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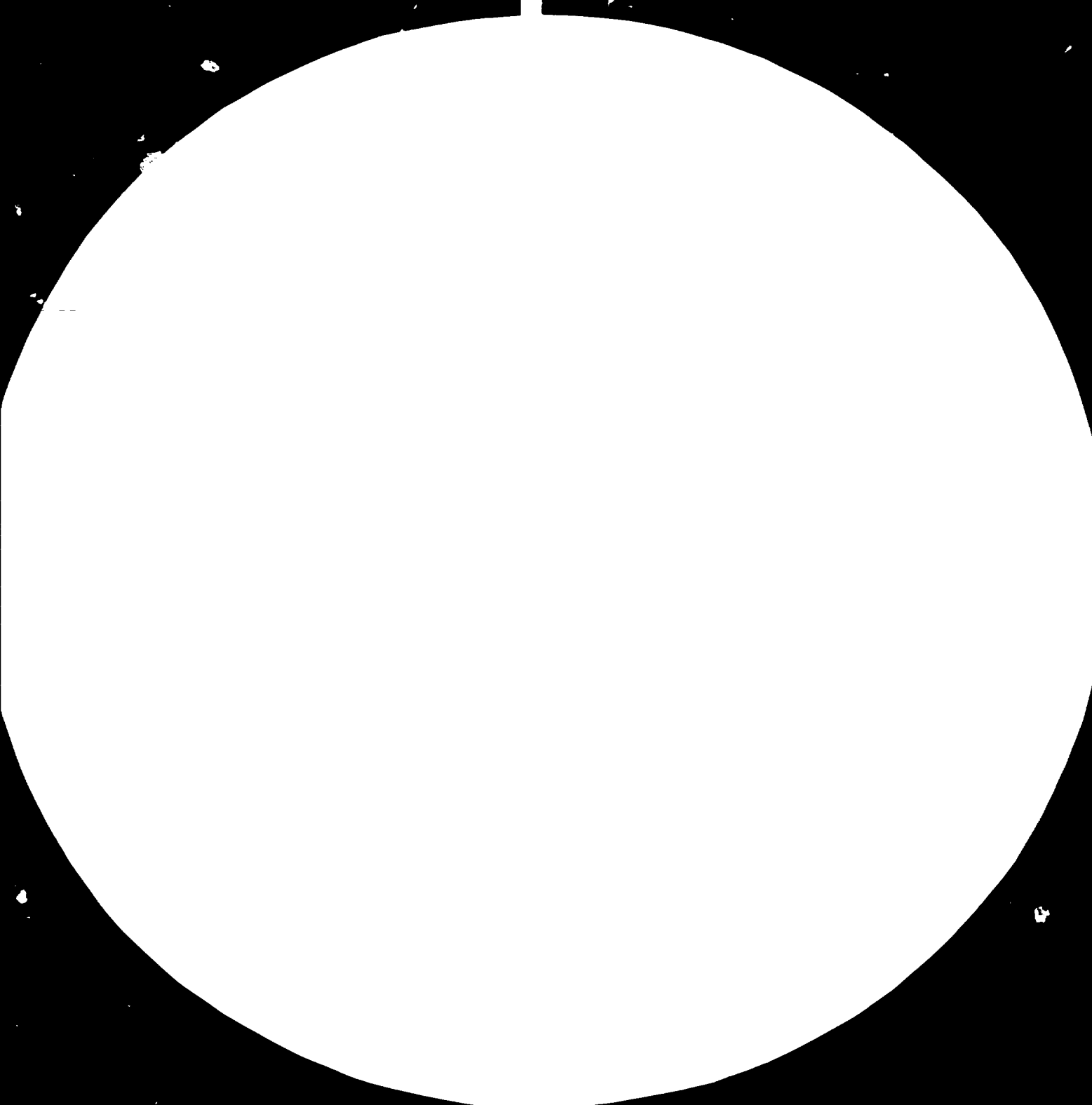
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Resolution Test Chart (NBS 1963-A)

Resolution Test Chart (NBS 1963-A)

UNIDO PROJECT No. SI/POL/75/805

"ASSISTANCE IN WEIGHT REDUCTION
AND

MECHANICAL STRENGTH
IMPROVEMENT OF GLASS CONTAINERS",

11812

F I N A L R E P O R T

of

THE TRAINING IN ROCKWARE INTERNATIONAL LTD.

