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HIGH SPEED BAGGING AND HANDLING

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SUMMARY AND INTRODUCTION.

This paper describes the development of a system by Fisons Ltd - Fertiliser Division for high-speed bagging and handling of fertilisers in plastic bags.

In 1963 the Company changed over from multi-ply paper bags to polythene sacks of .008" and .010" gauge. At the same time it was decided to re-examine the whole of the bagging and handling operations, with a view to improving the efficiency and economics.

To handle plastic bags a pneumatically operated sack holder for filling purposes and a heat sealer unit to seal the open top of the bag were purchased. It was apparent that although plastic bags were easy to fill and seal, the characteristics of the filled bag were such that they could not be stored satisfactorily due to excess air, and damaged bags amounted to approximately 6%.

The bag filling and handling rate over a shift averaged 600 bags per hour, each of 112 lbs. with a team of:

Chargehand	1
Shovel Operator	1
Filler	1
Sewer or Sealer	1
Outloaders or Palletisers	2
Fork Lift Operator	1
Total	7

This method of operation can be expressed as 85.7 bags per operator per hour.

There were four major problems that had to be solved before the standards required could be attained:

1) the filled bag characteristics had to be such that it could be easily handled and palletised,

2) the handling equipment must not damage the plastic bag,

3) it was necessary to develop a high-speed and economic method of palletising,

4) it was necessary to increase the rate of bagging in a single bagging line.

After incorporating the developments outlined under the above headings, the performance of a single bagging line is as follows.

Bags are filled and handled at a rate of 1,200 bags per hour with an average of 1,000 bags per hour over a complete shift, into palletised store 30 bags high, i.e. 5 pallets high each having 6 layers of 6 bags, with damaged bags running at less than ¼%. The team comprises the following:

Chargehand	1
Shovel Operator	1
Filler	1
Sealer	1
Palletiser Operator	1
Fork Lift Operator	1
Total	6

This can be expressed as 166.6 bags per operator per hour, an increase in productivity of almost 100%, and the details of how this has been achieved are outlined below:

1. FILLED BAG CHARACTERISTICS

At the beginning of the operation the handling of the bagged fertiliser was very difficult, due to excess air trapped in the bag after filling and sealing. The resulting ballooning made it difficult to produce a stable load for transport, and it also reduced the palletised storage capacity by nearly 50% owing to not being able to store safely more than 3 pallets high, each pallet having 5 layers each of 5 bags. To overcome this problem, 8 micro holes were made in each bag during manufacture, but this did not solve the problem because dissipation of air through the holes was too slow.

A bag vibrator and fixed sides conveyor unit was designed and installed under the filling spout and which maintained the bag shape until sealing was complete (Fig.1). This enabled us to expel the excess air from the granular mass and to maintain the bag at a thickness which allowed the materials to fill the bag more efficiently. This, followed by top folding to expel excess air above the mass before sealing, gave a good shaped package without ballooning, but with sufficient air content to keep the material free flowing.

This resulted in a vast improvement in handling the bags and the normal storage of pallets i.e. 5 high, each of 5 layers, was obtained with safety.

2. EXCESSIVE DAMAGE TO BAGS

During the conversion from multi-ply paper bags to plastic bags it was apparent that equipment which would handle paper bags was not satisfactory for plastic bags, due to an unacceptable high rate of bag damage. The major causes of this were:

a) tears in plastic film caused by fouling obstructions during transportation,

b) sliding of bags down chutes causing granules to pierce the plastic film from the inside,

c) rubbing of the bag by supporting members when in the upright position causing the same fault as (b),

d) twisting of the bag to change direction causing creases in the plastic, which tended to initiate a crack after a period of storage in cold weather,

e) pressure during storage forcing splinters and corners of rough pallets to pierce the plastic,

f) the back support frames of the forks on the fork-lift trucks caused damage due to impact when picking up the pallet, and during transportation when the backward tilt of the mast was adopted.

