: 500 - 1000 stabilized: over 2000

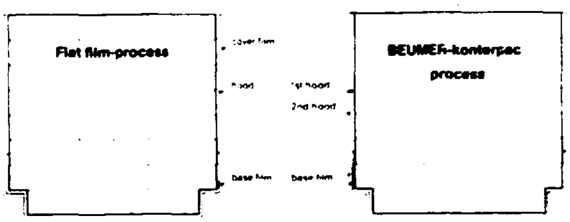
+) approximate values, partially determined under laboratory conditions

The film consumption per bag stack is determined by the packing method chosen as well as, of course, by the stack dimensions. In addition, the required strength of the wrapped stack has an influence on film consumption, this strength requirement being determined mainly by the frequency of shifting and the transport method in question (truck, rail or ship) with the resulting forces acting on the stack.

Two packing methods are available (Illustration 20):

1. the Beumer flat film process and

2. the Beumer Konterpac(R) process.



BEUMER-paketpac® in flat film design or
as BEUMER-konterpac® process

Ill. 20: Alternative methods for the palletless shrink wrapping of bag stacks

At this point, we will only deal with the differences between the two processes as far as they concern the film consumption. The differences in machine technology between the two shrink wrapping lines will be shown later.

The flat film process and the Konterpac(R) process differ basically in that, with the flat film process, the package surface is covered by a piece of flat film which overlaps the package on all sides, and this piece of flat film is welded in a shrink film heater to a hood previously fitted over the stack to form a waterproof seal; on the other hand, with the Beumer Konterpac(R) process, a second hood is applied in the opposite direction to the first hood already drawn over the stack in order to seal the package. Since the Konterpac(R) process has a significantly higher film consumption than the flat film process, as the second hood completely covers the first hood already drawn over the stack, it should be carefully considered in each individual case which of the shrink wrapping methods available should be used. The decision will surely be determined by the accompanying factors such as storage, shifting and transport conditions of the product to be shipped. In general, and somewhat simplified, it can be said that the film-saving flat film process can always be used when no unusual conditions due to the type of transport or to particular characteristics of the product itself are present that would place an extraordinary strain on the package. The flat film process has the additional advantage of having no welded seam on the upper surface of the package. An installation working by the flat film process also requires less building space, which is reflected in building investment. Finally, the machine is technically simpler so that less investment in machinery is called for.

Film consumption (G_{total}) is calculated as follows:

$$G_{total} = G_{hood\ 1} + G_{hood\ 2} + G_{flat\ film} + G_{base\ film}\ (kg).$$

The individual weights of the hoods or flat film pieces are each calculated from the result of surface, film thickness and specific film weight. The film surface area of the hood is calculated from the hood length L and the tube circumference U resulting from the stack width and stack depth dimensions, with a necessary additional value a taken into consideration. The weight of the flat film piece is calculated from the stack width B and the stack depth T, taking an overlapping on all sides b into account. A base film possibly used for additional reinforcement of the package base is calculated correspondingly. Here, overhang c can be smaller than with the piece of flat film because primarily only the recesses in the package base should be reinforced so that an overlapping of the base film on the sides with the hood placed later can be eliminated. The following data was used as a basis for the sample calculations for film consumption of the Beumer flat film process and the Beumer Konterpac(R) process:

Example for calculating film consumption:

Bag dimensions (full bag)	60 x 40 x 15 cm
Bag weight	50 kg
Number of layers	7 + 1
Number of bags	39
Packing pattern	7 alternating layers in 5-fold bonded pattern + 1 layer in 4-bag chimney pattern
Stack weight	1.95 t
Stack width B	100 cm
Stack depth T	120 cm
Stack height H	120 cm
Excess a	5 cm
Overhang b	30 cm
Overhang c	20 cm
Film thickness d	0.02 cm
Density of PE-film γ	0.00092 kg/cm^3

For the flat film process, which consists of a base film, a film hood and a piece of flat film for covering the package, the following film weight results:

$G\ (1)_{total} = G_{hood} + G_{base\ film} + G_{flat\ film}$

$G\ (1)_{total} = 1{,}4812\ kg + 0{,}41216\ kg + 0{,}52992\ kg$

$\underline{G\ (1)_{total} = 2{,}42328\ kg}$

With a film price of DM 2,80/kg of PE-film, packing material costs of approx. DM 6,80 per 1,95 tons or approx. DM 3,50 per ton result for the flat film process. If the additional base film is eliminated, the material costs are reduced to approx. DM 5,60 per 1,95 tons or approx. DM 2,90 per ton.