March 14th - April 4th 1982

1. INTRODUCTION

The visit of the Polish specialists was organized as a realization of the programme of technical assistance to the Government of Polish People's Republic by UN-UNIDO and UNDP under the Project SI/POL/75/805 - " Assistance in Weight Reduction and Mechanical Strength Improvement of Glass Containers" as well as subsequent agreement under a subcontract No. 80/99/IS between UNIDO in Vienna and ROCKWARE INTERNATIONAL LIMITED in England. The original aim of the Project was to assist the Polish glass industry in setting up the programme to reduce the glass container weight and advance its quality to world standards.

However, after the visit of Rockware specialists to Polish glass factories it was decided that the proposals of Rockware would be accepted to assist and supervise to preparation of I.S. machine and feeder at the "UJŚCIE" factory, making use of the most advanced technologies in glass containers manufacturing.

The Rockware specialists were to carry out the training for Polish operators and mechanics of IS Machine in the inspection and proper maintenance and the use of numerous complex elements of the equipment of IS machines and feeders in the Polish glass works.

In 1981 on the grounds of the agreement between ROCKWARE INTERNATIONAL Ltd and UNIDO in Vienna a similar training for Polish IS machine specialists was decided to be carried out by Rockware at their Advanced Training Centre in England.

Originally the training was to be held in the period January 19th till February 11th, 1982.

Due to the martial law introduced in Poland in December 1981 the date of the training was postponed because of the new passport and visa procedures.

For reasons beyond of Rockware, due to the limitations in air communication the period of the Polish specialists' stay was shortened to three weeks.

2. THE AIM of the VISIT

Instruction on:

- the newest glass containers production technologies,
- the technical and technological conditions of production of containers on high-speed forming machines,
- the organization and technology of overhaul and repair of IS machines and feeders and mechanisms.

3. MEMBERS of the POLISH TEAM

The following persons took part in the training :

Józef Zielonka, eng.	- Glass Factory "UJŚCIEŃ at Ujście
Jędrzej Gójski, eng.	- " " " "
Brunon Janke	- " " " "
Stanisław Klessa	- " " " "
Anna Malesińska	- Institute of Glass and Ceramic Branch in Kraków

4. TIME of the TRAINING

The Polish team had been staying in England for three weeks - March 14th till April 11th 1982, including travel.

The period from March 15th till 19th was devoted to visiting:

- Product Design Development Department and Customer Services Department in Northampton,
- & Glass Factory at Wheatley, Doncaster,
- Glass Factory Bagley and Technical Centre /the Mould Design Department/ at Knottingley,
- Advanced Training Centre at Wheatley.

The period from March 22nd till April 2nd was devoted the theoretical and practical training at the Advanced Training Centre at Wheatley according to the programme

worked out by Rockware International Ltd.

5. VISITED FACTORIES and CENTRES

Rockware Glass Ltd and Rockware International Ltd are one of the main subsidiaries of Rockware Group Limited. Rockware Glass with its head offices in Northampton includes four glass factories at Knottingley, Doncaster, Irvine and St. Helens.

In these four factories there are installed forty three 6, 8 and 10 sections IS machines for production glass containers operating with "blow and blow" and "press and blow" process.

The total daily production of Rockware Glass is over 4 550 000 bottles and jars of total weight 1 558 Mg.

The containers are produced in wide assortment from very small cosmetic bottles to special large bottles of over 1 litre capacity for wines and spirits and soft drinks. The containers are manufactured of flint, green, amber and opal glass.

The main assortment are bottles of 0,1 - 1,0 litre capacity for food and milk, beers, wines and spirits, juice and soft drinks and cosmetics.

