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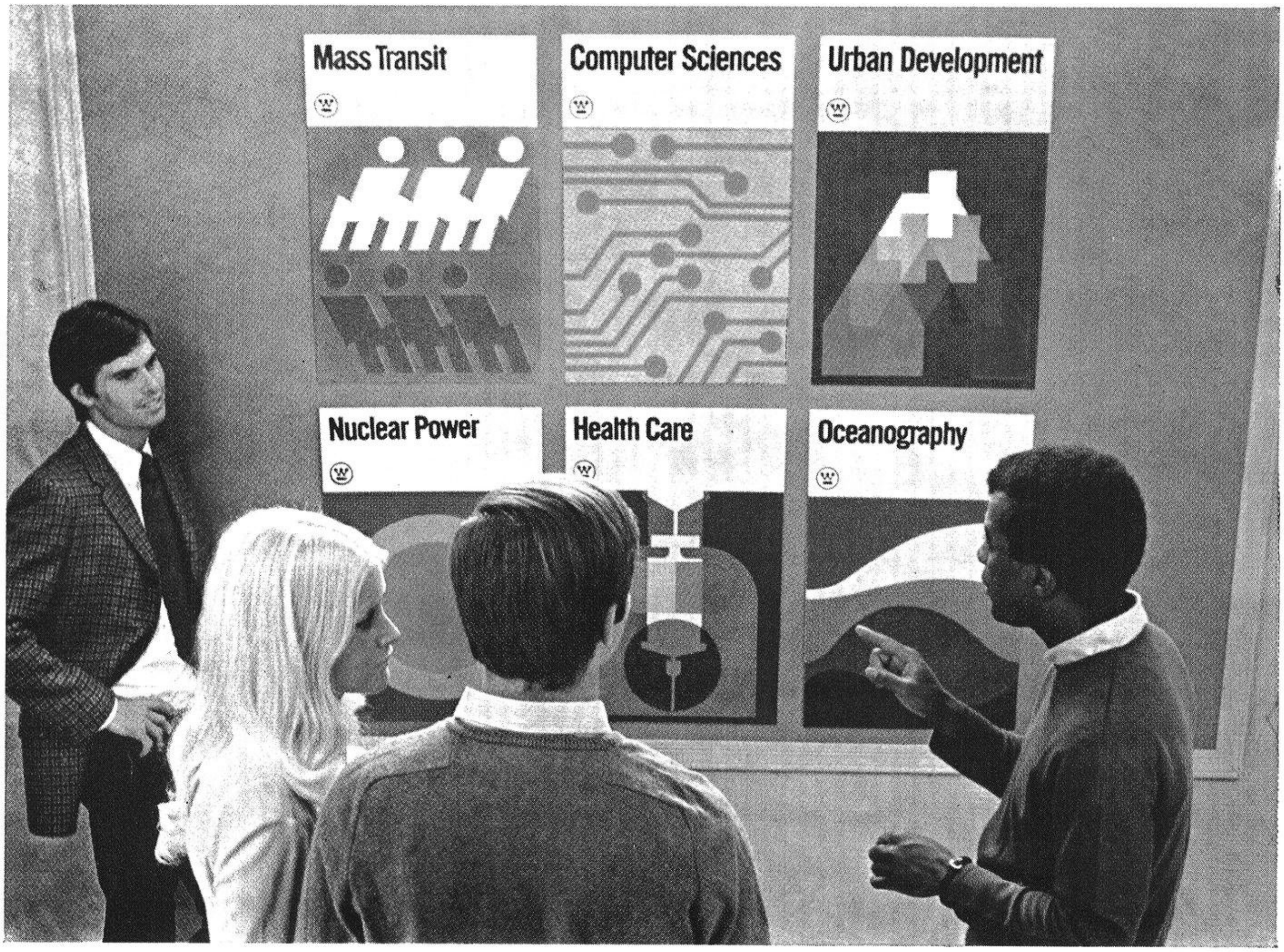
VOL. 75, NO. 1

35 CENTS OCTOBER, 1970

wisconsin engineer

If you want to engineer a better world...



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if you work for a company like this.

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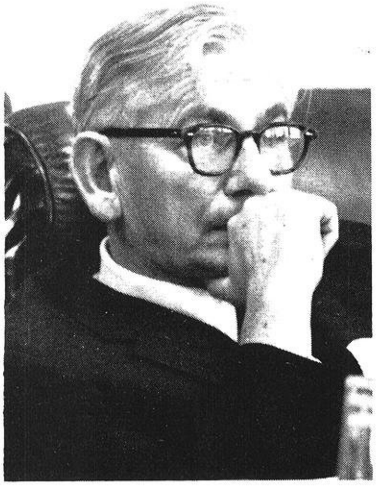

A Report from Chancellor Young

The initial wave of shock and horror which we felt on August 24 is being experienced fresh each day on Charter Street.

Thousands of students have passed the area and wonder what the ugly scars of this tragedy signal for the coming year.

The immediate costs of the bombing have already been published – the cost in human life, suffering, knowledge, and property. The long-range effects may not be known for years, but it is no exaggeration to say that they will depend almost totally on how we react – regents, administrators, faculty, and student body.

It is the intent of terrorists to create fear. To harass. To intimidate. The student who fears for his physical safety is not expected to be in a mood for effective classwork. A faculty member whose home has been threatened with rocks or firebombs may be understandably more reticent to speak his opinions in the future. An administrator who has watched funds being diverted from educational to security needs may be tempted to wonder if peace at any price is not desirable.

When we are attacked – either men or institutions – our first instinct is to fight back. And we will fight back. But the nature of the fight is all-important.

For the answer to fear is not panic. The answer is not to lash out in angry, blind vindictiveness. The answer is fear is really quite simple – the answer to fear is courage.

In the coming year, we will concern ourselves with the past. We will continue to expend whatever energy is necessary in cooperating with the lawful authorities to bring perpetrators of violence to justice. Not in any attempt to set a vengeful example, but because we believe that the orderly administration of justice is basic to the freedom of us all.

We will be concerned about the past—but we will be even more concerned about the future. In facing that future, what form must our courage take?

More than the courage to keep the University open—although we have said many times, we do intend to keep it open.

We must also seek the courage to progress; to proceed with the orderly change and reform of the University which has already begun. For the danger to our institution does not arise strictly from one source. Destroyers of lives and buildings are obvious menaces who can and must be dealt with under the law.

But there are others who threaten. Those who would react by demanding certain beliefs as a requisite for faculty status – they are a threat to the University, also.

They are a threat because they would destroy the atmosphere of free and untrammeled thought without which no university can remain great.

Those who demand that student voices be silenced by arbitrary and oppressive disciplinary methods – they are a threat; because they refuse to recognize the vigorous and positive contribution the vast majority of today's young people are capable of making to the academic community. A loss of this resource would be tragic to any university.

Those who propose such extreme measures are acting out of fear – without courage.

We believe it is possible to deal with advocates of violence, to punish those who put their theories to practice and break the law, to stand firm against attempts to disrupt and destroy – and at the same time, proceed with enlightened and responsible programs for change.

For this to be done, we must have the energetic cooperation of all – regents, administrators, faculty, and students. This cooperation already exists in substantial degree, but it must be heightened.

Committees exist in many departments to solicit the ideas and talents of the students to apply to academic problems. Others are being formed.

One hundred and forty combined faculty-student committees are now in operation, but we need new and better ways for helpful interchange between these two groups.

It is time to reexamine faculty-student relations on a broad level. The proportion of emphasis given to graduate and undergraduate instruction. The size and nature of undergraduate classes.

Individual faculty members will want to examine carefully the expenditures of their energies – the proportion of time given to research versus that given to teaching and student contact.

The Board of Regents has probably had more direct contact with faculty and students than any board in the University's history. It has recognized the urgent necessity for such contact and undoubtedly will seek additional ways to achieve it.

