Letters

Patent Assignment

Deborah Shapley's comment about Harold A. Rosen in her report "The Presidential Prize caper" (News and Comment, 8 Mar., p. 938) is somewhat ambiguous. She states that Rosen invented the synchronous satellite but "like most industry inventors, holds no patent on it." If she means that Rosen did not apply for or receive a patent, her statement is incorrect. Many patents have been issued in Rosen's name, quite a number of which are in the satellite field, including one applied for in 1959 on features of the synchronous communication satellite.

If Shapley means that, because Rosen is an industry inventor, his U.S. patent No. 3,396,920 (1968) pertaining to the synchronous communication satellite is assigned to his employer, who therefore "holds" it, that is not quite correct either. Although the patent application was initially assigned to the Hughes Aircraft Company, NASA took the patent under the National Aeronautics and Space Act of 1958 and now "holds" it on the grounds that the operability of the invention had not been successfully demonstrated until the Syncom satellite was operated in space under NASA contract.

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Applied Mathematics

With the financial support of the National Science Foundation, the National Council of Teachers of Mathematics and the Mathematical Association of America, through its Committee on the Undergraduate Program in Mathematics (CUPM), are engaged in producing resource materials for all the various applications of mathematics suitable for use by both teacher and student in mathematics instruction for grades 7 through 12, that is, the last 6 years of secondary school. Applications of arithmetic, elementary and advanced algebra, geometry, computing, and other more advanced topics are being worked on. In addition to the uses of mathematics in other disciplines, applications of mathematics in daily life and to skilled trades will be especially emphasized. Through hobbies or previous employment, readers may be familiar with special applications that might otherwise escape notice. We would appreciate suggestions regarding this project—sample problems, references, or any other suitable materials ranging from simple exercises to extended model building and mathematical development. Correspondence should be addressed to CUPM, Post Office Box 1024, Berkeley, California 94701.

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Fuel Economy and Emission Controls

Robert J. Naumann's letter (15 Feb., p. 595) on the consequences for fuel economy of auto emission standards is misleading on several points. He suggests, for example, that the approximately 30 percent increase in fuel consumption in recent model cars is due to emission controls. Widely reported data from the Environmental Protection Agency (*1*) indicate that only one-fourth to one-third of the increase is due to emission controls, while most of the rest is due to increased automobile weight (convenience and safety devices).

It is true that the Honda stratified charge engine has lower fuel economy than standard engines, but it should be mentioned that the Texaco version of this concept shows greater-than-standard efficiency. And to say that the automobile is "responsible for less than half of the pollution" may be true with today's emission controls, but prior to such improvements, the automobile was responsible in many areas for more than 90 percent of air pollution. To require large improvements in so gross a polluter hardly seems "arbitrary" or "disproportionate."

Finally, although I share Naumann's view that mass transit would be a step forward in urban areas, I do not share his optimism that money unspent by automobile buyers for emission controls could be used to finance mass transit. Nor do I believe that the dollar cost of lowered fuel economy cannot be weighed against the esthetic, physical, and health consequences of air pollution.

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References

1. Office of Mobile Source Air Pollution Control, Office of Air and Water Programs, *A Report on Automotive Fuel Economy* (Government Printing Office, Washington, D.C., 1974).

Naumann makes some surprising statements in the course of his argument that emission standards should be subordinate to fuel economy considerations.

First, he states that 1973 emission standards resulted in a average 30 percent increase in fuel consumption. I have seen lower estimates. Second, he assumes that a family-sized car weighs 4500 to 5500 pounds. However, the combined weight of our two "family-sized" automobiles, an Opel station wagon and a Volkswagen bus, is less than Naumann's minimum figure for one vehicle, and both average more than 20 miles to the gallon. Fuel consumption and vehicle weight are directly correlated; other things being equal, a 5000-pound car uses twice as much fuel as a 2500-pound car. Further, automatic transmissions and air conditioners on automobiles probably waste as much fuel as emission control devices (*1*). Third, Naumann makes the undocumented assertion that the automobile is "responsible for less than half of the pollution." He does not say what kind of pollution, nor does he define its domain; but in the next sentence he refers to Los Angeles. The auto is responsible for much more than half of the air pollution in Los Angeles; the Air Pollution Control District, County of Los Angeles, sets the figure at 90 percent (*2*).