These problems were tackled systematically by redesigning the equipment as follows.

a) All obstructions or side guides were removed from the transportation system and bags made to travel in the centre of all conveyor belts. Bags are accurately positioned at the start of the conveyor system by pneumatic pushers actuated by the bag itself (Fig.2).

b) Polytetrafluoroethylene (P.T.F.E.) lined loading chutes were limited to a length of 3 ft. and only then as a means of safe working, i.e. to enable operators taking bags at the end of a conveyor to work well away from any moving parts. Spiral chutes were replaced by spiral gravity roller conveyors when height had to be lost.

c) When bags travelled in an upright position following the filling and sealing operation, the vibrator and former had shaped the bag so that it was free standing and would travel without the need for further guide boards.

d) When the conveyor system required a change of direction, then mechanically driven curved slat conveyors were used to avoid chutes and twisting of the bag (Fig. 3.).

e) A standard pallet was designed laying down a strict specification as follows.

All boards to have corners rounded to a radius of 15 m.m where they can contact the bag.

The two surfaces must be smooth planed and free from splinters.

The gap between boards must not exceed 7.5cm so as to provide maximum area of timber to support the load, commensurate with an acceptable weight and cost.

f) The back support frame of the fork-lift truck was replaced by a full plate which eliminated corners and provided a larger surface area to take the pressure.

When these modifications had been carried out it was found that the handling and storage system was no longer a limiting factor in output, and that the bag damage was now less than ¼%.

3. PALLETISING AND STORAGE.

It was decided to look at the problem of palletising and storage of bags at a rate of 1,200 per hour, and a study was made of manual, semi-automatic and fully automatic methods of palletising. The conclusions were as follows.

a) Manual Palletising

The bags were of a tied pattern of 5 to a layer, 5 layers per pallet and 5 pallets high, giving storage of 125 bags over a floor area of approximately 25sq. ft. (equivalent to the pallet area). This gave an unused pallet area of 10/15% due to bag sizes permitting free space between bags.

Experiments were carried out with a non-tied pattern having 6 bags per layer and 6 bags high which provided 36 bags per pallet, an increase in capacity of 44% which resulted in considerable savings in the purchase of pallets. For the last three years this pattern has been used successfully when storing 5 pallets high which provides storage of 180 bags over an area of 25sq. ft. approximately (equivalent to pallet area).

To achieve a rate of 1,200 bags per hour would have required two stations each manned by two men i.e. a team of four operators.

b) Semi-Automatic Palletising

In this case a machine is used to reduce the work content to that of one man, who is engaged in forming the pattern of the bag layer which is then delivered to the pallet. It was felt that a high rate of bagging could be adversely affected by tying production to a man who was expected to handle one bag every 3 seconds without a break. As the palletising stations are in all cases remote from the bagging plants, relief could not be given by the chargehand and under these circumstances it would have been necessary to have two men operating transportation and palletising.

c) Automatic Palletising

A machine which had been successfully established in operation elsewhere was not known and it was necessary to collaborate with a manufacturer of a machine on an experimental basis and to carry out the development work jointly. This we have been doing since September 1965 with The Lawrence Engineering Company Limited who made the prototype machine. The machine has now reached a stage where satisfactory operation can be obtained continuously over a 5 day week provided that a maintenance period of 3 - 4 hours per week is allocated. Many changes in design have overcome troublesome or unsatisfactory parts.

A major problem that was encountered during the early operation was that the filled bags reaching the palletiser tended to be thinner at the top than at the bottom of the bag (wedge shaped) and the extent of this varied, depending upon the density of the material. With a non-tied formation which gave 6 layers each of 6 bags, the cumulative effect of the variation in thickness led to bad stacking in the store. It was found that this problem could be overcome by an operator allowing 6 bags to go forward, and then turning the next 6 bags through 180°, then 6 bags to go forward and so on therefore cancelling out the effect of the wedge shape on a pallet with an even number of layers.