The board, in its forceful statement of August 26, made clear its determination to stand up to the forces of terrorism and, at the same time, preserve our traditional role as a forum for free exchange of ideas and opinions. It needs and deserves the strong support of the legislature and the citizens of the entire state in carrying out this objective.

By having the courage to move forward in spite of disruption and lawlessness, we can harness the enormous reserves of genuine human concern and channel them to constructive purposes.

We must make clear that those of us who are responsible for the operation of the University are not interested only in budgets, rules, and applied research. That we are also personally concerned about the terrible problems of national and world society – environment, racism, war, population growth, and all the rest. That we are willing to help devote the resources of the University to finding solutions to those problems.

We must encourage students to participate in the politics of their government. We must understand that theirs is a special problem, in that their residence on campus usually means they are unable to participate in the campaign activities of their own districts. The University has indicated that it does not consider a two weeks recess to be the proper solution, but a faculty-student committee is currently seeking other methods by which students may be encouraged to participate in the selection of their government. [A committee report was made to the faculty Senate October 5] The year ahead is implicitly a critical year for us all. And yet an atmosphere of crisis can be a positive thing. [On the September 9 television news], a hostage in the Jordanian desert was asked if the passengers were friendly with each other. He replied, "In a time of crisis like this, everyone relies on everyone else – and everyone seems to come through."

In its crisis, the University needs to be able to rely on courageous support from its alumni, its friends and, above all, from the members of its own community. Only with such support can it stand solidly against terrorism and move with imagination to new standards of greatness. If it gets such support – and I am confident it will – there is no way the forces of intimidation can prevail.

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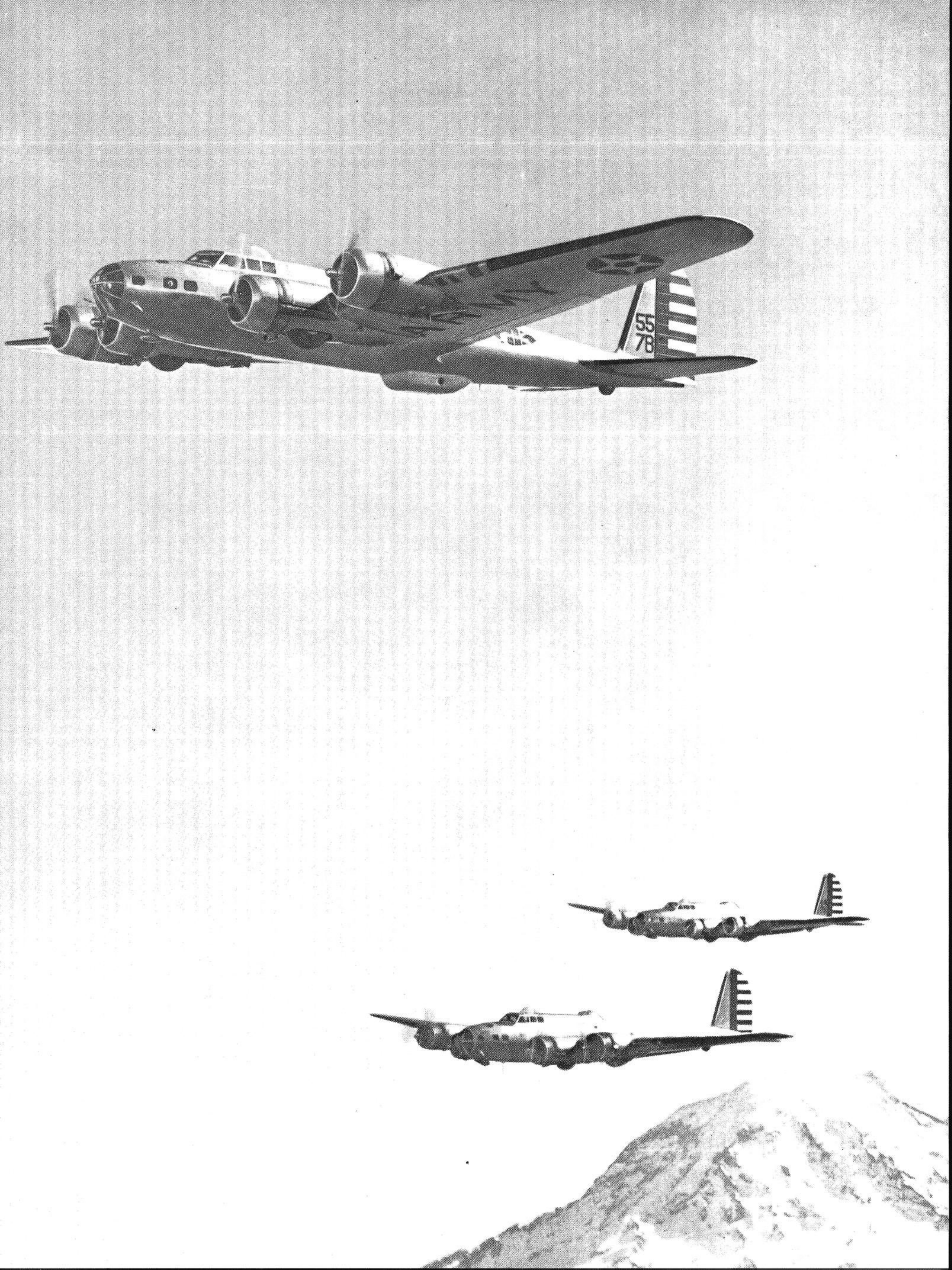
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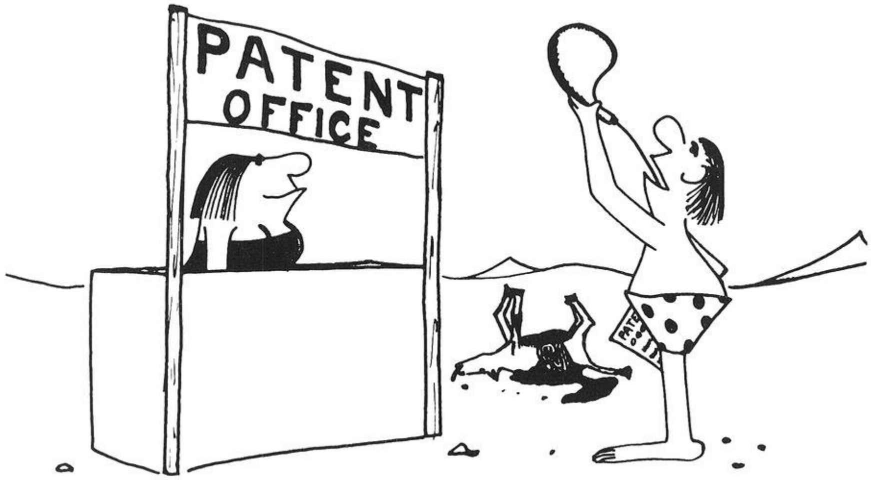
How to Obtain a U.S. Patent



During the reader's efforts to solve the world's environmental, economic and social problems though technology, many intriguing ideas or inventions may have been encountered.

This article, written by William Hess, now with Sunstrand Aviation in Rockford, Ill., provides valuable suggestions for the protection of the invention and the inventor so that the maximum benefit may be obtained.

Ed.

The protection granted by patents is of vital importance to engineers. Many engineers may some day decide they have an idea or invention which is useful, practical, and saleable, and will want to patent their invention to assure maximum compensation. Or an employer may wish to patent work done for his company and the engineer will be involved in the patent proceedings. Consequently, it is necessary that an engineer be aware of the basic idea of patents and the steps involved in obtaining a patent.