For the Beumer Konterpac(R) process, which consists of a base film and two completely overlapping hoods, the following film consumption results:

$G\ (2)_{total} = G_{hood\ 1} + G_{hood\ 2} + G_{base\ film}$

$G\ (2)_{total} = 1{,}4812\ kg + 1{,}4812\ kg + 0{,}41216\ kg$

$\underline{G\ (2)_{total} = 3{,}37456\ kg}$

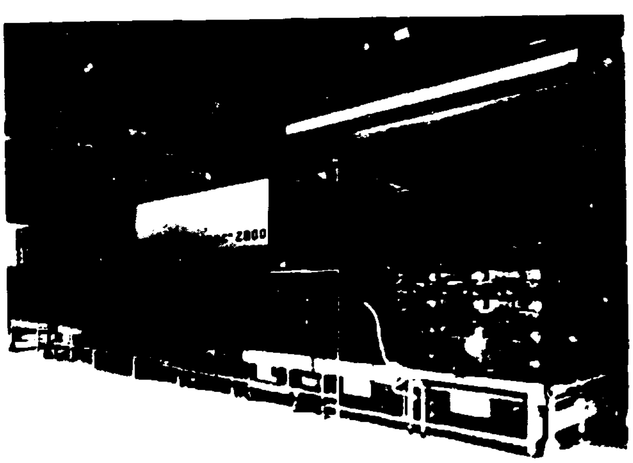
This results in packing material costs of approx. DM 9,45 per 1,95 tons or approx. DM 4,85 per ton or, if the additional base film is eliminated, approx. DM 8,30 per 1,95 tons or DM 4,25 per ton.

Therefore, quite clearly the packing material costs are higher with the Konterpac(R) process than with the flat film method. The difference in cost is around 40 - 50 % per stack or per ton of packing material. It is conceivable in order to reduce film consumption with the Konterpac(R) process to form the second hood as merely a short hood so that it only overlaps the first hood as far as the flat film in the flat film process does. However, in practice, this does not have any real advantage, but even has the disadvantage in that the upper package surface has a welded seam and, in addition, an expensive second hood forming machine must be used as opposed to the flat film placer.

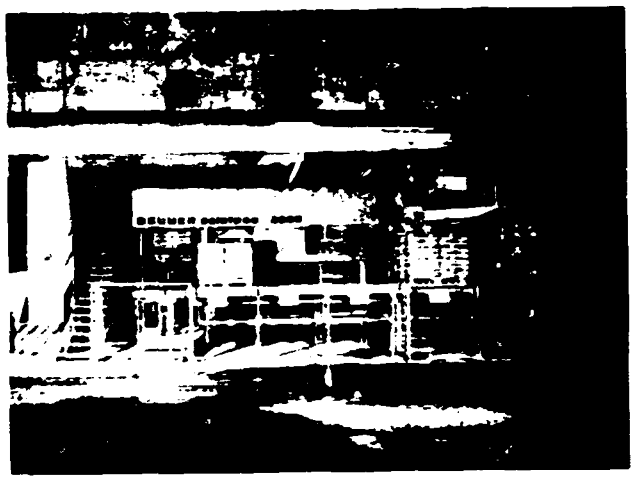
In summary, it should be mentioned that the Beumer Konterpac(R) process is perhaps preferable in cases of particularly heavy strain on the packages, such as, for example, when shipping them in ocean-going vessels, whereas the flat film process offers quite sufficient reliability for normal applications.

The Beumer Paketpac(R) lines consist of the high capacity palletizer and the subsequent components for completely wrapping the bag stack with shrink film, including the heating elements for the film. This makes particularly high demands on the palletizer, as the accurate formation of the bag stack is a prerequisite for the subsequent shrink wrapping and the quality of the final large package.

The Beumer palletizer series includes machines with a capacity of 800 to 4000 bags/hr. While the 800 to 1600 bag/hr. models are primarily for special products of the building materials industry, the machines in the 2000 to 2400 bag/hr. capacity class are the standard type to be found in the cement industry (Illustrations 21 and 22).

