Project 3320 Term A-95

Professor R. L. Norton

8/22/95

*Bulbous Inc.* has asked us to design a machine to convey fluorescent light-bulb tubes through a baking oven and spray their insides as they exit the oven. The bulbs must be coated inside with tin oxide while hot. The 46-in-long, straight glass tubes are carried through the baking oven on a metal chain conveyor that travels at a constant velocity of 5 500 bulbs per hour. The bulbs are spaced 2-in apart on the chain. As they exit the oven at 550C, your mechanism carrying two spray heads chases a pair of bulbs, accelerates to match their constant velocity, travels with them for a short distance, and sprays the tin oxide into the hot bulbs within 3/4 sec. The two spray heads mount on a 6-in x 10-in rectangular table that is carried on linear bearings. The spray equipment bolted to the table weighs 10 lb. All elements exposed to the tin-oxide spray must be stainless steel to resist chemical attack from the hydrochloric acid by-product in the spray. A cam drives the table to match the conveyor velocity and returns it in time to accelerate and catch the next two bulbs. A plate cam and follower train is to be designed to accomplish this action. Program Dynacam can be used to obtain the necessary dynamic data for the required cam design. The cam is driven from the conveyor line shaft.

What is required is a detailed design of the conveyor drive train including the line shaft, couplings, gearboxes to drive the conveyor chain and spray cam, the spray table, its drive-train, bearings and mounting hardware. Infinite life is desired. The dynamic loads on the cam and follower will be highly dependent on the mass of this moving assembly. Once an estimate of the moving mass is available from your preliminary design, program Dynacam can be used to quickly calculate the dynamic forces at the cam-follower interface. The stresses in the various parts of the assembly can then be estimated based on the level of dynamic forces present. See Chapter 9 in the text *Design of Machinery*, for information on using program Dynacam. Examples in that chapter are similar to this problem. Other analysis can best be done using a program such as *TKSolver* or *MathCad*, or with a spreadsheet. Note that it is required that a computer be used to solve this problem and *TKSolver* is recommended for the stress and design calculations. I will provide master TK files on disk to use as setups. Catalog information on bearings, conveyor chain, etc. will be made available.

We will attack this design project in five phases as defined below. Each phase will be allowed approximately one week of effort beginning in week 1 of the course. This will be a group project. You will arrange your own groups of 3 or 4 students. I need a list of your group members and its name by Monday 8/28. Anyone not in a group by Wednesday, 8/30 must let me know and I will put you in a group.

Five weekly progress reports will be required in a format defined in the P*rogress Report Specifications* handout supplied. A final *Project Report* will also be expected whose format will adhere to the separate *Project Report Specifications* handout supplied.

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| **Phase** | **Topics** | **Due** |
| 1 | Define the problem in detail. Model the mechanism dynamically. Do calculations to determine its kinematics and kinetics, approximate forces, torques, power levels, etc. Understand and bound the problem. Begin the design of the cam profile. | Week 2 Thursday 9/7 |
| 2 | Design a cam-follower train and determine the forces and stresses in the follower links and estimate their static safety factors. | Week 3 Thursday 9/14 |
| 3 | Design the line shaft, flywheel, keys and camshaft for fatigue loading. | Week 4 Thursday 9/21 |
| 4 | Design gear sets of suitable ratio and size to transfer power from the line shaft to the conveyor and camshaft | Week 5 Thursday 9/28 |
| 5 | Design a suitable follower spring for the cam and determine the surface stresses and lubrication condition of the cam-follower interface. | Week 6 Thursday 10/5 |
| 6 | Final Project report due | Week 7 Thursday 10/12 |

Additional information will be provided as the project proceeds. The section meetings are intended as hands-on help sessions for project activity. Please come with questions prepared.