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PROPOSED IMPROVEMENT IN EVACUATION TECHNIQUE FOR TV TUBES

ABSTRACT

The use of a good mechanical pump alone in evacuating TV tubes in production has been considered. Calculations show that from the pumping speeds and the ultimate vacua obtainable with some mechanical pumps this proposal should be feasible. Savings in maintenance and operating costs could result from the use of this evacuating procedure.

Class 2

INTRODUCTION

In numerous talks, with various members of the C-R Tube Department, evacuating procedures have been discussed. The impressions obtained were that the present procedure is not ideal in regard to: 1) time necessary for diffusion pump to heat up to pumping temperature 2) time necessary to cool diffusion pump down so oil will not oxidize when let down to air 3) high maintenance and operating costs of keeping diffusion pump in proper working order, supplying cooling water, etc. If the diffusion pump were eliminated, these difficulties would not be present. It has been reported[1] that some C-R tube manufacturers in England do not use diffusion pumps. It therefore seemed worthwhile to analyze the results to be expected from using only a mechanical pump for evacuating TV tubes.

DISCUSSION

The presently used oil diffusion pump and fore pump combination has a very high pumping speed at the throat of the diffusion pump. However, in order for this high pumping speed to be utilized, the tubing connecting the throat of the diffusion pump and the TV tube must have dimensions so chosen as to possess the same high pumping speed. Assuming the normal pumping lead size and length, the effective pumping speed of the connecting tubing may be calculated.[2] The effective pumping speed S_t of a tube of length L and inside radius r is very nearly represented by $S_t = \frac{r^3}{L}$ where S_t is given in liters/sec. when r and L are expressed in millimeters.[2] Assume the connecting tubing has a radius of 3 mm and is 100 mm long. The effective pumping speed would thus be .27 liters/sec. This is calculated for room temperature T_R of 300°K. For a higher temperature T_H, the pumping speed is increased in the ratio $\sqrt{T_H}/\sqrt{T_R}$.[2] Thus for $T_H = 700°K$ the pumping speed becomes $\sqrt{700}/\sqrt{300} \times 0.27$ or about 0.41 liters/sec. Therefore, regardless of how great a pumping speed the diffusion pump has, the pumping speed for evacuating the tube will not be greater than 0.41 liter/sec. at 400°C. Now of course the tubing radius could be increased and the length reduced so that the effective pumping speed can be somewhat increased. For example, if the radius were increased by a factor of two, the effective pumping speed would be increased by a factor of eight.

If the tubing cannot be made larger in diameter and shorter in length, a pump with a speed of 0.41 liters.sec. will evacuate the tube as quickly as a pump with a much higher speed, such as the large diffusion pumps now in use.

There is another consideration in regard to the pump for evacuating a tube; that is the ultimate vacuum obtainable from the pump. In all of the above calculations, it was assumed that the pressure at the throat of the pump was small in comparison to the pressure in the tube and could be taken to be zero. When the pressure in the tube approaches the ultimate vacuum obtainable by the pump, the pumping speed decreases. The ultimate vacuum obtainable from a metal oil diffusion pump should be quite low— of the order of 10^{-5} to 10^{-6} mm of Hg. However, if the oil becomes oxidized and contaminated through use, the ultimate vacuum may be much higher. It has been reported[3] that a pressure of the order of 10^{-4} mm Hg in the tube before seal-off is quite satisfactory; the getter is then flashed and the tube is aged with a resulting vacuum of 10^{-5} or 10^{-6} mm of Hg. With these factors in mind let us examine the properties of some mechanical pumps. There are mechanical pumps which are guaranteed to have an ultimate vacuum of 10^{-4} mm of Hg and a pumping speed of from .5 to 10 liters/sec. One pump which would seem ideal for evacuating TV tubes is the Welch Duo-Seal No. 1405, costing $145.00, which has a pumping speed of about 0.5 liters/sec. and a guaranteed ultimate vacuum of 5×10^{-5} mm Hg, which reportedly improves with operation. This pump has a speed greater than the normal tubing connecting the tube to the pump and an ultimate vacuum better than the expected pressure in the tube before seal-off. Therefore, the use of such a mechanical pump should enable one to obtain the same degree of vacuum in the finished tubes as when the diffusion pumps are employed. Some advantages in using only a mechanical pump to evacuate TV tubes are: (1) low maintenance cost, since oxidation of high temperature oil is no longer a major factor, (2) no cooling water needed (3) increase in production speed since heating and cooling times of diffusion pump oil are eliminated (4) elimination of the cost of power for the diffusion pump heaters.

SUMMARY AND CONCLUSIONS

Calculations show that the pumping speed and ultimate vacuum obtainable from a good mechanical pump are such that a diffusion pump is not necessary in evacuating production TV tubes. The elimination of the diffusion pump should enable a reduction in maintenance and evacuation costs and speed up the production.

It seems highly desirable to put in operation a system using only a mechanical pump at one of the C-R tube factories to verify the above conclusions. A thorough test could be made quite cheaply.

RECOMMENDED ACTION

It is recommended that the following be done at the C-R tube factory at Syracuse or Buffalo:

1. Remove the present mechanical pump and diffusion pump from one or two "buggies."

2. Mount a good mechanical pump, as described above, on the buggy so that the throat of the pump occupies the same position as the former diffusion pump throat.

3. Use the same connection between the mechanical pump and tube as the former connection between diffusion pump and tube.

4. Put this modified buggy in the production line and process a number of tubes using the same time schedule as the other buggies.

5. Compare the vacuum of the tubes from the modified buggy and the standard buggies.

6. Secondly, enlarge and shorten, as much as possible, the pump-to-tube lead.

7. Compare estimated saving in time per cycle due to
   a) elimination of diffusion pump, and
   b) change in pumping lead.

REFERENCES

1. H. Moss, "Advances in Electronics II" Academic Press p. 1 (1950)

2. J. Strong, "Procedures in Experimental Physics" Prentice Hall, Inc. p. 99 (1945)

3. C. Dichter, private communication

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