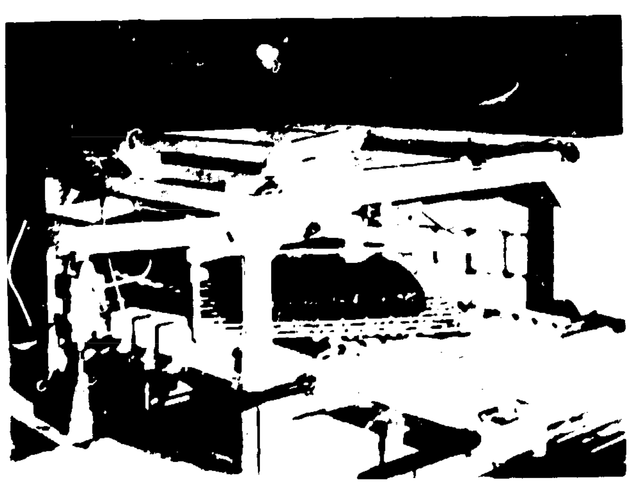


Ill. 21: Beumer Paletpac(P) 2000/2400 in the gypsum industry



Ill. 22: Beumer Paletpac 2000/2400 in the cement industry

When developing these palletizers, special attention was paid to a particularly careful handling of the bags, avoiding any deformation, as well as to an especially compact design, good accessibility of all machine components and high operating reliability. New components, such as a modern bag turner (Illustration 23), a bag distributing device and a full pallet turning system allow even bags with a poo[illegible]lling level or with inferior quality paper to be carefully palletized into stable stacks.



Ill. 23: Bag turner in the Beumer Paletpac(R)

With the Paletpac(R) 4000, now ready for production, a new capacity dimension was reached parallel to the development of new high capacity rotating packers for 4000 bags/hr.

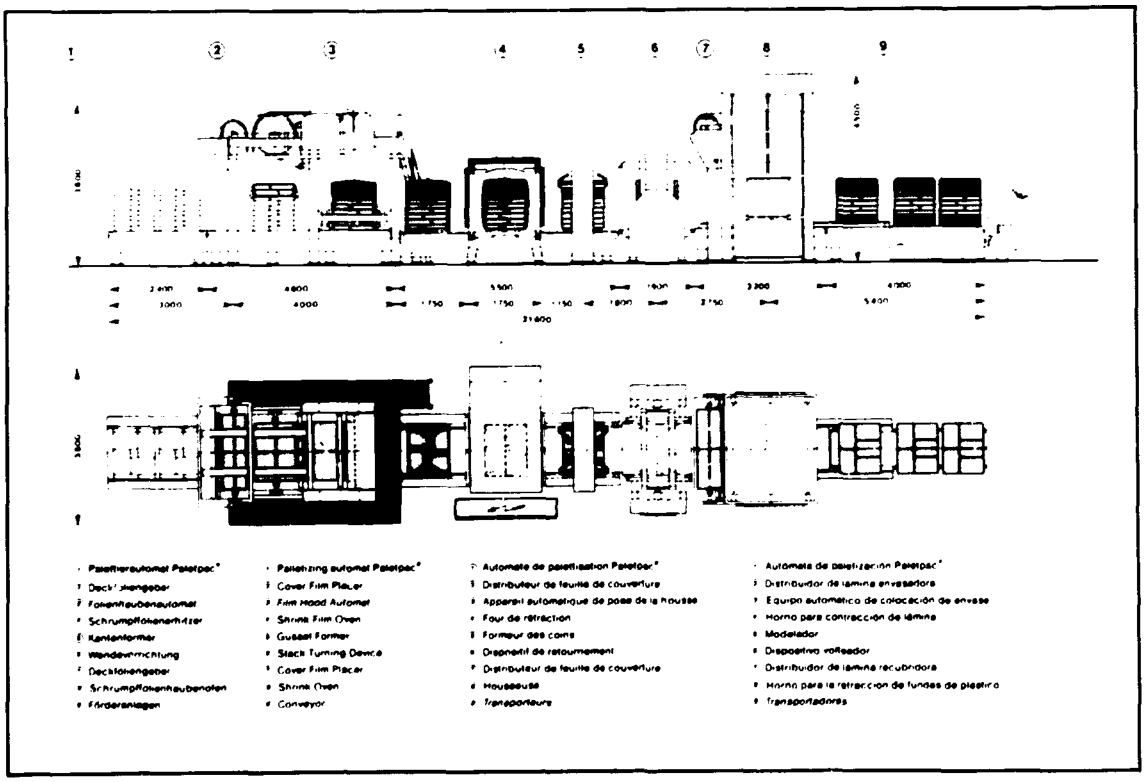
The Paletpac(R) palletizers are controlled by a memory-programmable electronic unit. Several reputable suppliers can be chosen for the hardware.

