jars and rendering them ready for a secure lifting process. The second method is applied to glass containers of non-uniform horizontal cross-section like beer bottles, which are unable to be squeezed with airbag grids in straight position. The method basically involves the settling of vacuumizing heads on top of the bottles, which pull and hold them in place.

There exist 13 palletizers in the inventory of the factory, which build compact towers of glass containers. These packs are then received by one of the two mobile shuttles moving on a rail, which serve as an intermediate transport unit between the palletizers and pack shrinking machines. A proper transfer of such heavy packs from the palletizer to the shuttle and from there to one of the five shrinking machines is done by a network of optical sensors driving the conveyors with signals. A pack shrinking machine prepares transparent polymeric packs and wraps with these packs (the pack shrinking machines surround the towers with heating zones first) tightly the towers. The carton boards are produced in pallet shrinking machines. After being packed, glass container towers are delivered to storage. Pharmaceutical bottles undergo additional microbiological controls before going to the palletizer.

During my work in the Cold End Department, I had the opportunity to observe the shutdown of furnace D and the extending production lines therefrom. I was informed that the lifetime of a furnace is about ten years and furnace D is through with it. So, the Batch-Furnace Dept. ceased to feed furnace D, the production continued until the remaining batch was fully utilized and then, the Production Dept. stopped the operation of the IS machines and hot covering units on the three lines extending. The fourth line was already shut down before.

I spent one day in the Project Department, or the Auxiliary Units Department; whose primary concern is to organize the air, water and

energy supply and circulation in the plant. Meant with air is surely not the air conditioning, but the pressurized air driving the pneumatic systems. Two pressure levels are generally employed; 4 bar for the settle, counter, final blows and 6 bar for driving mechanical systems.

Water circulation is needed to cool the continuously working and heated units, especially the compressors which provide pressurized air with enormous rises in temperature. Besides, the scissors under the plungers at the far end of the forehearths are cooled with a mixture of refined water and boron oil. The circulation must be steadily fed with water in order to compensate for losses in form of vapor. Circulating water is cleansed from microorganisms by using chemicals each 15 days. Cooling is accomplished by a technique termed "raining", which basically increases the cooling surface by separating the flowing water into droplets.

As mentioned before, the primary energy source utilized in production is natural gas. It can be substituted, however, with LPG or motorin for 24 hours when needed. Anadolu Cam is the second most natural gas spending company in Turkey with a cost of about one billion YTL per month.

The final couple of days of the internship I have spent in the Quality and Process Control Department and the Mechanical Maintenance and Repair Department. I have to state that all the quality control processes explained in detail in this text, including the manual checks at the row-sort and all the inspection machines are the concern of the Cold End Department. The principal difference which renders the Quality Department necessary is that in order to achieve a continuous development in quality, one must make measurements. All the quality checks of the Cold End Department eliminate products which have attributes being out of some tolerance range. The quality department, however, exactly measures the values attached to those attributes, and feeds back the Production Department to enhance the efficiency. The purpose of the Mechanical Maintenance

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and Repair Department is to avoid any malfunctioning of the mechanical systems present in the factory by making periodic controls and to solve any problem occuring on these systems. Hence, all the machines operating in the factory establish the focus of this department.

Anadolu Cam Sanayii A.Ş.
Cam Fabrikası

(7) An Assessment of the Internship

7.1 The most crucial gain I think I have obtained in this final 20-days summer internship was the opportunity to observe the three main manufacturing processes applied in glass forming, and to recognize the utilization of the special blank and blow molds in this processes. This significance originates from the fact that I have implemented the preceding training (internship) in the factory which produces these molds from their raw materials (OMCO Istanbul). Hence, I got an extensive vision of the glass production sector by accomplishing two such complementary internships. Additionally, I have developed the skill of optimizing the production flow and enhancing the production efficiency by endeavouring to minimize the role of labor and to utilize more and more automatic machinery. I broadened my understanding of complex machines and linkage systems and enhanced my capability of performing proper heat transfer analyses. I got an understanding of the quality control processes which have to be applied in such a sector where tolerances of production are extremely narrow. Further, I learned the software Seedlab 3 and developed my skills in MATLAB. Finally, I was provided with the vision of such a large and complex production flow.

7.2 As mentioned before, I have accomplished many tasks given by my instructors apart from my detailed and stepwise analysis of the production flow. Among those, the greatest responsibility was accompanied with the imperfection control, implemented on an optical machine and its software (SGCC Seedlab 3). My reports regarding the seed, bubble and blister (imperfection types) concentration in the bulks of the specimens were directly fed back to the batch preparation unit to reconsider the receipts. Besides, I helped the very calculation and establishment of these production receipts. Also, the recording process of the results coming from the manual control at the row-sort to the special quality templates was a big responsibility taken.

