

## A DEVICE FOR AUTOMATICALLY CONTROLLING THE CONCENTRATION OF GLYCOL VAPORS IN THE AIR\*

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Practical application of the fact that glycol vapors are capable of killing air-borne bacteria and viruses has been impeded by the lack of a method of controlling the concentration of these vapors in the air. Such regulation is necessary in any installation where human beings reside because of the relatively narrow margin that obtains between the concentration necessary for effective bactericidal action and the saturation level. If the glycol level exceeds the saturation point fogging of the atmosphere results. Although this condition is in no way harmful, as shown by toxicity tests involving exposure of both human beings and animals to glycol mists for prolonged periods (1), it is nevertheless undesirable from a psychological standpoint.

### *Method*

The first method by which we attempted to control the concentration of glycol vapor consisted in the focussing of a beam of light on a photocell 12 feet away. The photocell current was amplified and then made to control a relay which operated the glycol vaporizer. The presence of a fog so faint as to be unnoticeable to the eye was sufficient to decrease the intensity of the light reaching the photocell, to the point where the vaporizer was turned off. This method, though capable of great sensitivity was found to be unreliable in rooms where tobacco smoke or dust was present. These aerosols would affect the control device just as did a glycol fog and so would cause the vaporizer to be shut off.

A means of regulating the concentration of glycol vapors within a few thousandths of a milligram per liter or less was achieved by means of the following principle of operation: Glycol vapor in the air is condensed on a cooled surface in such a way as to interfere with the transmission of a ray of light. A photoelectric cell, responding to fluctuations in illumination intensity so produced, causes a glycol vaporizer to be turned on or off, depending on whether the air contains too little or too much of this material.

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Fig. 1 schematically presents the arrangement used. A light beam is focussed on to the polished, chromium-plated rim of a slowly rotating copper disc, and reflected therefrom into a photocell. This disc is 3 inches in diameter and one quarter of an inch thick and its lower third dips into a constant-level water bath. On each side of the disc is sewed a cloth wick which presses closely against the metal surface and takes up water from the reservoir below. The wheel is cooled by rapid evaporation of water from the wetted cloth wick, brought about by a current of air from a small fan. As a result, glycol vapor condenses on the polished rim of the wheel forming a fine film. The extent of this glycol condensation has been found to vary directly with the concentration of the vapor in the air.

By interference and scattering, this film of condensate diminishes the intensity of the light reflected into the photocell. Thus when glycol vapor is present in the air, the photocell output is reduced. This current is amplified by a single stage electronic amplifier, and is made to operate a relay which in turn controls the current to the glycol vaporizer. The amplifier voltage may be adjusted so that any desired glycol concentration can be maintained in the air. When this concentration is reached, the thickness of the film on the cool wheel is just sufficient to reduce the light reflected into the photocell to the point where the relay disconnects the glycol vaporizer. Then, as the concentration of glycol vapor in the air gradually diminishes, the extent of condensation also decreases and the amount of light entering the photocell begins to increase, ultimately reaching an intensity at which the glycol vaporizer is again turned on.

The portion of the wheel just emerging from the water is wiped clean by a piece of rubber which presses against the wheel's rim. Thus a fresh surface is continuously supplied on which condensation may occur. A large bottle of water connected to the bath by means of a constant-level device maintains the supply of water for the rotating disc.

A rate of 1/10 R.P.M. has been found to be satisfactory for the rotation of the wheel. This speed is achieved by further gearing down a 1 R.P.M. synchronous motor.<sup>1</sup> Four narrow, radial slots cut in the disc serve to diminish heat conduction from the lower part of the wheel which is at room temperature, to the upper part which is approximately at the temperature of the wet bulb thermometer. The small fan which directs an air stream over the disc serves the double function of cooling and bringing a fresh supply of glycol-containing room air to be impinged on the rim of the disc.