The granting of a patent by the United States Patent Office represents a great deal of work. The layman would have a difficult time doing all the necessary research to determine if he has a valid claim for a patent and successfully completing the application to insure that he will receive his patent. Although the law doesn't require that an inventor hire a patent attorney, almost all patents are obtained with the assistance of qualified patent attorneys. Thus, the purpose of this report is to give the inventor a basic idea of patents and the steps he must go through to get his invention patented in the United States. The report will not include a detailed account of the work of the patent attorney or an explanation of patent laws.

When an inventor receives a patent, he has the opportunity to profit by the manufacture, sale, or use of his invention in a protected market or to profit by charging others for making or using it. Patents granted for the invention of new manufacturing processes, machines, or compositions of matter run for 17 years from the date the patent is issued. A patent on ornamental design may run for 3½, 7, or 14 years as desired by the patentee. Patents may not be extended except by a special act of Congress and this seldom occurs except in unusual circumstances.

After the patent expires, the inventor has no more control of the use of his invention. Anyone has the free right to use it as long as he does not use features covered in other unexpired patents.

The Patent Office does not help prosecute infringements on rights granted by patents. It has no jurisdiction over questions relating to the infringement of patent rights. If a patent is infringed, the inventor must sue the infringer in the appropriate United States Court at his own expense. In a case of infringement, the claimant is entitled to recover damages if he can prove his case. Patent laws give the courts power to grant unjunctive relief when proper and also to increase any verdict against an infringer up to three times its original amount.

The granting of a patent does not protect the inventor against claims of others who assert that he is infringing on their patents when he makes, uses, or sells his own invention. There may be a patent of a more basic nature on which an invention is an improvement. If an invention is a detailed refinement or feature of a basic protected invention, it may not be used without the consent of the patentee of the original invention. No one can use the improvement, however, without the consent of its patentee.

The patent laws provide that any new and useful art, machine, article of manufacture, composition of matter, design, or an improvement of any of these may be patented if it involves invention. Such as:

1. A new improvement for any known machine or apparatus which makes it more efficient.
2. A new combination of elements or parts which in themselves is old.
3. A new improvement for any known article which makes it more useful.
4. A new process or method.
5. A new compound.
6. A new composition of matter or a new design

These are just some specific examples of the types of things that may be patented. However, invention must always be involved.

Anyone who has invented something patentable may obtain a patent. There are no restrictions regarding age, sex, place of residence, or nationality.

The issuance of a patent is no guarantee of commercial success or economic value of the invention. The Patent Office concerns itself only with the question of patentability. The inventor must still make his invention a commercial success after he receives his patent if he is to profit by it.

The first step to take before applying for a patent is to make sure the invention is useful, practical, and saleable. Re-emphasing, no one will profit from an invention just by patenting it; the invention must be sold or used. Therefore, the inventor should assure himself of this before he spends money for patenting.

The second step is to prepare good records in the form of sketches and drawings or written descriptions of the invention immediately after the idea is conceived. Trustworthy persons should read the records and then sign and date them as witnesses. A dated record of other steps taken in working on the invention should also be kept and witnessed.

The third step in the patent process is to search through patents already issued to insure that the invention is really new. This should be done for several reasons: it is cheaper to make a search of existing patents than to try to obtain a patent if the invention can not be patented, this step will save money; also, earlier patents may be better ways of doing a job than the new invention – therefore a patent on a new invention would be worthless.

This search for existing patents is made in the Search Room of the Patent Office in Washington, D.C. The inventor may do this himself if he wishes, but most inventors hire patent attorneys to make this search, since a proper job requires both skill and experience. The Patent Office has a list of all registered attorneys who are available to prepare and prosecute patent applications for inventors.

If, after the patent search is made and the inventor decides to continue, the next step is to file a patent application. This formal application describing the invention and petitioning the Commissioner of Patents to grant a patent is sent to the Patent Office.

The patent application will include the petition, a power of attorney, and an oath in which the inventor swears that he believes that he is the first inventor of the invention. These are called the formal papers, the application must contain a description of the invention, which is called the specification, and a definition, which is called the claims. The application must also contain a drawing if the invention can be illustrated. At one time, the Patent Office required models, but this is no longer mandatory except in unusual cases.

The specifications and claims of a patent application must be carefully prepared. The patent specifications must give a description of the invention that is sufficiently full and clear to teach someone skilled in invention to make and use the new invention. The patent claims must uniquely distinguish the new invention from all other inventions so that no other claims can be granted by the Patent Office on the same or similar inventions.

Every inventor has the right to prepare his patent application and presecute it himself. But, considering the importance of strong patent protection, it is usually better to employ a registered patent attorney.

The final step in obtaining a patent takes place in the United States Patent Office. The Patent Office examiner will read the application to insure the invention has been properly and sufficiently described. Then another search will be made of earlier patents and printed publications to find those claims most closely related to the features or the invention.

After the search, the examiner will decide if the new claims should be rejected. Then, the examiner will write to the inventor informing him of acceptance or, most commonly on the first try, rejection. The reasons for rejection will also be explained.

Patent Office correspondence must be answered by letter to the Commissioner of Patents within six months or the patent proceedings will be dropped. Assuming rejection, the inventor's letter may direct that some of the original claims be cancelled and it may change the language of other claims; in any case, the letter must give reasons that the patent should be accepted. This letter is called an amendment.

After the Patent Office examiner receives the amendment, he will again study the application and take additional office action. This may be a notice of acceptance and granting a patent, or it may be a rejection of all claims, or it may be

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Campus Degredation

The following paper was presented as a class project by a team of authors for a course entitled Environmental Resource Management taught by Prof. Clay Schoenfeld.

Submitted by: Don Holt, John Daniel, Vicki Gutgesell, David Jasperson, Joan Peters, Cary Scott, Dorothy Watts and Gerald Ziemer.

We are interested in finding out how the inhabitants of the campus — the students, faculty, and staff — feel about the intrusion of the buses in their world. We feel that perhaps the buses have been passively accepted as part of the environment by most of the community. Our survey evaluating these findings will be presented shortly.

At present the Regents of The University of Wisconsin maintain a continuously running contract with the Madison Bus Company. The bus company takes complete care of the maintenance and repair of the buses. Although the buses do have mufflers, some of which are quite aged, they lack any other pollution control devices for air or noise. The actual amount of waste materials in the exhaust has not been measured.

Mr. John Erickson of the Physical Plant feels that noise and air pollution are not a general concern. The consensus in the Physical Plant is that the bus sytem is necessary and is here to stay. Other systems have been suggested but none seriously.

Dr. Van Potter of the Campus Planning Committee indicated a different attitude toward the bus system. The Committee has passed resolutions condemning the pollution generated by the buses. They have recommended that Observatory Drive remain closed in order to limit traffic on central campus and have also suggested that traffic be limited to the Union, Langdon st., South East Student Area, and other peripheral areas of the campus. They are considering the use of Housing and Urban Development funds to establish a prototype transportation system from the Union to Van Hise. A committee of the Ecology Students Association is also investigating the bus problem.

In order to evaluate student and staff attitudes toward the campus buses, we conducted a poll. Of the 276 respondents, 40% were at least fairly regular bus riders. On a value scale consisting of 10 pairs of opposites, the responses reflected a general negative attitude toward the buses — they were regarded as unpleasant, dirty, noisy, dangerous, obnoxious and so forth. However, the most significant result was that 70% felt that they are very necessary, and only 38% would support rerouting traffic to peripheral streets.

Over ¼ indicated that their classes had been disrupted by noise from the buses, and virtually every building along the bus route was cited as a place of disturbance.

In the questionnaire we stated that anti-pollution and noise reduction devices are available and are in use in other cities. Out of 4 action alternatives, 58% preferred to add the anti-pollution devices, 17% to eliminate all buses from the central campus; 6% wanted to wait for a new transportation system, and 5% felt that we should do nothing. Over four-fifths of the people questioned indicated that they would support a campaign to persuade the bus company to adopt these devices. This support included signing petitions, writing letters, being on committees, boycotting the buses, picketing, demonstrating, promoting educational programs on air pollution, and attempting to have state and municipal anti-pollution ordinances passed.