Both of the above alternative shrink wrapping methods, namely the Beumer flat film process and the Beumer Konterpac(R) process, will now be described and compared.

The shrink wrapping line working by the flat film process consists of the palletizer and the Paketpac(R) equipment, which together form a fully automatic palletizing and packing unit.

The bag stack is formed in the palletizer, with the last layer of the stack smaller than the remaining layers. As a rule, the normal layers are formed in a 5-fold bonded pattern with alternating layers, with the final smaller layer consisting of 4 bags in a chimney pattern. However, it is also possible to form the normal layer in the 5-fold pattern and the base layer in a 3-fold pattern, or, with a normal layer consisting of 3 bags, to form the base layer out of 2 bags. The smaller final layer provides for spaces to the left and right of the normal layer, into which the transporting equipment (for example the fork lift) will reach later in order to lift and transport the stack after it has been turned 180^0 after passing through the shrink wrapping line.

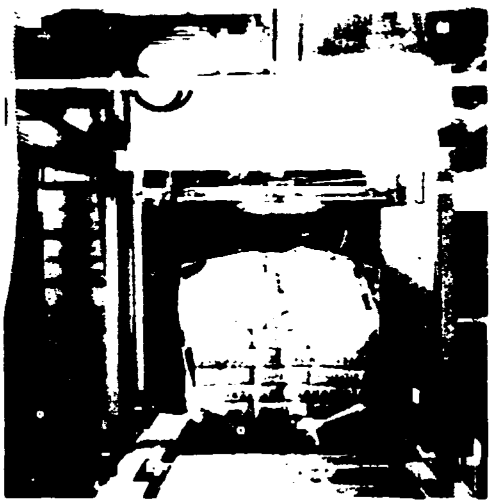
Illustration 24 shows the flat film line with its individual components and most significant dimensions. The process begins with the placing of a piece of flat film onto the stack in order to reinforce the film package in those areas which will later form the package base. The cover piece is positioned by two pneumatic clasps. After this, the bag stack is brough* into the automatic film hood forming machine (Illustration 25).



Ill. 25: Placement of the film hood in the Paketpac(R) line

This machine forms a hood out of a film tube with deep side fold, the required tube length being measured by an automatic bag stack height sensor and pulled off of the supply roll. Then, a film hood is formed by means of a welded seam. A cutter separates the hood from the film tube. The hood is grasped on its four lower edges by pneumatic clasps, opened and drawn over the stack.

In the next step, the bag stack, which is now partially surrounded by a piece of flat film and a film hood, is brought into a tunnel oven (Illustration 26) and heated at a shrinking temperature of approx. 190°C. This heating and subsequent cooling shrinks the film and forms a secure wrapping around the bag stack. After passing through the shrink oven, the recesses, which result from the difference between the smaller 4-fold layer and the larger 5-fold layers, are formed by a shaping device. Later, the fork lift will reach into these spaces. Of course, these spaces must be formed as neatly and rectangularly as possible in order to avoid damage to the film wrapping later during transport.