The greatest achievement of Rockware Glass in the weight reduction is widemouth milk bottle "Pintie" manufactured with "press and blow" process which improved the distribution and strength of the container. The bottle of 1 pint \approx 0.55 litre/ capacity weights 9oz /273 g/.

The "narrow neck press and blow" container manufacturing techniques enables glass distribution to be controlled more accurately than has been possible before, with the result that the container wall thickness is more uniform - the variations in thickness are about a third of those common with usual "blow and blow" process.

It is possible to reduce the amount of glass used in a bottle without sacrificing its resistance to thermal shock,

internal pressure, mechanical impact and vertical loading. Rockware does not produce the mould equipment or spare parts for IS machines and mechanisms. Each factory does cleaning and repairs of mould equipments as well as repairs of mechanisms and IS machines at their workshops.

The Polish team was enabled to visit: the Product Design Development and Customer Services Department in Northampton, Mould Design Department at the Technical Centre at Knottingley, the Glass Factories at Wheatley and Knottingley.

Product Design Development and Customer Services Department in Northampton

A strong competition makes this kind department indispensable. This is due to the constant necessity to modernise the product as well as to meet the requirements of the numerous customers since the Firm's production has a very wide assortment. The design of product manufacturing with traditional methods did not keep pace with the demands - the production time of design of a new container with traditional methods was two days and a large team of designers was necessary.

The application of computer aided design techniques has enabled the manufacturers and the users of glass containers to achieve unparalleled levels of customer service and satisfaction.

Installed at Rockware the Hewlett-Packard is a high speed computer with an associated graphic plotter for designing a new glass container. It is programmed to calculate bottle volumes and all dimensions which are necessary to the customer and the mould maker and to the drawing automatically in 15 minutes. The basic relations to the bottle is listed in a form frame at the side of the drawing.

Programmes are available which assist the designer in developing the packaging which is used to transport the container from the glass factory to the user.

Rockware Glass has installed two computerised design systems— one at the head offices in Northampton and one at their Technical Centre at Knottingley.

Now an exciting new technological development has been made by Rockware Glass. It is "All-rounder" bottle for soft drinks manufactures. The bottle is to be pre-labelled in the glass factory with composite material which consist of a good Kraft-paper /in contact with glass/ covered by laminate of polypropylene. All-rounder's laminated label protect from scuffing or damage of glass surface and improves mechanical strength of bottle. It also reduces noise level by avoiding glass - to glass contact.

Glass Factory at Whetstley, Doncaster

There are three large flint furnaces and two smaller opal furnaces. The total pull of flint glass from all the furnaces is about 800 Mg per day, from the opal furnaces 45 Mg per day.

The flint furnaces are cross fired regenerative furnaces with five ports on each side of the furnace. The furnaces are equipped with gas and oil installation.

One of the flint furnaces W-1 has been working for nine years and is said to have achieved the world record of the total output during one working life of furnace. The operation period itself is imposing.

The opal furnaces of 7,25 m² area each are sexangular furnaces and use only electric energy.

At each flint furnace are installed five IS machines of various number of sections and at each opal furnaces two 6 sections IS machines of double gob.

Together in the factory operate eighteen IS machines of double gob, out of which one is 10 sections machine and four 8 section machines.

The machines with over 6 sections, which are the newest development, are equipped with electronic timing. The older 6 section IS machines have traditional mechanical timing

system. All the IS machine were supplied by EMHART Sweden, except the 10 section forming machine equipped with a more advanced electronic timing so-called "FUTRONIC" designed specifically for this machine and produced in West Germany in cooperation with Rockware. The Futronic system makes it possible to store in computer memory the technical data of previously manufactured ware.

One of the 8 section machines was equipped with experimental electronic and gob weight automatic regulation produced by POWERS USA.

A central Lincoln lubrication system is used for all eighteen machines from the centre installed in the hall between the furnaces.