Although everyone would benefit from a quieter, less polluted atmosphere, only 1/3 felt that the financial burden for these devices should be distributed equally over the campus population in the form of fee increases or salary deductions. Only 35% would be willing to have their fees increased. Over 1/2 thought that the devices should be paid for strictly by increasing bus fares, passes, and parking permits. Other suggestions for financing these devices included city taxes, government subsidies for all buses, campaign contributions, parking fines, and direct revenues from legalized marijuana.

With respect to other campus problems, the bus problem placed 4th in urgency behind pollution of Lake Mendota, litter, and pollution by the heating plant.

Our interpretation of these results is that students view campus buses as a necessary evil and that although the problem is not considered as pressing as others, something should be done about it now.

We have therefore examined three fundamentally different approaches to solving the problem of bus pollution. We have considered:

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Goodbye, lake.

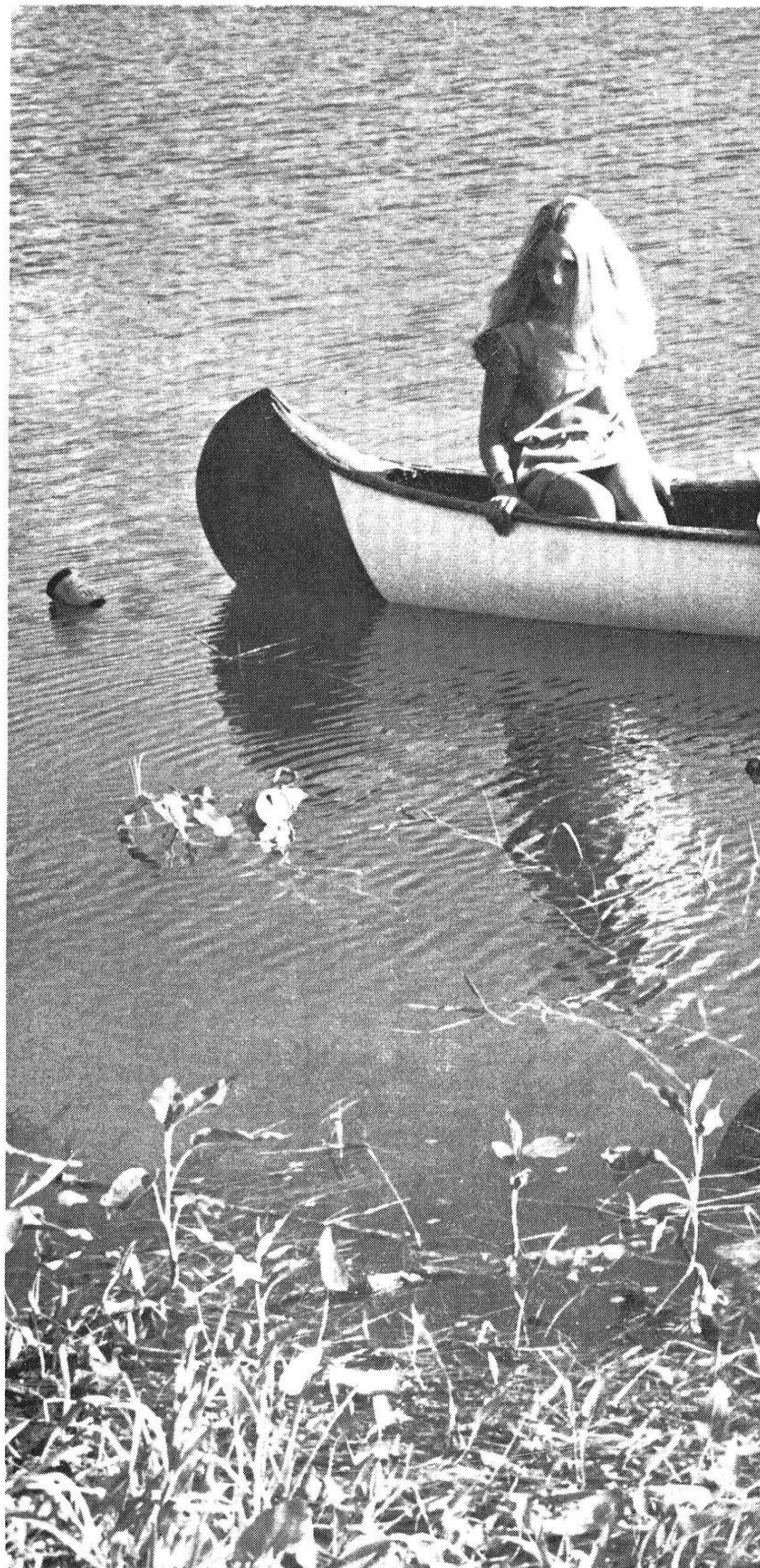
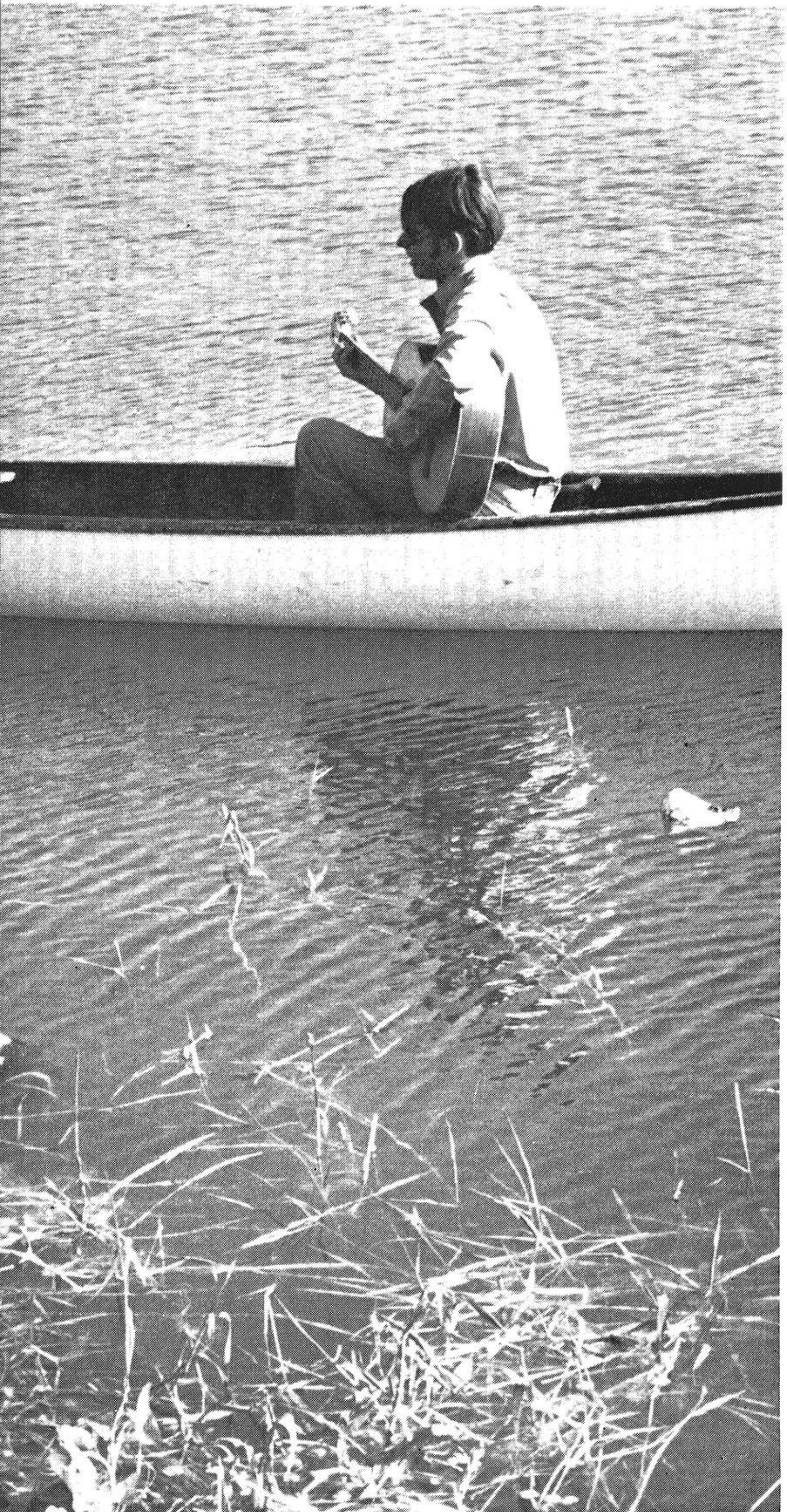


