Venting of Cigarette Smoke

In describing the selective venting of cigarette smoke, Anderson *et al.* (*1*) present a convincing, but unnecessarily complicated, demonstration that warm air rises. If a straight cylinder, open at top and bottom, were placed in a vertical position and warmed, one would expect the contained air to be warmed, to become lighter than the outside air, and to rise out of the cylinder, forming a current. This principle is applied in the construction of tepees, igloos, and stovepipes. Angulation of the cylinder as described would not alter the behavior of the air column. If, then, cigarette smoke is introduced with a "slow influx," one should expect it to be carried upward with the existing current of air.

While the observation reported is clear-cut and its mechanism is equally so, it is without pertinence to the distribution of lesions in emphysematous lungs. Two main points distinguish the intact lung from the heated Y tube and the dissected fume-fixed lung models. First, the bronchial tree is closed at its distal end, and thus there is no course from bottom to top for air to travel. Second, inhaled air is warmed, or cooled, to body temperature before it reaches the intrapulmonary bronchi (*2*), and so the temperature differential required in the models does not exist in the lung in vivo.

The implication that the selective distribution of centrilobular emphysema may be related to the phenomenon described by Anderson *et al.* is unlikely.

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My associates and I mentioned the hazard of unqualified translation of our results to human events. Pratt has posed specific points in this regard. Although valid questions may be raised, his critique, based on warm air, in tepees, igloos, and stovepipes is, we think, misleading.

Pratt was critical of the open ends of the passages. In the ductal system, as in man, pressure differences between proximal and distal ends provided impetus to the smoke bolus and air. This would remain true whether ends of air passages were open or closed. The major factor contributing to smoke buoyancy would be its relative density to injected (or inhaled) air.

We are aware that inhaled air is warmed quickly to body temperature. Therefore, to permit an appropriate exposure interval, routes through tubing and fume-fixed lungs corresponded closely in length and diameter to the routes in man. Although a tendency to equilibration certainly occurred in the circuits, significant differential undoubtedly persisted to levels of intrapulmonary bronchi. Smoke would not otherwise have retained sufficient buoyancy to seek upper channels. This in no way implies that attendant room air had not already achieved body temperature.

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Tidal Friction and Time

Pannella, MacClintock, and Thompson (*1*) have presented evidence that the rate of slowing down of the earth by tidal friction has varied through Phanerozoic time and have argued that this is due to the variations of the extent of shallow seas, resulting from continental drift and other changes in world geography. Their observational data consist of paleontological counts of the number of days in the month for various geological periods. However, it is well known that the dynamics of the earth-moon system cause a retreat of the moon from the earth as the earth's rotation is slowed down by lunar tidal friction. Thus, from Kepler's second law a lengthening of the month as well as a lengthening of the day takes place so that it is not a priori obvious, as Pannella, MacClintock, and Thompson suppose, that the rate of change in the number of days in the month should vary directly as tidal friction. It is desirable to show this explicitly.

The mechanics of the situation can be set down simply (*2*). The month (T') recorded by marine life must surely be the synodical month, as emphasized by Runcorn (*3*), and the length of the day (t'), the solar day. The length of the sidereal month (T) which enters dynamical calculations is given by $T = T'/[1 + (T'/Y)]$ where Y is the length of the year. Similarly the length of the sidereal day t is given by $t = t'/[1 + (t'/Y)]$ but this is very nearly equal to t'. The number of days (s) in the month recorded in paleontological specimens is therefore $s = T'/t' = T/t\ [1 - (T/Y)]$. If we suppose the universal constant of gravitation does not vary [though this is sometimes suggested, see (*4*) for review], then Kepler's 2nd and 3rd laws give

$$(T_0/Y_0)\cdot(Y/T) = T_0/T = (L_0/L)^3$$

where L is the orbital angular momentum of the moon and where the subscript zero denotes present values. We must leave open the possibility which most writers on this subject do not consider, that the moment of inertia of the earth has slowly varied during its evolution—but this is likely to be at a rate, so far as its effect on the earth's rotation is concerned, much smaller than the effect of tidal friction (*2*). Thus we can write

$$(1 + \beta)(L_0 - L) = (L_0/4.83)\,[(1 + dI/I_0)\,t_0/t - 1]$$

where β is the ratio of the solar to the lunar tidal frictional torque and dI is the decrease of moment of inertia since the geological period considered. The present ratio of the earth's spin momentum to the moon's orbital angular momentum is 1/4.83. Thus

$$1 + 4.83\,(1 + \beta)\,[1 - (L/L_0)] = \frac{[1 + (dT/T_0)(t_0/T_0)]\,s}{[1 - (T_0/Y_0)(L/L_0)^3]\,(L/L_0)^3}$$

If $L = L_0(1 - x)$ then the ratio of s to the present number of days in the synodical month

$$s/(T_0'/t_0) = [1 - (dI/I_0)]\,(1 - 3x)\,[1 + 4.83\,(1 + \beta)\,x]$$

As $\beta = 1/3$ or $1/5$ depending on whether tidal friction is nonlinear or linear, the fractional decrease in the angular momentum of the earth from past geological time to the present or the fractional lengthening of the day is equal to 0.40 or 0.43 respectively of the fractional decrease in the number of days in the synodical month, if changes in the moment of inertia are ignored.

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