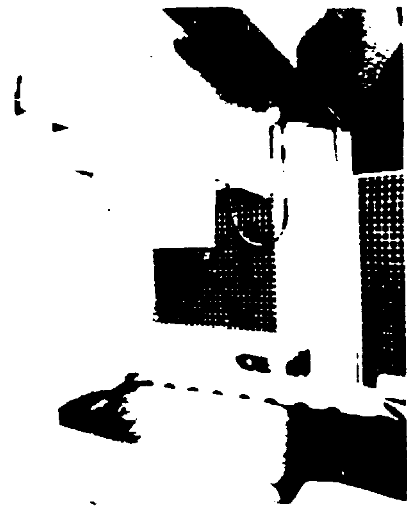


Ill. 26: Stack entering the shrink film heater

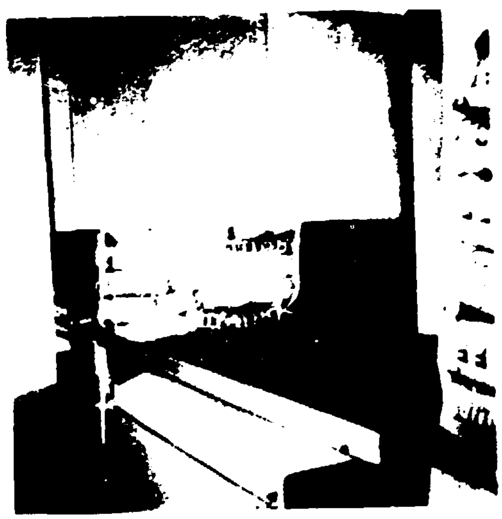
Ill. 27: Shaping the stack recesses into which the transporting equipment will later reach

In the next step, the bag stack is turned 180^0 (Illustration 28) and the recesses for the transporting devices reshaped. During this same process the upper and lower stack surfaces are pressed completely even and flat. This guarantees a stable stacking of the packages for intermediate storage and transport. After leaving the turning device, the stack surface which has not yet been covered with film is now the upper surface. The upper surface is now covered by another piece of flat film (Illustration 29) and the stack brought underneath a lowerable hood oven (Illustration 30).

Ill. 28: Stack turning device



Ill. 29: Placement and separation of the flat film for covering the upper stack surface



Ill. 30: Stack underneath the lowerable hood oven

After the hood oven is lowered, it heats only that part of the bag stack which was just covered by the flat film overlapping the stack on all sides. This process avoids a reheating of the remaining part of the bag stack after it has already been heated once in the tunnel oven. To heat this part of the stack again would deform the recesses for the transporting equipment and require an expensive reshaping with subsequent cooling of the stack base. The hood oven is a very simple technical means of avoiding the considerable extra expense which would otherwise be involved with the reshaping and cooling of the stack base.

Bar chain conveyors are used in the tunnel oven. Belt roller conveyors are used in the remaining portions of the line, as these conveyors guarantee a particularly gentle run for the packages.

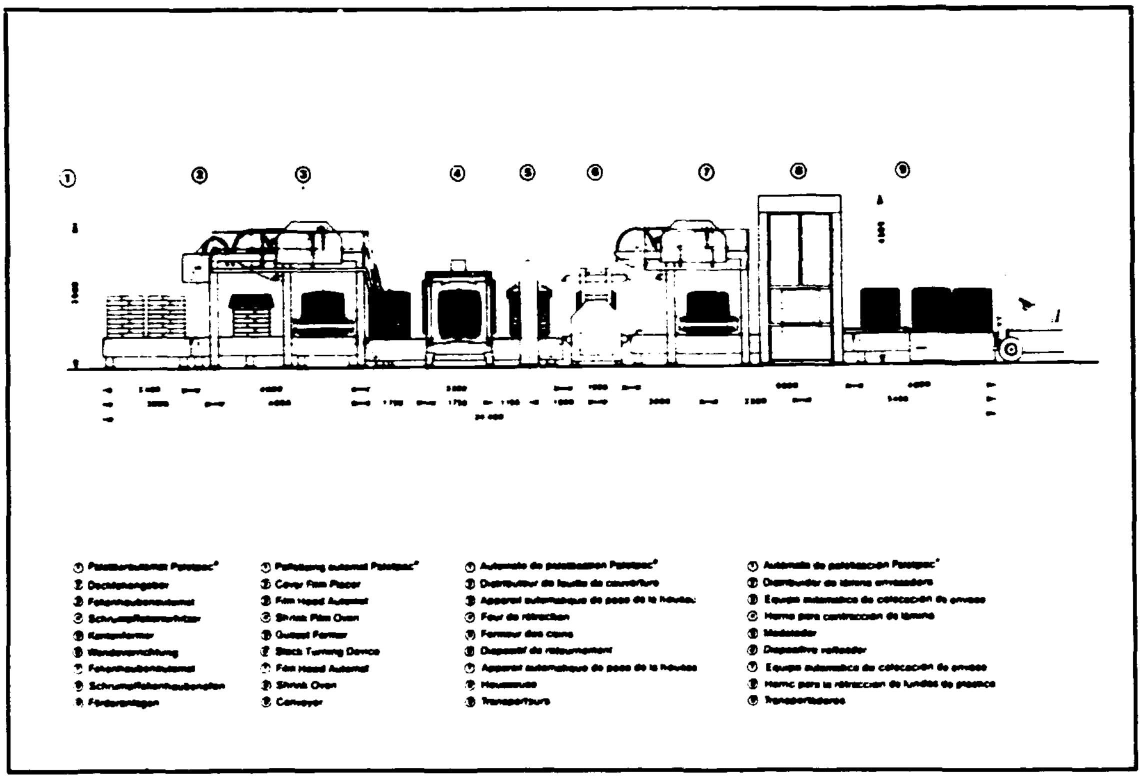
The alternative to the flat film process is the Beumer Konterpac(R) process. As mentioned, it differs from the flat film line only in that, instead of the cover film placer located near the hood oven in the flat film process, there is a second hood forming machine located between the stack turning station and the hood oven. Since, with the Konterpac(R) process, the second hood almost completely overlaps the previously placed hood, the hood oven at the end of the line must be lowered further than is necessary with the overlapping piece of film in the flat film process. Illustration 31 shows a packing line according to the Beumer Konterpac(R) process.