PHOTO: JOHN HARRISON



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another rejection of some claims and an allowance of others. The exchange of office correspondence and amendments is continued until the application is accepted or a complete rejection is made.

If the patent application receives a final rejection, it may be appealed to the Board of Appeals of the Patent Office which consists of eight Examiners-in-Chief, the Commissioner of Patents and three Assistant Commissioners. Any three of these make a quorum and have the power to review and determine the justice of the primary examiner. The decision of the primary examiner to reject an application is often reversed by the Board of Appeals.

An adverse decision by the Board of Appeals may be further appealed to the Court of Customs and Patent Appeals. Appeals aren't necessary very often and aren't advised unless the appeal appears certain of success and the inventor will receive a large advantage if the appeal is won.

The time needed to prosecute a patent application is not fixed. It may range from several weeks to several years depending on the condition of business in the Patent Office and the prosecution necessary to obtain the proper claims.

The cost of obtaining a patent consists of two parts, the attorney fees and the government fees. The fee of a patent attorney for preparing and filing patent applications depends entirely upon the amount of time, study, and skill necessary. Government fees are $30 for the filing fee and $30 for the final fee for patents on mechanical, electrical, process, chemical, or plant patents. Government fees for design patents are $10 for 3½ year protection, $15 for 7 years, and $30 for 14 years. Some inventions can be protected only by design patents while others may need mechanical, electrical, etc. patents. Many inventions require both design and a mechanical patents to receive full protection.

It is not contended that an inventor must patent his invention; he has the common law right to enjoy the benefits of his invention exclusive of the rights granted by statutory provisions. That is he may keep his invention a secret and not apply for a patent, but once the general public learns of the invention, the protection is ended. Therefore the inventor should not rely on his limited common law protection, but should go through the patent process to receive full protection.

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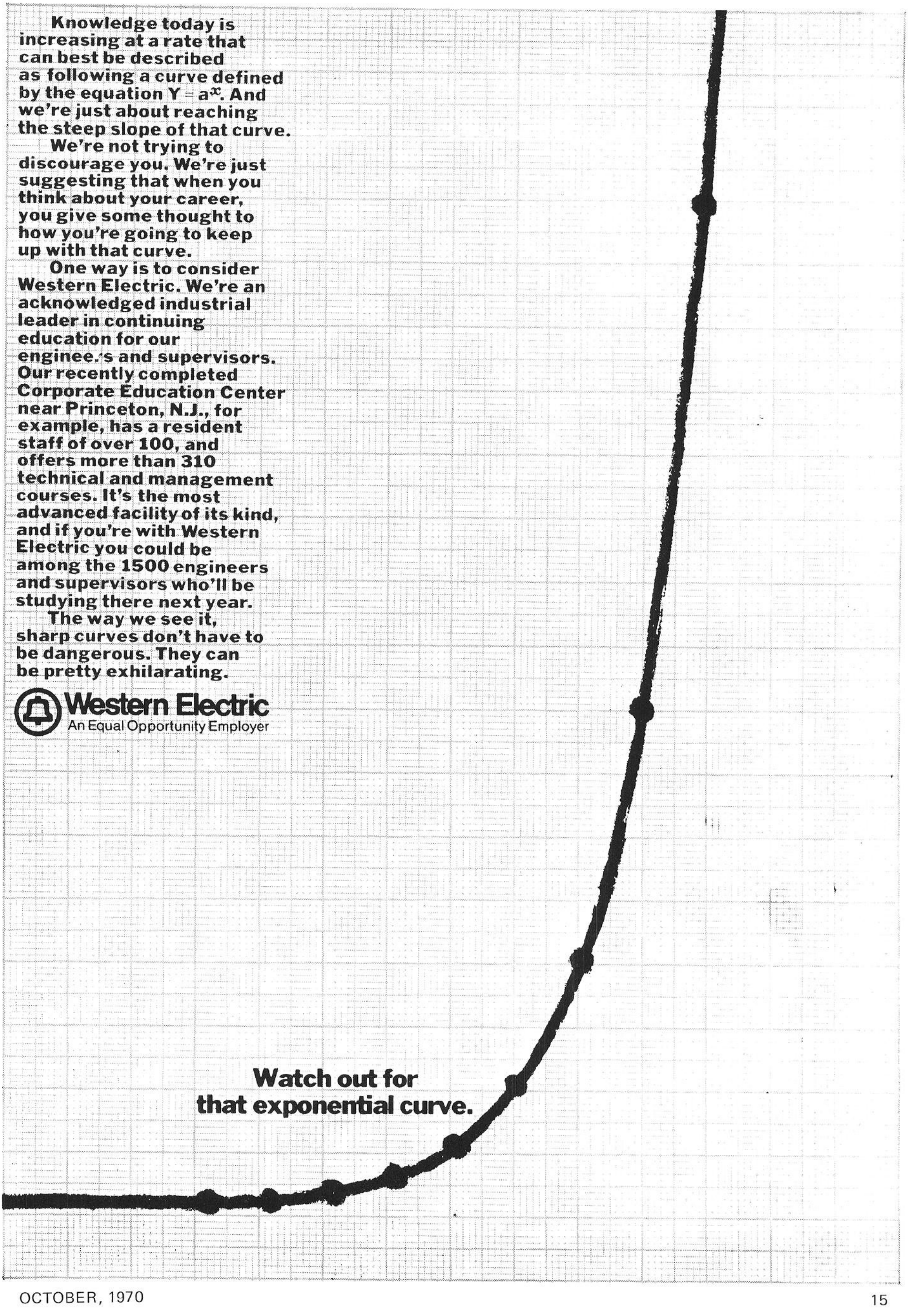
Knowledge today is increasing at a rate that can best be described as following a curve defined by the equation $Y = a^x$. And we're just about reaching the steep slope of that curve.
We're not trying to discourage you. We're just suggesting that when you think about your career, you give some thought to how you're going to keep up with that curve.
One way is to consider Western Electric. We're an acknowledged industrial leader in continuing education for our engineers and supervisors. Our recently completed Corporate Education Center near Princeton, N.J., for example, has a resident staff of over 100, and offers more than 310 technical and management courses. It's the most advanced facility of its kind, and if you're with Western Electric you could be among the 1500 engineers and supervisors who'll be studying there next year.
The way we see it, sharp curves don't have to be dangerous. They can be pretty exhilarating.
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Watch out for
that exponential curve.

clean air car race

by
H.W. Sigworth, Jr., B.D. Peters,
P.S. Myers and O.A. Uyehara

The 1970 Clean Air Car Race, sponsored by the Massachusetts Institute of Technology and California Institute of Technology, was an intercollegiate competition intended to stimulate interest in low pollution vehicles. All types of propulsion systems were eligible to be entered into one of six separate classes provided they were driven by students, could meet minimum performance levels and 1975 Federal exhaust emissions levels. The race score included fuel economy, performance, dependability, but was weighted heavily towards exhaust emission levels.