To eliminate the need for this manual assistance a novel mechanism which automatically turned each alternate set of six bags through 180° was designed (Fig. 4). The unit is also used in the conveyor system to turn bags through the required change of direction.

4. DEVELOPMENT OF HIGH-SPEED BAGGING PLANT.

The potential capacity of the handling and palletising system was now 1,200 bags per hour, but a single line bagging output was still only 600 bags per hour. Considerable effort was devoted to the development of a new unit which would provide 1,200 bags per hour from a single bagging line and at the same time retain such desirable features as - low maintenance, simplicity and reliability.

Feeding and Filling of Bags

A study of the system which was used at that time i.e. one man putting a bag onto a single spout, waiting for the filled bag to partially move away in the bag vibrator, before placing another bag on the spout, showed that:

1) time was wasted,
2) work was tedious, done in one standing position,
3) working conditions were not good due to the operator being in close proximity to the filling spout.

It was obvious that given the right conditions and no delay, an operator could emplace a bag on the spout every 3 seconds.

The considerations in the new design were as follows:

1) the condition of the empty bag supply was not sufficiently uniform to allow automation,
2) the operator must be uninterrupted,
3) good working conditions must be provided,
4) male or female labour must be able to operate,
5) 1,200 bags per hour must be filled,
6) identification of weighing machine for check weighing must be provided.

To fulfil these requirements a Turret Bag Feeder was developed (Fig.5). This consists of six separate bag feed hoppers traversing on a track. At the point of putting on the bag the travel is in a straight line and this also applies at the point of filling, which is diametrically opposite to the operator. The straight parts of the track are required to feed the bag whilst filling in line with the bag vibrator.

Each hopper is an individual unit provided with its own drag link from a central drive shaft, thus allowing the variation in centres as they traverse the circuit.

Approximately 200 empty bags, lying flat with open mouth towards the operator, are positioned on a magazine conveyor directly below the position of emplacement. To put a bag on the travelling hopper the operator places a thumb in each end of the mouth, which opens the top of the bag sufficiently to place over the closed spout which is fitted with gravity operated bag holders.

The bag is carried forward to the filling position where the top is mechanically opened by the spout and held against P.T.F.E. pressure plates, during travel for filling purposes. After filling, the spout closes and the hopper rises above the top of the bag for return to the operator.

The operator can sit on a adjustable seat, or stand as preferred, and his arm movements are minimised to ensure the least discomfort in carrying out a tedious operation.

The six hoppers are fed by three Simon E.P.G. type weighing machines, each capable of 600 bags per hour, but are operated at 400 bags per hour to ensure maintenance of accuracy and long life.

The same weigher always fills the same two travelling hoppers as they are married together and are identified by colour.

Blue	weigher	feeds	2 blue	hoppers
Red	"	"	2 red	"
Yellow	"	"	2 yellow	"

This provides identification for check weighing and in the event of maintenance being required by one weigher then the operator does not feed bags to the two corresponding hoppers, and a reduced output to 800 bags per hour results.

As the empty bag passes a point just prior to entering the bag vibrator, it passes through an ultra-sonic sensing device which signals to the weigher that a bag is attached. If a bag is not attached then the senser is not activated, and the weigher will not discharge.

After two years' operation, this bagging machine has given full satisfaction in all aspects when operating at a rate of 1,200 bags per hour.

<u>Vibration of Bag</u>

The need to vibrate and form the filled bag was discussed under heading (1) Filled Bag Characteristics.

The bag vibrator and conveyor fixed sides have been fitted into the high-speed bagging plant and the details are as follows:

The empty bag enters the vibrator and the spout is opened, pressing the walls of the plastic bag against P.T.F.E. coated pressure plates. Filling commences and when approximately 20 pounds weight of granular fertiliser has entered the bag the weight overcomes the side pressure support, and the bag settles gently onto the bottom of the vibrator, reducing shock load to a minimum, but the top is still supported by the pressure plates to prevent collapse of the bag before filling is complete.