73 This internship provided me with an understanding of the skills and knowledge required to direct and govern such an organized and complex production flow. After this training, I know that both theoretical and practical knowledge about the present engineering activities, especially knowledge regarding the dynamics of present mechanical systems, is obligatory. However, such an engineering basis would prove to be insufficient for the directorate of such an industry. Using the experience I gained in this internship, I guess that one must equip the engineering knowledge with appropriate finance and management skills. I can state that optimization of a mechanical system, for instance, is as important as its very structure. Hence, I established my career plans accordingly: I intend to obtain a Master of Science degree in Industrial Engineering and only then to enter the worklife in heavy industry, having bolstered my mechanical engineering knowledge with the skills mentioned of.

74 My analysis of the huge production flow of this factory confronted many times strong correlations of theoretical knowledge obtained in school and the practice made in the factory. I can summarize such correlations as follows:

The level control for molten glass at the forehearth, as well as the height control of the tube which adjusts the gob weight are accomplished with PID control, as learned in ME 335.

Mold design and the processes under the IS machines involve extensive heat transfer analysis. As mentioned in the preceding section, all three manufacturing processes are accompanied with varying temperature profiles in glass surface, causing residual stresses. Proper conduction and convection calculations have to be done in order to avoid such stresses. Besides, the molds are equipped with cooling fins, which are also related to ME 361.

The casting-like, but more complicated IS production is a concern of ME 318 by itself.

Receipt calculations I have made, which utilize phase diagrams in order to obtain eutectoid structures, are related to ME 212 and ME 318. Also, the principles of imperfection control are under the scope of ME 212.

⑧ Conclusions of the Report

For the sake of concluding this discussion and divulging what I have mainly derived from this internship experience, I can state the following:

My aim in implementing this summer training in Turkey's most productive glass container forming plant was to build up an extensive vision of the glass sector, together with my prior training in the factory which produces the molds used here. Indeed, I analyzed in detail the types of manufacturing processes applied in glass forming and all the subprocesses on the production lines as well as the fundamentals of the involved machinery. What I have observed to be crucial is the need of utilizing automatic machines instead of labor work in the processes of glass forming. Also, I recognized numerous advantages of using pneumatic driving and linkage systems in these processes.

As to the glass container production sector, it is to conclude that due to the low marginal profits, the producer must strive for enhancing efficiencies and enlarging series produced per unit time. Besides, the complicated glass forming processes require both broad theoretical knowledge and practical experience from the producer. The need for enlarging production capacities obliges the use of automatic machines,

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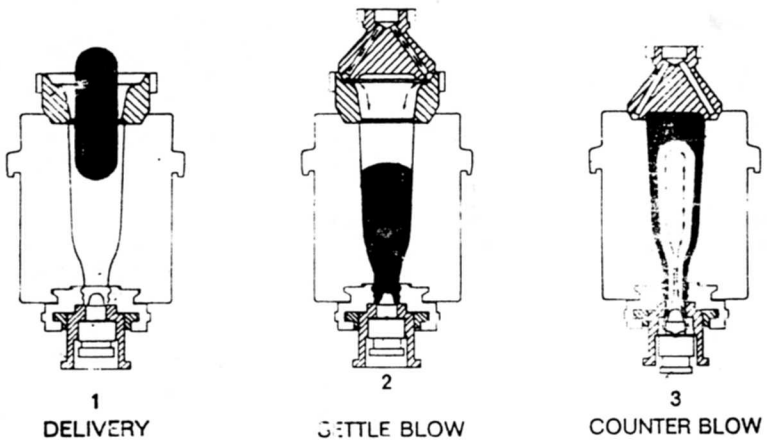
which makes any investment in the sector extremely costly. For these reasons, and together with the fact that Anadolu Cam has greatly dominated the Turkish production and market, the glass sector can be concluded to be hardly investable.