The University of Wisconsin entered two vehicles in this race. One car was a 1970 Lotus Europa using unleaded gasoline incorporating exhaust gas recirculation, exhaust manifold air injection, two catalytic mufflers and a thermal reactor. The second car was a 1969 Opel GT powered by LP-gas and modified to use exhaust gas recirculation and a catalytic muffler. These two cars obtained exhaust emission levels that were substantially below the values obtained with the unmodified vehicles.

The University of Wisconsin cars were successful in this competition. The Opel came in sixth out of nineteen cars in the gaseous fueled internal combustion engine class. The Lotus was third in a class of thirteen liquid and multi-fueled internal combustion engine cars. In addition, the Lotus was selected by a panel of five judges to be one of the five best cars in the competition. This selection was based on the car's performance, practicality, emission levels and ingenuity of its design.

The race results led to several observations. Only five of the thirty-two internal combustion engine cars competing in the race met 1975 standards using cold start constant volume sampling test procedures. Gaseous fueled internal combustion engine's in general had slightly better emissions during cold start test procedures than liquid fuel cars with the one methyl alcohol car being a possible exception. The electric, electric hybrid and turbine cars generally had lower race scores in the competition than the internal combustion engines. However, because of their complexity, most of these cars required further development time.

Prior to entering the 1970 Clean Air Car Race, students at the University of Wisconsin conducted an informal study to determine what type of vehicle propulsion system would in theory obtain the maximum score in the competition. Based on the preliminary set of rules which were obtained in March of 1970, it was felt that one would want a vehicle with the lowest possible emissions capable of continuous operation at approximately 60 mph with minimal energy consumption. Also, it appeared that the more performance one had the better one would do in the pre-race testing. Since minimum energy consumption and maximum performance require opposite approaches, it was necessary to compromise.

With these objectives in mind, various types of power schemes were studied. Because of the requirement that one travel approximately 600 miles each day and maintain a speed above 45 mph (for interstate highway driving) it was felt that an all electric car using current batteries was not desirable. Fuel cell power for an electric car looked good in theory, but was not developed to a state where fuel cells could be used dependably and purchased at a reasonable price. It appeared that the hybrid electric approach might yield a desirable type of low emission vehicle. However, it was felt that too much development time would be necessary to make an efficient and dependable automobile which would surpass modified current production vehicles.

With pure electrics and hybrid electrics eliminated from the list, internal and external combustion engines along with some unique schemes were reviewed. Rankine cycle engines were dropped from consideration because of their low thermal efficiency and because they generally have an oxide of nitrogen problem in their exhaust. The Sterling engine offered high thermal efficiency but no engine of the necessary size was available. The gas turbine was eliminated due to its lower thermal efficiency and a possible oxide of nitrogen problem. It was finally decided to use a spark-ignition engine. This choice yielded an engine with reasonable thermal efficiency, dependability, availability, and potential for very low exhaust emissions.

The choice of a fuel was made from hydrocarbons, alcohols, and hydrogen. A hydrogen-oxygen combination has the distinct advantage of negligible emissions but it was felt that it should not be used because of safety problems. Alcohols were eliminated because of their low heat of combustion which would require a large fuel capacity to yield a satisfactory vehicle range. Consequently, it was decided to use a hydrocarbon fuel. A gaseous fuel was desired over a liquid fuel because of the potential advantage of better fuel distribution in the engine. Also, a fuel with a low reactivity was desired because of the reduced smog forming potential of the unburned hydrocarbons in the exhaust. With these points in mind, the choice was narrowed to natural gas and LP-gas. LP-gas was selected because a cryogenic container would not be required to obtain a suitable vehicle range.

Once the decision to use a spark-ignition engine operating on LP-gas was made, the next choice was that of a car to use. It was decided to use a new or nearly new car to obtain a dependable chassis and the latest safety features. Because of the way race points were to be given, a small car with good fuel economy and performance appeared to be the logical choice. Many cars were examined and the final choice was a 1900 cc Opel GT. This vehicle has reasonably good handling, moderate weight (2109 lbs.) reasonable performance, and above average fuel economy. In addition, the availability of parts for this car is better than other foreign cars examined.

After selecting the car and fuel, the emission control devices were selected. It was decided to try to operate the car lean enough to obtain reduced oxides of nitrogen and carbon monoxide. In addition to the lean operation, exhaust gas recirculation and a catalytic muffler were selected for installation.

The vehicle chassis was left unchanged and radial ply tires were used.

Modifications

The alterations made to the basic car included the installation of a LP-gas fuel system, intake manifold modifications, widening the valve seats, and adding exhaust gas recirculation and a catalytic muffler.

I. LP-Gas Conversion

The conversion to liquified petroleum gas required installing a LP-gas tank, new fuel lines, a fuel filter, solenoid valve, regulator, and a gaseous fuel carburetor (Figure 1). In addition to this new

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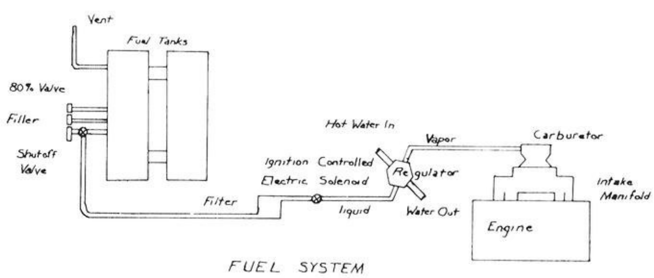


FUEL SYSTEM

FIGURE 1

Photography by W. Eugene Smith.

(Continued from Page 10)

New and revolutionary transportation concepts for future use now under development;

New power sources, as well as old ones such as steam, which are now being tested.

Anti-pollution devices to disarm the internal combustion engine, which are already available.

One of the new transportation concepts for the near future is the minibus, pioneered in Washington, D. C. It holds 19 people, is relatively quiet, and is useful as a shuttle bus.

A novel system of roller roads has been developed by the Westinghouse Corporation to carry automobiles over metropolitan commuter routes at 75 miles per hour and across open country at speeds up to 150 miles per hour.

A Transit Expressway, especially well suited for cities too small for conventional railway commuter lines and too large to be efficiently served by buses, has also been designed. Lightweight automated vehicles operate singly or in trains on lightweight aerial roadways. The cars resemble buses and run on 4 pairs of rubber tires. This sytem, being tested in Pittsburg, operates 24 hours a day and is controlled by a central computer.

Other revolutionary transportation systems include transit trains which ride on air cushions and are propelled electrically; underground electric trains; and the flying bus which is carried by helicopter.

Coupled with these new transportation schemes and more important in the long run for pollution abatement, are new approaches to fueling and power, many of which are sponsored by grants from HUD.

Possible power sources for the future include electricity, steam, freon, fuel cells, and solar cells.

The power source for the electric engine consists of a battery system and an electric motor. Presently known battery systems, however, cannot provide a reasonable traveling distance between rechargings or enough power to compete with gasoline.

The steam engine consists of a water boiler, a steam piston motor, a radiator to condense the steam to water, and numerous pumps to feed fuel, steam and oil into the engine. This engine can supply a car with sufficient horsepower by increasing the capacity of the boiler and the steam pressure. However, with this sytem, huge quantities of steam must be condensed to water.

In order to overcome this problem, a freon-vapor drive propulsion system is being tested in Dallas. This system utilizes a steam engine in which freon vapor drives the pistons, rather than steam. Both a 125 horsepower engine for propulsion and a 45 horsepower engine for air conditioning and braking are used in each bus. Since the engine is a closed circuit unit, virtually no air pollutants are emitted; it is also considerably quieter than the internal combustion engine.