As a light source we have employed a 6 volt auto headlight bulb operating from the 110 volt line by means of a step-down transformer. A lens of about 5 cm. focal length focusses an image of the filament on the rim of the copper disc. A constant voltage transformer is necessary to stabilize the line voltage supplied to the lamp and the photocell. Otherwise variations in the 110 volt line distort the response of the instrument. A complete electrical diagram is presented in Fig. 2.<sup>2</sup>

This instrument (which has been named a "glycostat") can also be used to measure the glycol content of air directly. A voltmeter connected across the output of the 70L7 tube, as shown in Fig. 2, records quantitatively the degree of light extinction due to the film of condensed glycol. Once the instrument is calibrated these readings can be converted directly into degree of saturation of the air by glycol vapor. Calibration curves over a wide range of

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<sup>1</sup> Supplied by Leich Electric Company, Chicago.

<sup>2</sup> We are indebted to Dr. Russell Morgan of this department for suggesting the use of the 70L7 amplification circuit. The complete cost of the materials used in the construction of the instrument amounts to about \$60.00. A more compact and probably less expensive arrangement involving a simplified electrical system and a greater sensitivity is now being designed in cooperation with Dr. A. L. Chaney, Industrial Hygiene Division, Lockheed Aircraft Corporation, Burbank, California.

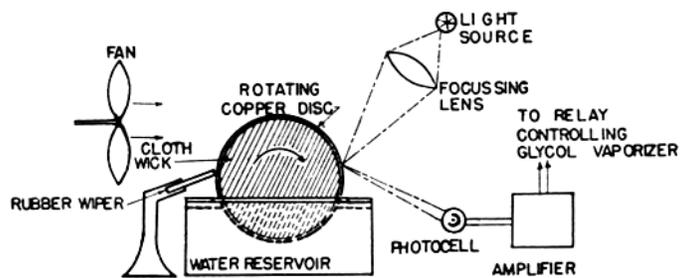


FIG. 1. Diagrammatic sketch showing the principle of operation. Condensation of glycol vapor on the cooled rim of the wheel forms a film which interferes with the reflection of the light beam into the photocell.