The chief goals for automotive transportation at this point should be high fuel economy and reduced emissions. Since the automobile manufacturers do not necessarily subscribe to these goals, their solution to the emissions problem may not be the best one. Before abandoning the Clean Air Act, however, we should pursue paths the manufacturers apparently have chosen to ignore, such as reduction of weight, elimination of unnecessary accessories, and improvement of the fuel metering (*3*) or the combustion process (*4*), or of the engine itself (*5*). We should also take more of our short trips by bicycle or shanks' mare, since "... half the consumption of gasoline in autos occurs on trips of 3 miles and less" (*6*).

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References and Notes

1. R. E. Train, *Sci. Pub. Aff.* **29**, 43 (November 1973).
2. *Profile of Air Pollution Control in Los Angeles County* (Air Pollution Control District, County of Los Angeles, Los Angeles, Calif., 1971).
3. Various modified carburetors have been made, for example by W. Z. Kendig. See P. Michaels, Glendale [Calif.] *Ledger*, 29 and 30 December 1973, p. 1, sect. 1.
4. Several methods have been suggested; air injection by A. C. Nixon, *Science* **182**, 967 (1973); water injection in the Los Angeles *Times*, 16 February 1974, p. 1, part 2; and the use of alcohol (methanol) as fuel by T. B. Reed and R. M. Lerner, *Science* **182**, 1299 (1973). The Aerospace Corporation, El Segundo, Calif., also is pursuing the last method, which reduces carbon monoxide and lead emissions, allows higher compression ratios, and permits replacement of up to 10 percent of the gasoline with methanol (see *Ind. Res.*, February 1974, p. 42).
5. Honda's new engine, for example; reported, among other places, in *Bus. Week*, 24 February 1973, p. 70.
6. See P. H. Abelson, *Science* **182**, 339 (1973).

Naumann writes that thermal efficiency in automotive engines is incompatible with necessary reductions in nitrogen oxide (NO_x) emissions and concludes that we cannot build efficient engines that can meet pollution standards in urban areas. However, there are already in production automobile engines of high efficiency whose emissions of NO_x are low enough to be compatible with good air quality (*1*) and which have obvious potential for further reduction of NO_x emissions.

Two diesel-powered passenger cars tested by the Environmental Protection Agency (EPA) have shown emissions of hydrocarbons (HC) and carbon monoxide (CO) less than one-half the maximum limits specified by the Clean Air Act of 1970 (*2*) for 1976, with emissions of NO_x less than 1.5 grams per mile (*3*). A slightly modified version of one of the tested cars showed HC and CO emissions of less than one-third the 1976 limits. These cars were not equipped with any auxiliary devices for reduction of emissions. They showed fuel economy in miles per gallon that averaged more than 60 percent higher than the average of 1973 model gasoline-powered cars tested by EPA in the same weight classes (*4*).

The tested cars were not competitive with gasoline-powered cars in acceleration, quietness, or weight of power plant, but these are the kinds of problems that yield to engineering development, and almost no effort has been directed toward the development of a light-duty, lightweight diesel engine for exclusive use in passenger cars (*5*). An adequately powered car with such an engine would operate at a lower average load factor than the underpowered cars tested, and it must be assumed that it would have lower NO_x emissions and somewhat lower economy, because both efficiency and NO_x increase as load factor increases.