Another power source is the fuel cell used by astronauts. Because it involves liquid or high-pressure oxygen and hydrogen, cost, storage, and safety are major problems.

Other alternatives include a solar cell relying on radiant energy and a heat engine which uses thermo-electric principles.

One anti-pollution device now available is the fuel additive, which "neutralizes" unburned hydro-carbons emitted by the internal combustion engine. This cover-up – rather than solution – comes in three scents – pine, lavender, and rose, and has been used successfully in Detroit and London.

The catalytic muffler, a much more important means for promoting the oxidation of unburned hydro-carbons, uses chemically coated ceramic pellets. It is presently being evaluated in NYC buses.

Other means of reducing exhaust include recirculation of exhaust gases, exhaust suppression devices, and afterburners.

Aluminum covers damped with fiber glass reduce the noise of diesel engines when fitted closely over the engine surface.

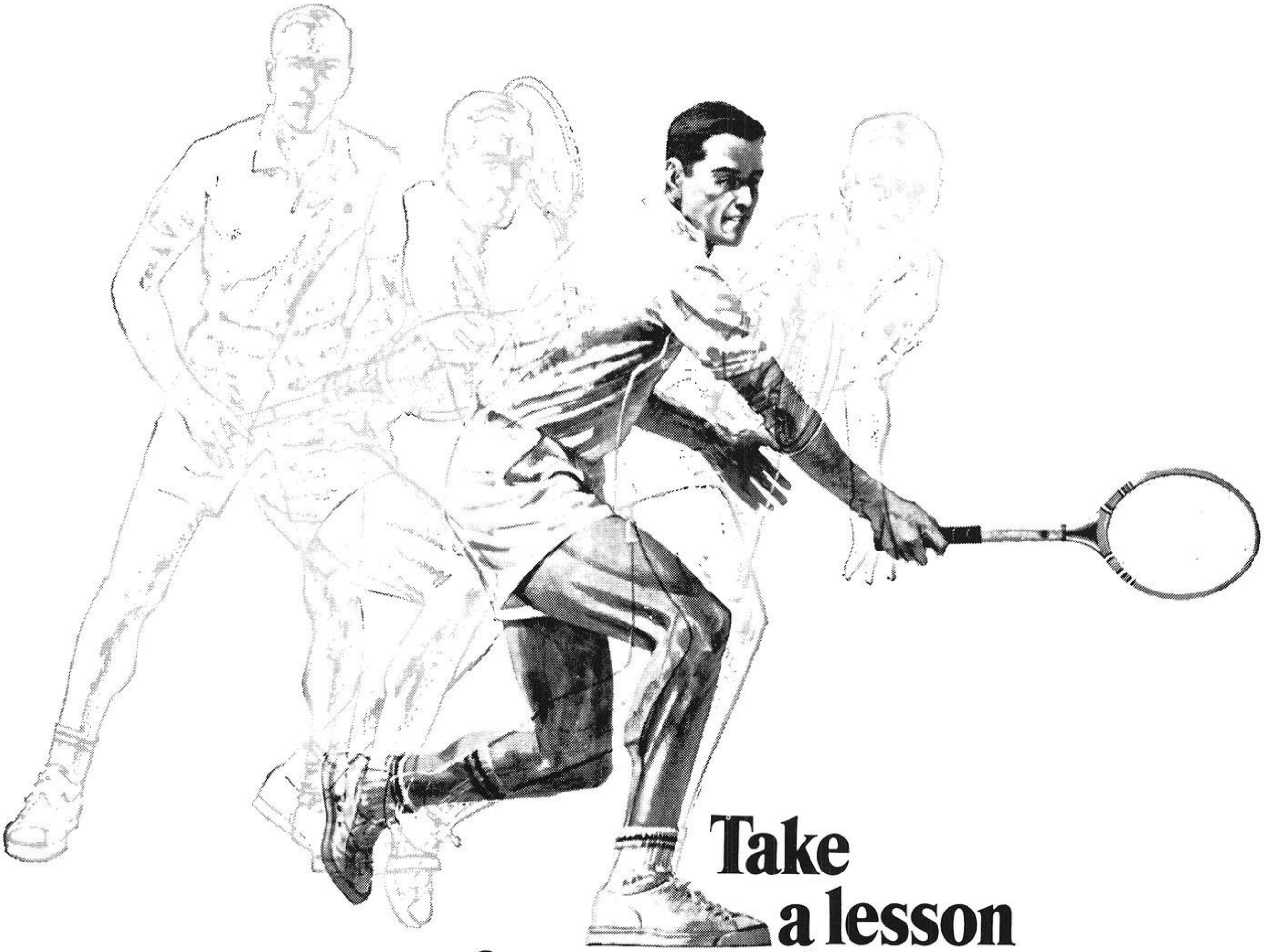
Although buses have been eliminated entirely from the Berkeley campus, this alternative, and that of re-routing, are not in favor on our campus at the present time. In view of our research and the results of our poll, Team One therefore recommends that afterburners and noise suppressors be added to the campus buses at once. Purchase and installation of afterburners is approximately $200 per bus; we suggest financing this project by fare increases since 60% of the respondents indicated that they would be willing to pay 5 - 15c more per ride.

We look forward to a power source which produces little noise or pollution. Internal combustion engines are passe. With steam powered and electric engines just around the corner, we recommend that budgeting begin now for the purchase of these buses of the near future.

In closing, we would like to leave you with this thought. A campus community is composed of many systems and sub-systems. Here in Madison we have a grading system, a research system, a social system, an athletics system, a communication system, and a transportation system. As stated in **From Sea to Shining Sea**, "The goal of all these systems should be a total environment capable of satisfying the broadest range of human needs. The effects of activities within each of these systems must be evaluated for its influence on all other systems constituting the environment."

Our bus system therefore should be measured not merely for its efficiency in moving people, but also for its effect on the total compus environment.

[***]



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A tennis champion's powerful backhand looks as smooth and unhurried as a ballerina's graceful bow. How's he do it? By being in the right position in plenty of time.

"Remember this about the backhand," the pros advise. "Get both feet around pointing toward the sideline. And always make sure the right foot's forward, so your body doesn't cramp your swing."

Getting into proper position early is good advice for college seniors, too. Here's the first step:

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(Continued from Page 17)
equipment, the heater in the intake manifold was removed and the valve seat width was increased.

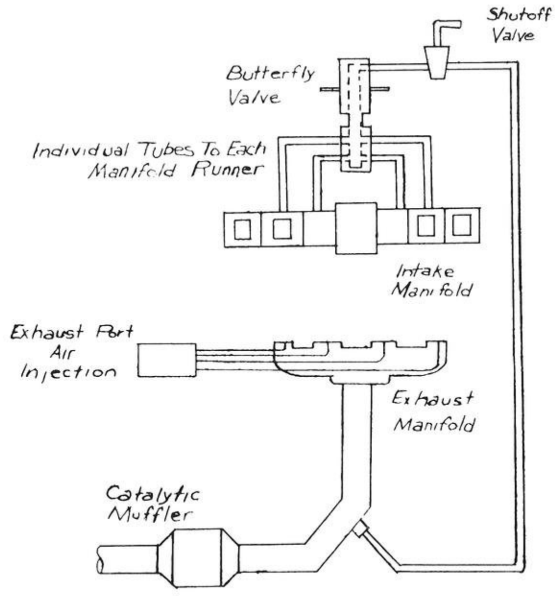
A Brunner manifold type fuel tank comprised of two 10-inch diameter by 35-inch long cylindrical tanks was installed transversely in the rear of the vehicle in the location previously occupied by the gasoline tank and the spare tire. The liquid fuel, 80% vent, and filler lines were then connected with wire braided hose to fittings mounted on a panel under a fold-down rear license plate. The vapor relief line was connected to a plate on the rear deck to enable any gases in the relief line to be vented outside the vehicle. Finally, a sheet metal bulkhead was installed between the passenger compartment and the compartment containing the fuel tank.