The top of the bag is moving continuously whilst being filled and the vibrator is adjusted to provide the same speed to the bottom of the bag, which ensures that the bag remains upright.

As the vibration of the contents of the bag is commenced at an early stage this ensures maximum efficiency of air removal throughout the package, but consolidation of granules is such that free flowing properties are still maintained.

The sides of the bag vibrator are lined with P.T.F.E. $\frac{1}{8}$" thick, this has reduced side friction to a minimum and has a life of over 2 years when operated for 120 hours per week.

This machine could handle more than 1,200 bags per hour and has been proved completely reliable with low maintenance costs.

Maintenance of the Shape of the Bag

The bag passes immediately from the vibrator on to a slat conveyor with fixed sides so that the shape of the bag is maintained until sealing of the bag is complete, after which the bag retains its formed shape in an upright position without any side support.

The fixed sides are of plywood, lined with P.T.F.E. and placed above the slat conveyor with a clearance of 15mm. They are approximately 60cm high with internal measurement between the sides the same as that of the vibrator.

Heat Sealing Unit

The operator passes the folded bag top into the machine where it is contained between two steel P.T.F.E. coated bands. Electrical heating bars are applied to the other side of the bands and heat transfer melts the plastic whilst under pressure exerted by the bars. This is followed by cooling, carried out in a similar fashion to the heating, and the cooling medium is water which passes through the bars.

On leaving the machine the seal is hot, but sufficiently cooled to be self-supporting i.e. does not fold over.

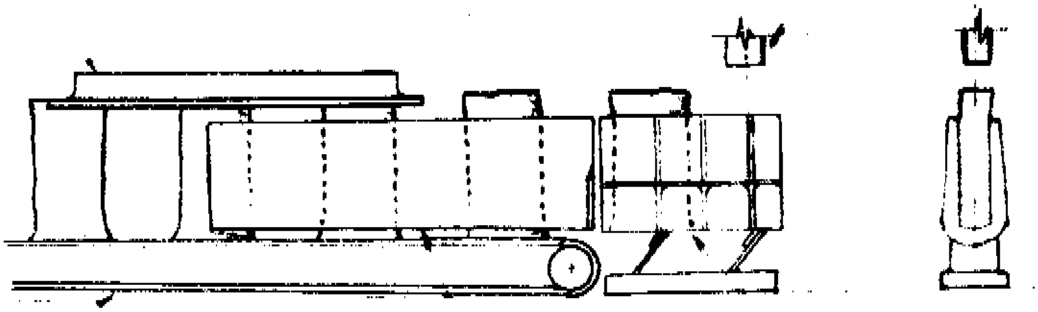
A unit with a band speed of 45 ft. per minute will handle 1,200 bags per hour satisfactorily if regular daily maintenance is given.