Anadolu Cam Sanayii A.Ş.
Topkapı Fabrikası

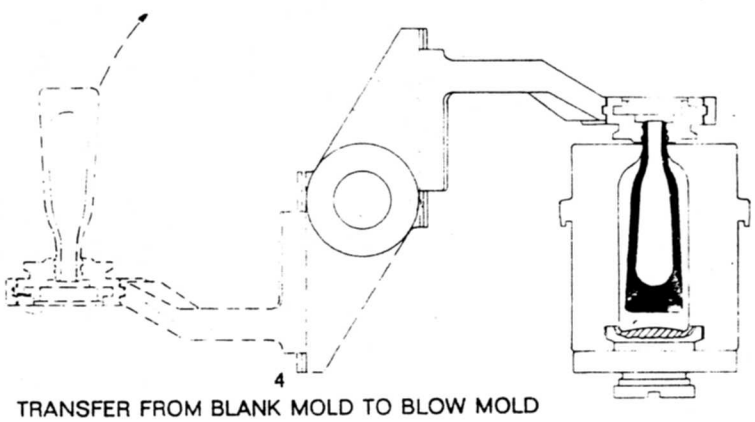
(9) Appendices and Supplementary Material



1
DELIVERY

2
SETTLE BLOW

3
COUNTER BLOW



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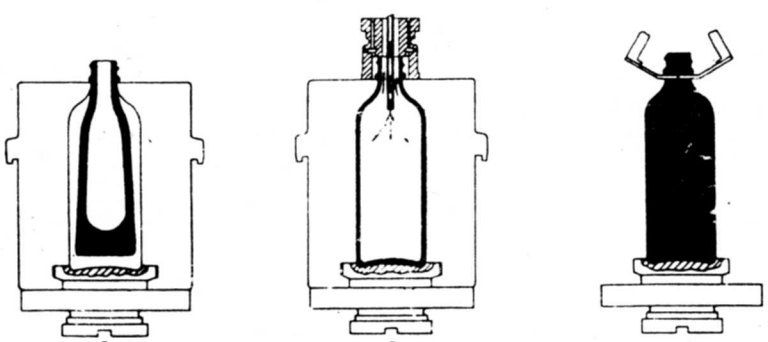
TRANSFER FROM BLANK MOLD TO BLOW MOLD



5
REHEAT

6
VACUUM FORMING
AND/OR FINAL BLOW
WITH INTERNAL COOLING

7
TAKEOUT

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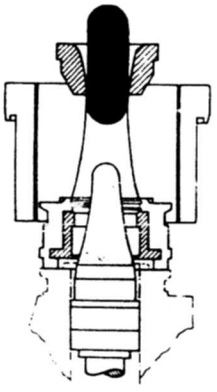

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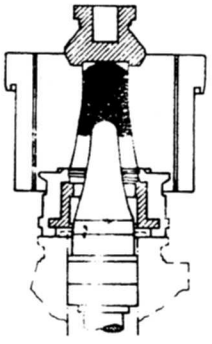
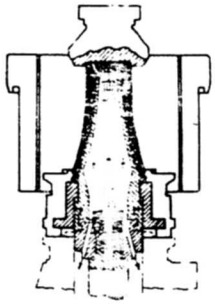
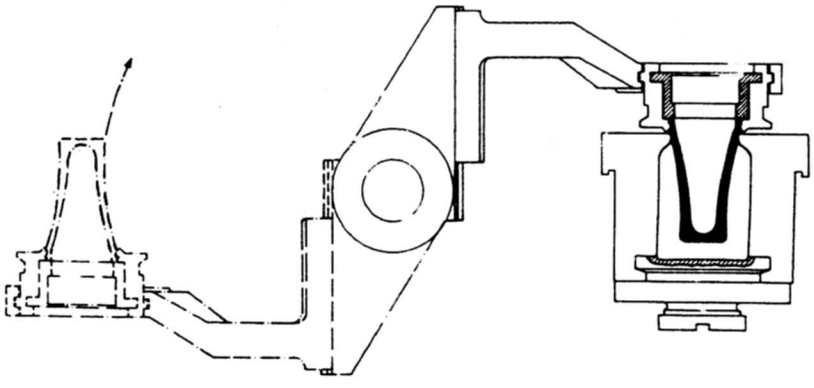


2

START OF PLUNGER PRESSING STROKE

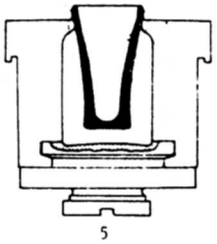


FULL PRESSING STROKE



4

TRANSFER FROM BLANK MOULD TO BLOW MOULD



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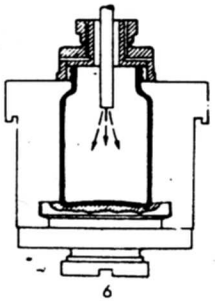
REHEAT



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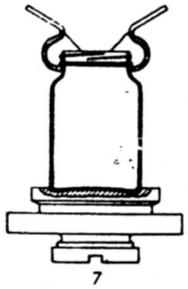
VACUUM FORMING AND/OR FINAL BLOW – WITH INTERNAL COOLING



7

TAKEOUT

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(10) References

- Authorized Documentation, Anadolu Cam Sanayii A.Ş. Topkapı Plant Training Department