Illustration 32a shows the components of the Konterpac(R) line with their major dimensions. In comparison to Illustration 24, which shows the flat film process, it is clear that the Konterpac(R) line is somewhat longer than the flat film line. The different levels of film consumption have already been discussed.

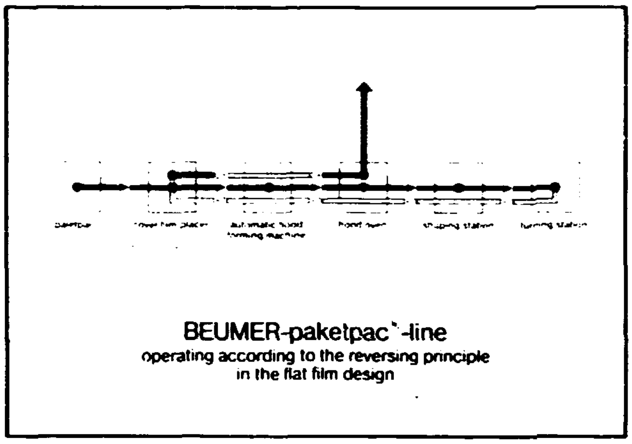
Ill. 31: Beumer Paketpac$^{(R)}$ line according to the Beumer Konterpac$^{(R)}$ process

The capacity of the Beumer Paketpac$^{(R)}$ lines is 60 - 70 packages per hour. Whereas, in the cement industry, lines with reduced capacity are generally not acceptable, lower hourly output is not unusual with special products.

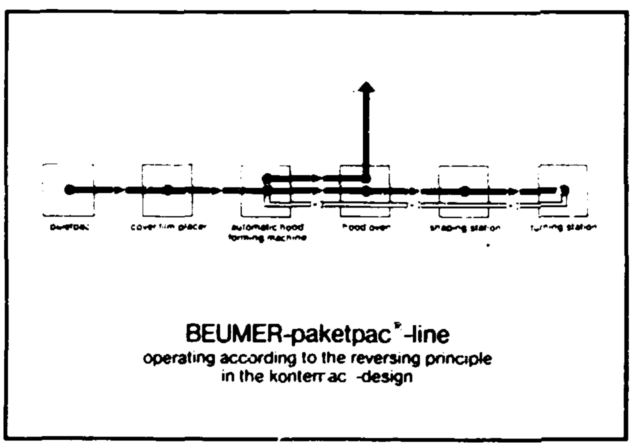
There are two possibilities for reducing machine expense and required building space. On the one hand, parts of the line can be run in reverse operation, on the other hand, some components can be passed through twice by running the line according to the circulation principle. The reversing and circulating operations are basically possible for both the flat film and Beumer Konterpac$^{(R)}$ processes. Illustrations 32 and 33 show the reversing principle for both methods, and Illustrations 34 and 35 picture the circulation principle as used with both processes.