The diesel engine is the only alternative to the gasoline engine that is entirely compatible with existing vehicles, transmission components, and production facilities, so a gradual and orderly changeover to diesel-engine production could be accomplished without problems. A study (*6*) of the oil industry's potential for increased production of automotive diesel fuel indicates that the balancing of outputs of gasoline and distillate fuels would not present problems until the passenger-car consumption of diesel fuels was approximately the same as the consumption of gasoline. This would be when the proportion of diesel-powered cars was about 60 percent of the total, which would take at least 7 years even if we were to change over to 100 percent diesel production tomorrow morning. This would leave plenty of time for the development of new fuels, additives, and processes, so that it is hard to predict what the ultimate optimum mix of diesel- and gasoline-powered passenger cars would be.

The diesel and gasoline engines are like Jack Sprat and his wife in their appetites for octane numbers—the gasoline engines can tolerate no low octanes and the diesels can tolerate no high octanes. It is safe to predict, then, that whatever the optimum mix of diesel- and gasoline-powered cars, there should be available enough high-octane clear stock to satisfy the needs of the gasoline-powered cars. This would permit the complete elimination of lead from motor fuels without decreasing the yield of motor fuels from crude oil, and without large investments in additional refining facilities (*7*). If we had 60 percent of our passenger cars powered with diesel engines, we would accomplish a 20 percent saving in our consumption of motor fuel and an even greater saving in our consumption of crude oil, an objective worthy of some effort.

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References and Notes

1. Air Pollution Control Office, Environmental Protection Agency, *Air Quality Criteria for Nitrogen Oxides* (Government Printing Office, Washington, D.C., 1971). Measurement methods of ambient NO_x and transfer coefficients for the computation of emission standards are complex and not yet firmly established. Standards for NO_x are presently being reviewed, and 1.5 grams per mile has been set as an interim standard. Levels of NO_x and oxidants (HC and CO) are to some degree complementary in their effects on air quality, from which it is concluded that, with substantial reductions of oxidant emissions below the original limits, some increase in NO_x can be tolerated.
2. The Clean Air Act of 1970 specifies maximum emission limits of 3.4 grams of CO per mile, 0.41 gram of HC per mile, and 0.4 gram of NO_x per mile, effective 1976 (now 1977).
3. *Exhaust Emissions from Three Diesel-Powered Passenger Cars* (Report 73-19 AW, Emission Control Technology Division, Office of Air and Water Programs, Environmental Protection Agency, Ann Arbor, Mich., 1973).
4. In the 3500-pound inertia-weight class, the fuel consumption was 23.6 miles per gallon for the Mercedes-Benz 220 diesel (the average for gasoline-powered cars tested was 14.0); in the 3000-pound class, the fuel consumption of the Opel Rekord diesel was 23.8 (the average of gasoline-powered cars was 16.2). For a Mercedes diesel with added dampers on the fuel lines, the fuel consumption was 24.6 miles per gallon.
5. In separate unpublished presentations in 1972 to the Advisory Committee for Advanced Automotive Power Systems, Council on Environmental Quality, W. B. Schwab, vice president of engineering for the Cummins Engine Co., and Rex Robinson, director of research for the Caterpillar Tractor Co., two leading independent producers of diesel engines, stated that it is feasible to produce a passenger-car diesel engine that weighs between 4 and 5 pounds per horsepower.
6. "Potential increased production of automotive diesel fuels" (Study Contract 70-68, Refinery Process Division, M. W. Kellogg Co., Houston, Tex., prepared for the Office of Air and Water Programs, Environmental Protection Agency, Washington, D.C., 1972).
7. Panel on Automotive Fuels and Air Pollution, U.S. Department of Commerce, *Automotive Fuels and Air Pollution* (Government Printing Office, Washington, D.C., 1971), pp. 19–22.

Blended Fuels

Gaylord B. Castor (Letters, 22 Feb., p. 698) comments on the use of ethyl alcohol as a substitute for gasoline. Many methods for the use of lower-carbon alcohols as fuels in internal combustion engines have been suggested in the patent and the scientific literature. The letter from William H. Smyers (22 Feb., p. 698) attests to