FILLED BAG FORMING AND SEALING
FORMATION ET SCELLAGE DES SACS REMPLIS

FIG 1

Heat sealer
Appareil de scellage à chaud

Filling spout
Goulotte de remplissage



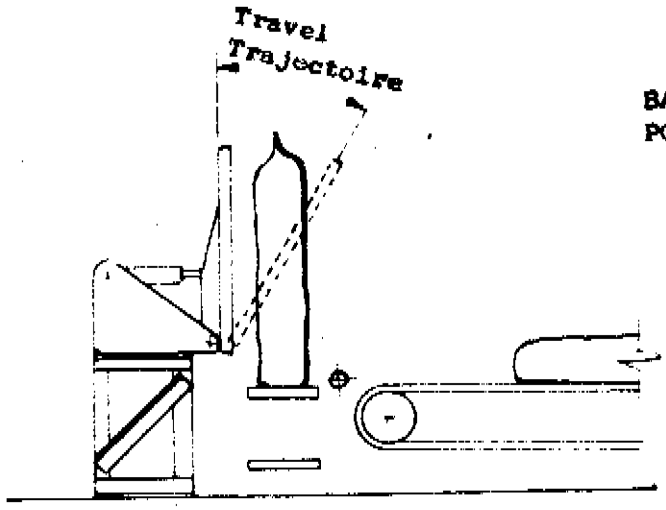
Conveyor
Transporteur

Former
Machine à former

Bag vibrator
Vibreur de sacs

BAG PUSHER
POUSSEUR DE SACS

FIG 2

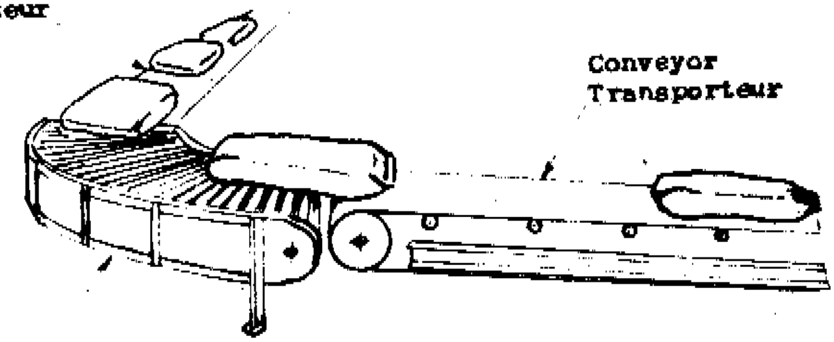


CONVEYOR DIRECTION CHANGER
CHANGEUR DE DIRECTION DU TRANSPORTEUR

FIG 3

Conveyor
Transporteur

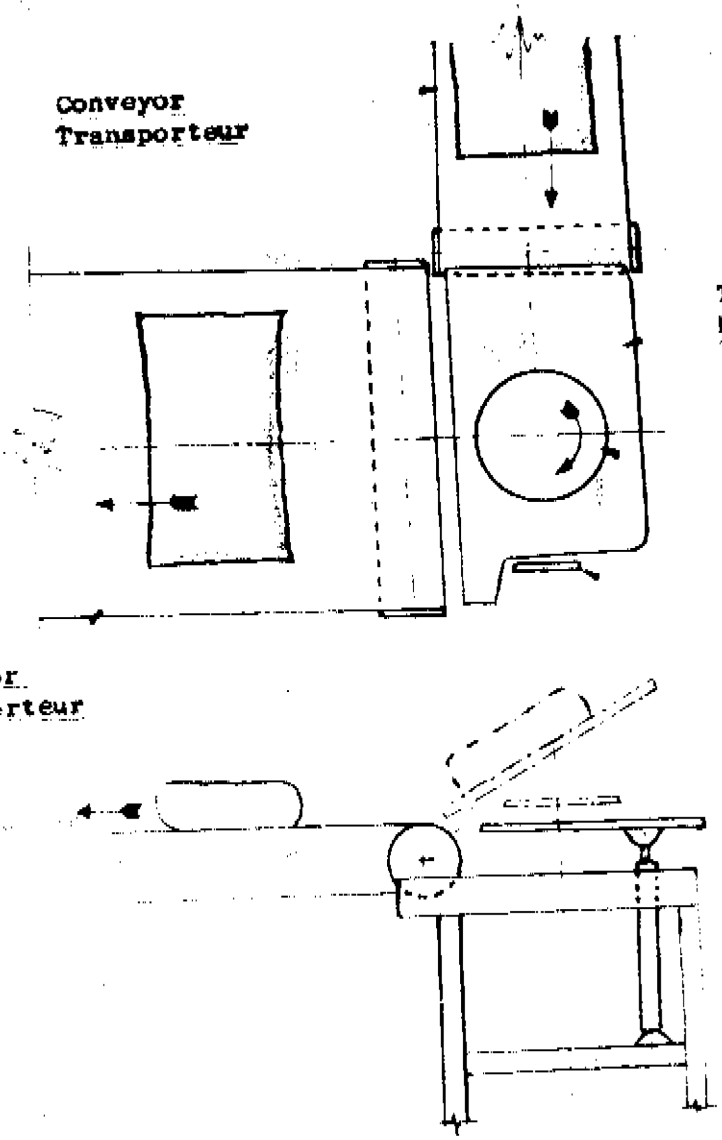
Conveyor
Transporteur



Mechanical curve conveyor
Transporteur mécanique courbe

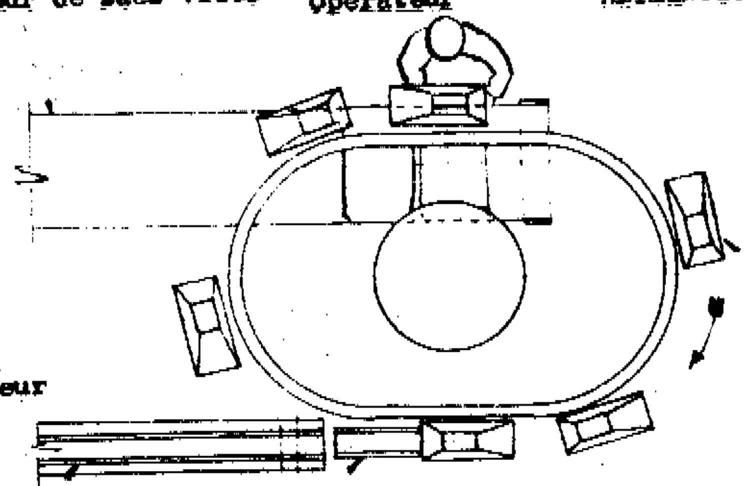
FIG 4

BAG TURNER AND DIRECTION CHANGER
TOURNEUR DE SACS ET CHANGEUR DE DIRECTIO



TURRET BAG FEEDER
ALIMENTEUR DE SACS A CAROUSEL

FIG 5



DISCUSSION

MR. R. DEAN (Fisons Ltd., U.K.): presented a film showing various aspects of the process described in the paper.

MR. P. MORAILLON (Pechiney-Saint-Gobain, France): I should like to thank Mr. Dean for this most interesting paper. The film that we have just seen is particularly noteworthy and illustrates better than any speech the various aspects of the process. Fisons' technical experts have worked out some extremely ingenious solutions to the various problems which they have encountered in the use of plastic sacks for fertilizers and in the handling and palletisation of these sacks. We should also congratulate them on the considerable progress they have achieved with regard to the rate of throughput, the productivity and also the considerable reduction in the number of damaged sacks.