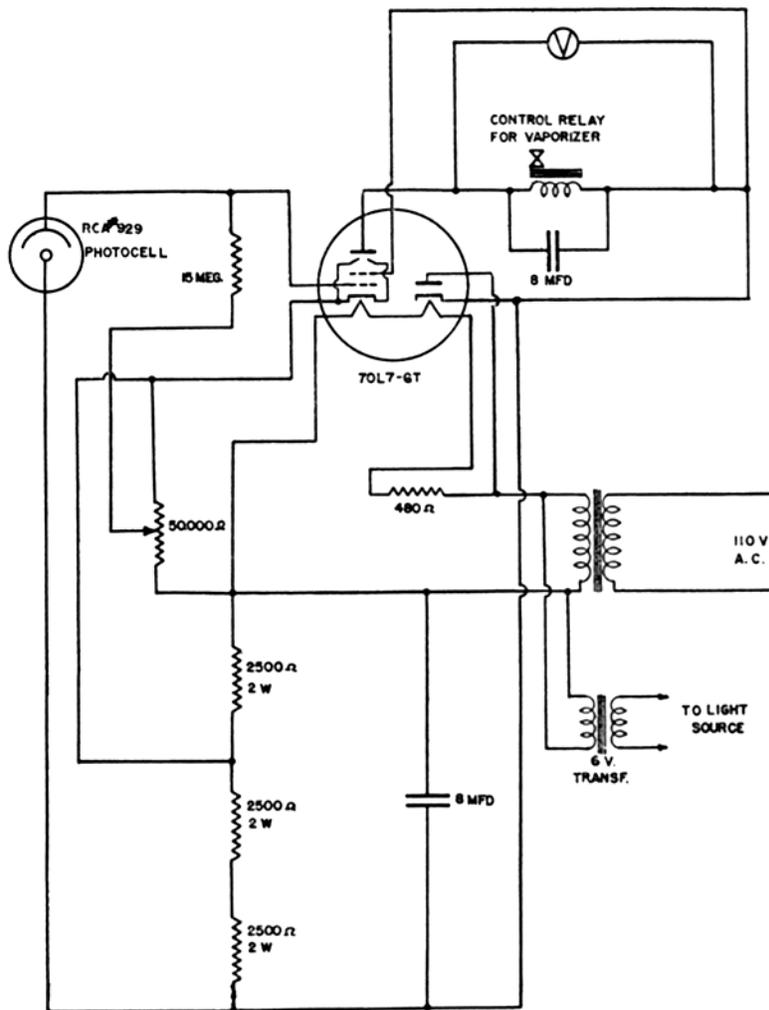


FIG. 2. Electrical circuit by which the photoelectric cell controls the output of the glycol vaporizer.

temperatures and humidities are being determined in this laboratory. Experiments have shown that the glycostat can be used for either propylene or triethylene glycols.

Such a method of determining glycol concentrations is not only much more rapid and convenient than the chemical one (2) but is also applicable to atmospheres containing high concentrations of dust or other foreign materials which interfere with the chemical analysis. The presence of even dense clouds of cigarette smoke have no effect on the reading registered by the glycostat.

#### DISCUSSION

The instrument here described has been developed for the purpose of maintaining the concentration of triethylene glycol vapor at a bactericidal but sub-fog level in inhabited rooms. To this end, it is necessary not so much to maintain a given concentration of a certain number of milligrams per liter, as it is to keep constant the degree of saturation of the air by glycol vapor. For, with a given glycol concentration a rise in room temperature would result in a lowered degree of saturation of the air with a consequent diminished bactericidal effectiveness (3). Similarly, a fall in temperature would result in supersaturation and fogging if the absolute amount of glycol were to be kept constant. The "glycostat" automatically compensates for changes in room temperature, since the photoelectric cell responds only to the extent of condensation of glycol on the rim of the cooled metal disc which in turn, depends directly on the degree of saturation of the glycol vapor in the air. A rise in temperature increases the capacity of the air to contain glycol vapor and, hence, less glycol condenses on the cooled rim of the wheel. This is presumably the very same process which is responsible for the decreased bactericidal efficiency of a given concentration of glycol vapor with increase in temperature; *i.e.*, a diminished extent of condensation on the bacterial droplet (4). Thus, the principle of the mechanism by which the glycostat regulates the vapor concentration is precisely the same as that which controls the bactericidal action.

Interference with the operation of the instrument because of condensation of water vapor on the rim of the disc can never arise because the lowest temperature which the disc can attain is that of the wet bulb. Since this always lies above the dew point for water vapor, it is impossible for water vapor to condense, no matter what relative humidity obtains.<sup>3</sup>

For best results the glycostat should be mounted in a location such that the air tested is fairly representative of the average glycol concentration in the room.

<sup>3</sup> Any other effect of changes in the relative humidity on the operation of the instrument will be small because two factors which operate in opposite directions, are brought into play. An increase in relative humidity increases the degree of saturation of glycol vapor in the air (5) and hence its tendency to condense. However, simultaneously the temperature of the metal disc rises because of the rise in the wet bulb temperature, so that the extent of condensation tends to diminish. Thus, these two factors tend to compensate for each other.

Otherwise, if mounted in a corner, for example, it may be responding to the conditions in an isolated air pocket.

The glycostat has been in operation in a hospital ward for a period of many weeks. During this time it has maintained the glycol vapor concentration at a sub-fog but adequately bactericidal level. These experiments will be described in a forthcoming publication.

#### SUMMARY

A device for automatically maintaining any desired concentration of triethylene or propylene glycol vapor in air is described. It can also be used to measure very rapidly the glycol content of room air. This instrument should greatly facilitate tests of the efficacy of glycol vapors in preventing air-borne infections.

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