The flint furnaces serves five production lines. The fore-hearthes are gas-fired. The feeders are the BHF series 900, the maximum production speed was 175 shear cuts per minute with associated outpull Of 110 Mg per day. There are also the BHF feeders 907 series for 8 and 10 section IS machines with high production pull 150 Mg per day.

The ware annealing is done in electrically-heated lehrs of forced recirculation and automatic temperature control of the belt width of 10 ft /about 3 m/.

The inspection of containers is done along inspection lines with POWERS inspection equipment for testing the finish dimensions and width for bore and leak detection as well as for choke, crack and crizzle detection. There is also visual inspection of containers on the screen when the other faults are being eliminated. For detection of critical faults and the "bird swing" the American INEX equipment is used.

In the manufacture of accurately dimensioned glass containers e.g. bottles, it is difficult to maintain the required volume and hence weight of ware. The walls can fluctuate in thickness and capacity fluctuates accordingly. The automatic weighing and the electronic control equipment weighs each glass containerx separately before it goes into the lehr.

The weight of each bottle is used to control the stroke of feeder plunger which enables the weights of the finished ware to be kept reasonably constant.

From high pull machines of 8- and 10 sections are used two inspection lines, each equipped with a set of automatic inspection devices.

There is installed a fully automated palletised load conveyor. The conveyor accepts pallets which are loaded with glass containers, separately or in cartons, at the end of the inspection lines and conveys them via wrapping equipment /automatic shrink wrap machine/ to the warehouse. These pallets which have a standard base area of 1 x 1,2 m may be stacked with glass alone or in crates up to a height of over 2 m. Approximately 98 per cent of all pallets are shrink wrapped. The containers are delivered by Rockware Glass themselves to the plants that fill them up.

As was mentioned at the beginning of the report, the Glass Factory at Wheatley manufactures a wide assortment of flint and opal ware. The basic flint containers are jars and wide-mouth milk bottles "Pintie". Below are given the production speeds for some glass containers manufactured at present with the "press and blow" process.

assortment	weight /grammes/	speed/cpm/	M/C
Jar	216	136	IS-6/DG
Bottle	202	138	IS-6/DG
Milk bottle 1/2 pint	176	196	IS-8/DG
jar	240	176	IS-8/DG
Milk bottle "Pintie"	273	215	IS-10/DG

These speeds are very high and have not been achieved in our industry so far. The conditions for such high speed, besides the usual process of glass melting, are first of all perfect technical performance of the forming machines and feeders as well as good qualifications of the inspection and service staff.

Mould Design Department at Technical Centre at Knottingley

As was mentioned before, there is also installed the computer with plotter. It is programmed to calculate the mould equipment which is used on the IS machine, as parison design, blank and mould design, plunger design etc. with all dimensions and engineering details for mould specification. Suitable programming allows a complete set of mould drawings to be made in a matter of hours rather than several days as before.

Glass Factory Bagley at Knottingley

There are installed five furnaces with thirteen forming machines out of which only twelve were working.

The factory produces glass containers of amber glass on two furnaces, of green glass on two furnaces and of flint glass on one furnaces.

The amber furnaces are cross-fired with three pairs of burners. One of them, of melting area of 39 m^2 and melting capacity of 110 Mg per day, is equipped with electric boosting installation which allows such high melting capacity.

The other furnace of melting area of 38 m^2 has melting capacity of 80 Mg per day and has no electric boosting installation.

The furnaces melting green glass are horseshoe flamed equipped with electric boosting and bubbling installations and each has the melting area of 41 m^2 and melting capacity of 130 Mg per day. The electric boosting power is 1500 kW for each furnace. The installation has six electrodes - four of them are mounted on side walls /two on each side/, one in the bottom. The bubbling installation is equipped with seven burners mounted in the bottom which mix the molten glass at the melting end by means of compressed air. A thick layer of block isolating the bottom blocks is 200 mm / the blocks used in Polish factories are 100 mm/.