I should like to ask Mr. Dean some questions. In your paper you state twice that after the sack is vibrated there remains sufficient air inside it for the product to flow freely. Could you perhaps comment on this point? Would excessive vibration lead to caking? Do you have particular specifications for the quality of polyethylene used in the manufacture of the sacks? What in your opinion is the optimum thickness? From your paper and film it would seem that all your fertilizers are bagged and stored on palettes. Is this correct? What reasons have led you to prefer this solution to bulk storage and bagging at the time of dispatch without intermediate palettisation?

MR. R. DEAN: The first question refers to the amount of air retained in the bag after vibrating. In the very early days of development we spent 6 months determining the approximate amount of air that should be left in the bag before sealing. We had, when compaction was too great, material which did cake and would not break down. It also brought about damage during stacking because the compaction caused the particles on the top layer of the bag to penetrate the plastic. Whereas now the granules flow evenly thoughout the bag and therefore the maximum area of granules inside the bag is presented to the plastic. It is absolutely essential that some air is left in the bag in order to maintain the free flowing quality.

With regard to the specification of the plastic I am afraid that I have not got this specification, but this information could be provided.

Regarding thickness, we fill all our bags for home use in what we call 0.008 of an inch thick plastic. For export purposes we fill in 0.010 of an inch thick plastic. With regard to the ultimate thickness we consider that for home use we could come down to 0.006 of an inch thick plastic. But most development must be made at the users' premises so that excessive damage does not occur there.