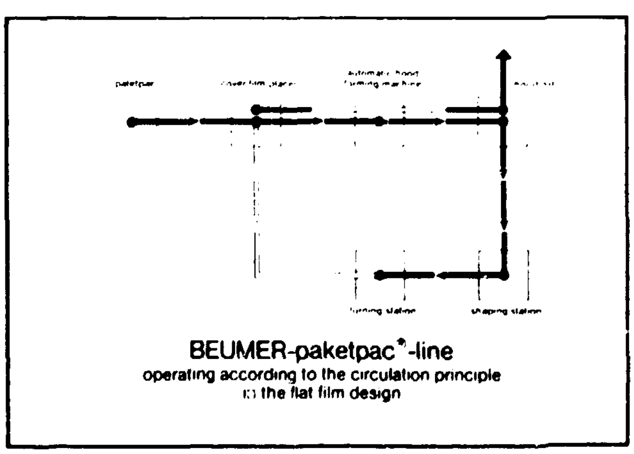
Ill.32a: Beumer Paketpac(R) line according to the Beumer Konterpac(R) process



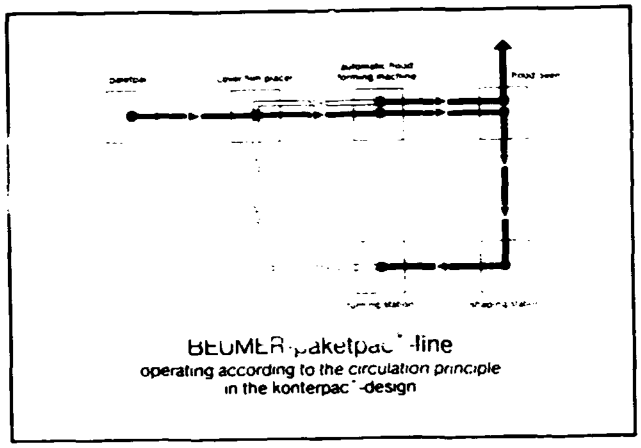
Ill. 32: Layout of the Beumer Paketpac(R) line according to the flat film process for reversing operation



Ill. 33: Layout of the Beumer Paketpac(R) line according to the Konterpac(R) process for reversing operation



Ill. 34: Layout of the Beumer Paketpac(R) line according to the flat film process for the circulation principle



Ill. 35: Layout of the Beumer Paketpac(R) line according to the Beumer Konterpac(R) process for the circulation principle

The capacity of a line working by the reversing principle is reduced ~~by~~ to 15 to 20 packages per hour. Savings in machinery investment are approx. 15 % as opposed to the full-length line with the Konterpac(R) process and approx. 10 % compared to the full-length flat film line. With the Konterpac(R) process, building length can be reduced by 6 m and by 4 m with the flat film method.

The capacity of the lines using the circulation principle is around 30 packages per hour. Savings in machinery amount to approx. 10 % for the Konterpac(R) process and approx. 5 % with the flat film line. Compared to the full-length lines, about 10 m building length can be saved with the Konterpac(R) method and approx. 8 m with the flat film process. However, the width of the line is increased by about 3,5 m.

The variations of the Paketpac(R) lines are mainly interesting from the point of view of reduction in building length in the case of the flat film process and reduction in machinery investment with the Konterpac(R) line.

Below is the significant project data for a Paketpac(R) line working by the flat film process now operating in a German cement plant:

Product	Portland cement
Bag type	valve bag
Bag material	paper, 2 - 5 layers
Bag weight	50 kg
Bag dimensions (full bag)	600 x 400 x 130 mm
Packing pattern	5-fold bonded pattern
Max. number of layers	9
Max. stack dimensions	1000 x 1200 x 1200 mm
Stack base dimensions	1000 x 1000 mm, chimney pattern
Packaging capacity	60 - 70 packages/hr.
Film material	high pressure polyethylene shrink film
Film thickness	200 my
Installed electrical rating	210 kW
Required air pressure	6 bar
Air consumption	200 Nm^3/hr.
Electrical insulation	IP 44
Surface area requirement	incl. 2 removal points, platforms and safety clearances approx. 82 m^2