The flint furnace is also a horseshoe flamed furnace of melting area of 20 m² and melting capacity of 40 Mg per day. All the furnaces have gas and oil installations. The green glass furnaces were both gas and oil fired and reheated with electric energy. The noted instantaneous consumption was as follows : gas 66,6 litres per second, oil 7,8 litres per sec. The melting capacity at the time was about 3,6 Mg from 1 m² per day.

The forehearths and feeders are the same as in the factory at Wheatley, those for coloured glass have additional equipment for mechanical stirring of molten glass in the channel of the conditioning zone by means of two ceramic helical stirrers. This improves the thermal homogeneity of molten glass which is difficult to maintain in coloured glass because of worse heat conduction.

One of the feeders feeding green glass to the 8 section IS machine of double gob was heated in a combined way - with electric energy in the forehearth and with gas in the feeder. The electric heating installation had forty two electrodes mounted on both sides and dipped in the molten glass through the whole length of the channel. According to the information received, the system of electrode heating is particularly favourable in case of coloured glass and decreases the heat energy consumption which is over 85 per cent of all the energy used by the gas-heated feeder of the same size.

The forming machines installed in this factory:

- at amber furnace No. 1 of melting area of 38 m², there were two IS machines: one IS-6/DG but operated only on five sections, and one IS-6/SG also operated only on five sections. The smaller number of operating sections in the IS machine is due to a limited melting capacity of the furnace in case of heavy containers.
- at furnace No. 2 of melting area of 39 m² for amber glass operated three IS machines: IS-6/DG, IS-5/SG and IS-8/DG.

- at furnace No. 3 for green glass worked two IS machines: IS-8/DG and IS-6/DG.
- at furnace No. 4 for green glass of melting area 41 m² worked two IS-8/DG machines.
- at flint furnace No.5 of 20 m² melting area there worked three IS-6/DG machines producing small cosmetic bottles. One of feeders is adapted to colouring the molten glass in the forehearth. This makes production more flexible and easier meets the requirements of the clients. The equipment of such forehearth consists of additional helical stirrers in the end zone of the channel and a device controlling the delivery of fusible colour frit of a given colour.

The inspection equipment used in this factory is of the same type as in the factory at Wheatley.

The production speeds achieved at Bagley at the production of narrow-mouth containers of coloured glass with "blow and blow" process :

Assortment	capacity	Weight	Speed	M/C
Bottle	1 liter	538 gram.	36 bpm	IS-5/SG
Bottle	0.34 "	265 "	110 "	IS-6/DG
Bottle	0.25 "	166 "	210 "	IS-8/DG
Bottle	1 "	542 "	100 "	IS-8/DG
Small bottle		75.5"	214 "	IS-8/DG

These speeds are higher by more than 15 per cent than those at our factories. In case of smaller bottles this difference is still larger: e.g. a bottle of 0.25 liter weighing 166 g has the speed higher by about 30 per cent for similar bottle produced at our factories.

Advanced Training Centre at Wheatley, Doncaster

The Advanced Training Centre located on the site of Rockware's modern factory at Wheatley is the central pivot of technical training emphasis of Rockware and many of its international

clients. The A.T.C. uses the advanced teaching methods for training in the theory of machine operation and provides excellent opportunities to practice immediately the lessons during instruction periods.

At the Centre there are three single section IS machine deployed in various forms to provide the fullest possible insight into the operation of the entire machine. The same approach has been adopted with forehearths and feeders and where mechanisms are complex, working schematic models have been specially constructed to aid the learning process. In addition to production equipment the A.T.C. is stocked with a wide range of manuals, bottle fault libraries and other training aids such as: video equipment, films, transparencies, slides, etc.

The Rockware approach to training and development is based on the systematic step-by-step approach which since its initial development in 1966 has shown consistently that not only is the learning time reduced, but the depth of knowledge and understanding is increased.

The Centre carries out the training first of all for the technical working IS machines producing glass containers and the melters of furnaces services, the inspection staffs, the personnel for control and wrapping equipments, and others. The Centre also arranges retraining for employees when a technical and technological know-how has been introduced as well as retraining for promotion to a higher position.