The last question, if I understood correctly, is why do we put all our bags on pallets. In two of our factories we do and the trend in our other factories will be to this method. The reason for this is:

> we must obtain a high productivity rate at all times from the bagging plants so we keep feeding to the filled bag store at the rate of 400 tons per 8-hour shift into store. Occasionally we do have to load direct from plant, but this is mainly to rail vehicles which we have not the facilities for loading from our filled pallet store. This reduces the

plant output to 800 bags per hour.

In our future designs of factories, material will go to store on pallets and will be despatched from the store only, and the team we have operating the bagging plant would be fully operative and despatch will take place at any rate people require without interference with our bagging rate.

MR. L.J. CARPENTIER (I.S.M.A.): With regard to the measurements given by Mr. Dean, I think the thickness of the plastic was 0.22 and 0.25 mm.

MR. P. VERSTEEGH (ENCK Windmill Fertilizer Works, Holland): Mr. Dean finishes his paper on page 8 referring to regular bagging maintenance. Would it be possible for him to tell us what is to be considered normal for regular daily maintenance of a system like that, maybe in man hours or something like that?

MR. DEAN: The kind of equipment we are now operating requires regular maintenance on a planned basis. We provide daily maintenance of one half hour per day which is taken when the bagging operators are at breakfast. In this period the maintenance people check the Doboy Heat Sealer and after adjustment the maintenance fitter carries out test sealing for efficiency. We also look at the 3 weighing machines feeding this plant, as it is imperative that we keep our accuracies at ± 1 ounce in order to conform to the law and to prevent give away of material which at the end of the year can amount to a fabulous tonnage.

With regard to the palletiser this is the only other piece of equipment which needs this daily maintenance. One electrician checks all switches to ensure that the operations would carry on for the next 24 hours.

One day per week the bagging plant is closed down for cleaning on the morning shift only. Then the maintenance people move in on a 6 hour plant maintenance system whereby everything is checked and put right so that it is fully operational for the next week.

This form of maintenance is growing throughout our industry and it is the only way we can see of obtaining very high operational efficiency for this type of equipment.

MR. O. KILLINGMO (Svenska Salpeterverken, Sweden): I would like to ask Mr. Dean if he has some experience of sealing with a Doboy machine, specially referring to dusty material and damage of bags caused by the hard corners you get in that type of sealing.

MR. DEAN: The only bags we have sealed on the production unit are what we call open mouth plastic bags. These are noncoated and we seal with the Doboy unit. Our main problem in sealing is dust and we are now looking into proper dust extraction units so that we shall eventually obtain perfect sealing. Sorry if I did not answer your question but this is the only experience we have.

MR. G. LUTH (B.A.S.F., Germany): Does the amount of air which remains enclosed in the bag depend very greatly on atmospheric humidity and temperature or other environmental conditions at the time of bagging?

MR. DEAN: We found that the vibration appears to provide the necessary free flowing qualities regardless of temperature or density and the correct folding of the top of the bag after filling makes due allowance for the changes in height due to density. We have never changed this system for any kind of various materials and we have in the order of 54 different grades of material to handle.

MR. van Der HOREN (Coppée Rust): I have seen that you use a man to close the sacks between the bagging machine and the welding machine. Did you try to use a machine to close the sacks automatically?

MR. DEAN: Yes, we have investigated mechanical means of closing bags, but have not pursued this matter because, firstly, we know of no machine which could go along with us at the rate we intend to go to. Secondly, you will appreciate that putting on a bag every 3 seconds can be a very tedious operation, therefore the 2 men interchange their duties as and when they like in order to maintain the high output, which I am sure would not apply if one man had to do the one job. Thirdly, we realise that a man is useful when he is not actually operating the machine as there are many duties to be done, cleaning of plant, all kinds of things they have to do. Fourthly, we have times when the man has extreme difficulty in folding the bag owing to the height of the contents of the bag. No machine can cope with these variables.

We do not consider it is wise at this time to venture into automatic sack closure equipment, but when products and bag sizes are better related then we shall investigate the matter again.