The complete sections are used for practical training in setting up, mounting and performance control on particular mechanisms in a section as well as putting into service and control of the whole section of IS machine in cooperation with feeder. The separate mechanisms are used for practical instruction on their construction and operation, on defects and the trouble shootings with them and to train the competence of carrying out overhauls and maintenances.

6. THE REALIZATION of THE TRAINING PROGRAMME

As was mentioned before, for reasons independent of Rockware the original scheme was finally limited to the most important problems. First of all attention was paid to the latest design developments and improvements affecting the machine speed and the quality of the glass containers.

The omitted problems were connected with doing overhaul and repairs of certain mechanisms. However, emphasis was put on the ways of testing separate parts and mechanisms and alignment and regulation of mechanisms by means of new fixtures, i.e.:

- neck ring set up. The Rockware method is a system used for the setting up of neck ring holders on IS machines. The objective is to set up the holders level on the blank side of the machine.
- new set of fixtures for checking mould holders and invert mechanism before setting up on the machine. It was manufactured on Rockware design by WEST YORKSHIRE ENGINEERS of PUDSEY which also manufactures some spare parts for IS machines.

Another interesting item was new design and technical developments used in the forming machines and technological practice of Rockware. Some of them are:

- the so-called "Cracked Blank", i.e. preliminary minimum opening of blank mould by means of an additional pin on the drum with a raised washer. It hastens reheating of the cooled outer layer glass and the temperature of parison is balanced faster.
- additional sort parison puff at the blank mould opening moment by means of an additional pin on the drum with a raised washer. This prevents the formation of "bird swing" which is formed easily at higher speeds.
- additional short blow at the finish mould opening moment

which prevents the sides of containers from sinking when are manufactured flat and oval bottles.

- a special sleeve in the valve block which drives the higher pressure of compressed air to close the blank mould to prevent them from parting when the parison is blown,
- invert mechanism with oil cushioning and its improvement by Rockware by means of constant oil supply of lower pressure, i.e. 5 kG/cm^2 instead of cyclic supply which was used by Emhart / 60 kG/cm^2 /. This kind of device works more smoothly and considerably decreases the number of finish faults. The lower pressure eliminated oil leaks which are difficult to remove at high pressure.
- ball springs in the valve block of greater port diameter which allows the air to flow faster particularly important at high speeds.
- a simplified installation of compressed air to settle blow in the blank mould and final blow by means of its direct flow through flexible pipes from collector to the upper zone of the bottom plate mechanism and blow head mechanism. This decreases the loss of and hastens the air flow. It requires a special valve controlling the air flow from the valve block,
- an automatic system form the air temperature in the vicinity of fans. This allows temperature of the mould to be kept constant and a stable ware quality,
- two stage invert/revert cushion - the Mauß Bross two stage invert/revert cushion has been developed to yield a progressive adjustable cushioning motion of invert/neck ring mechanism. It has two stages, full stroke and half stroke, as opposed to the traditional single stroke cushion,
- and other information on the technical and organizational improvements in the glass container manufacture.

7. CONCLUSION

The Rockware Glass Limited presents a very high standard of the production quality as regards both the workmanship and up-to-dateness of the glass containers. The products in both visited factories have highly esthetic surfaces, good glass distribution in the walls and both modern and economical design. The Company is also on a high world level as regards the machine speeds measured production speeds and the output rate as well as melting capacity.

These results are achieved at Rockware owing to a well organized technical base and in particular :

- glass container design and mould design,
- constant introduction of improvements in technology and forming machines,
- use of advanced machines and devices and systematic maintenance works,
- attention paid to raising the professional qualifications of technical staff at a well organized training centre.

The UNIDO fellowship has enabled us to receive information on the latest developments in glass container manufacturing, on advanced technologies in forming machines and feeders and other mechanisms.

The training has been very usefull and the information we have obtained will help us in introducing any feasible technical and technological improvements in order to increase the production speeds, improve the quality of glass containers and maximum use of the machine potential in the "UJSCIE" glass factory and other factories in Poland.

Władysław J. Zielenka