The fuel filter, regulator, and gas carburetor were all standard Ensign brand products manufactured by the American Bosch Co. The regulator was a water heated two-stage unit. The carburetor was a 1½-inch throat diameter model which is calibrated to deliver a 17 to 1 air-fuel ratio up to air flow rates approximately 300 lb/hr. At air flow rates above this level, the mixture gradually became richer to improve the power under heavy loads.

The stock aluminum intake manifold had a series of fins that were inserted into the attached exhaust manifold to act as a heater for the incoming fuel-air mixture. Since this heater was unnecessary and unwanted when using LP-gas fuel, it was removed. This was accomplished by milling off the fins and covering the remaining hole in the exhaust manifold with a steel plate. A stainless steel radiation shield was then inserted between the milled off intake manifold and the plate on the exhaust manifold. This work was designed to keep the incoming fuel-air mixture cooler and thus improve the volumetric efficiency of the engine. The final alteration performed in the LP-gas conversion was to increase the valve seat width on both the intake and exhaust valves from approximately 0.060 inch to 0.080 inch. It was felt that by using LP-gas fuel, the valve seats would probably not become partially coated with deposits as sometimes occurs when seats are widened. When this happens, it could prevent the valve from closing all the way and thus burn the valve. Since the danger of this problem was thought to be small, it was felt that the extra heat transfer from the valves with the wide seats would be worth the risk to prevent valve seat regression which is a problem on engines operating on unleaded fuels.

II. Exhaust Gas Recirculation

Exhaust gas recirculation was used on the car to help reduce the oxides of nitrogen. A diagram of the system is shown on Figure 2. The exhaust gas was taken out of the exhaust pipe just upstream from the catalytic muffler and routed by tubing in front of the radiator to a shut off valve, which also adjusted the maximum amount of recirculation. From the shut off valve the gas passed through a butterfly valve which was operated by a linkage connected to the carburetor throttle (Figure 3). This butterfly valve shut off the recirculation at idle and wide open throttle. The recirculation was shut off at idle to improve engine smoothness and at wide open throttle to improve maximum power. From the butterfly valve, the gas was passed through a manifold that directs the flow to the four runners of the intake manifold through individual tubes. The gas was then injected upstream in the intake manifold to obtain good mixing with the fuel-air mixture.

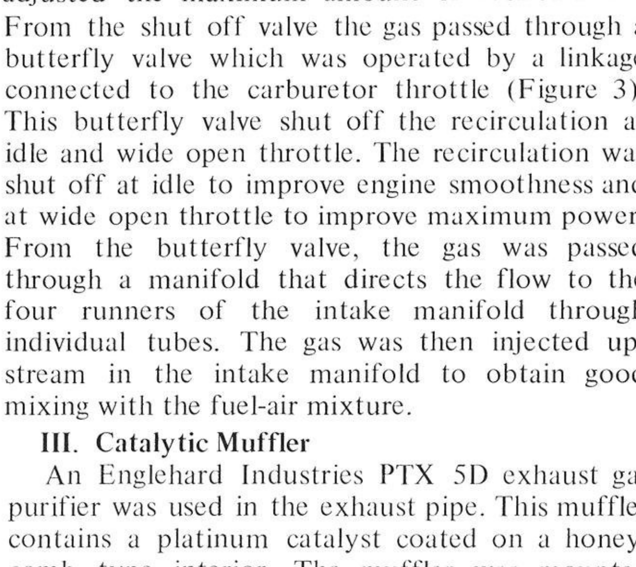


EXHAUST RECIRCULATION SYSTEM

FIGURE 2

III. Catalytic Muffler

An Englehard Industries PTX 5D exhaust gas purifier was used in the exhaust pipe. This muffler contains a platinum catalyst coated on a honeycomb type interior. The muffler was mounted approximately 18 inches from the exhaust mani-



BUTTERFLY VALVE AND LINKAGE FOR EXHAUST RECIRCULATION

FIGURE 3

fold which has exhaust port air injection and was followed by the conventional Opel GT exhaust system of a muffler and resonator.

Conclusions and Results of Modifications

The intention of the Opel design was to operate the engine at an air-fuel ratio of 22 to 1 to obtain low NOx concentrations with little or no exhaust gas recirculation. This technique was tried successfully in conjunction with retarded ignition timing and the catalytic muffler. However, immediately before the race started it was found that a form of oil was sometimes in the LP-gas that was used and this tended to enter through the carburetor in drops causing the engine to occasionally misfire. It was found that if the air-fuel ratio was decreased to around 17-to-1 the problem of misfires diminished. Since this problem wasn't discovered until a few days before the race it was decided to operate the car at an air-fuel ratio of about 17/1 and use the maximum amount of exhaust gas recirculation that the recirculation system would provide. As a consequence of this decision the emissions increased over the smooth running car operating at the 22 to 1 condition. The emission levels obtained are tabulated in Table 1.

The performance of the car in the raced condition was considerably down from the unmodified car. The 0-60 mph time increased from around 12 seconds to 18 seconds. The fuel economy obtained was approximately 25 miles/gallon of LP-gas (LP-gas has about 15% less energy per gallon than gasoline).

In conclusion, it appears that with some more developmental work to eliminate the misfires at air fuel ratios around 22/1 and further optimizing the distributer advance curve, which was not modified, the Opel exhaust emission levels could be reduced to the proposed 1980 Federal levels.

The teams would like to thank these sponsors for their contributions and interest in the Clean Air Car Race: Zimbrick, Opel GT and parts; Wisconsin L.P. Gas Assoc., cash; General Motors, Chevelle station wagon chase car; American Bosch, carburetion; Englehard Mineral & Chemical (Newark, N.J.) catalytic mufflers; Brunner Engineering and Manufacturing (Bedford, Ind.), L.P. gas tanks; Skelgas (Madison), fuel, oil, and L.P. conversion equipment; Standard Oil of California, Lotus and fuel; International Harvester, Travelall chase car; Pride Motors (Madison), discount on Lotus price.

[***]

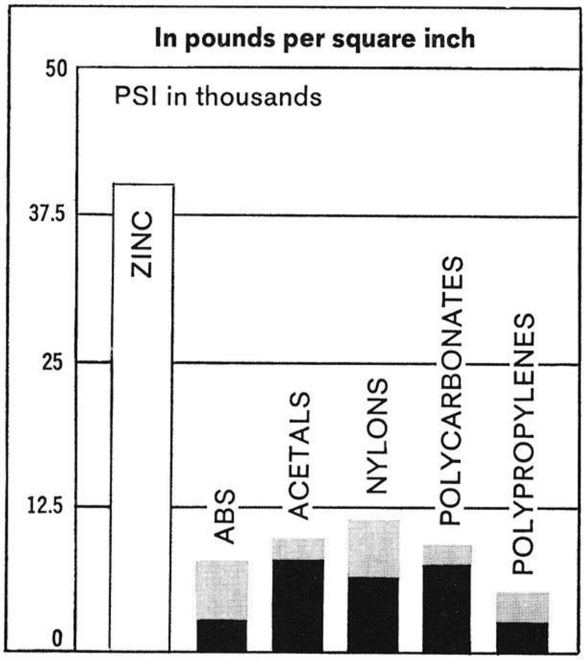
	Concentrations in grams/mile		
	HC	**CO**	**NOx**
Before modification using gasoline	**2.1**	**12.1**	**5.1**
After modification A/F – 22 to 1	**0.11**	**0.59**	**0.46**
In Race Condition A/F – 17 to 1 and exhaust gas recirculation	**0.5**	**0.6**	**0.75**
Proposed 1975 Federal Standards	**0.5**	**11.0**	**0.9**
Proposed 1980 Federal Standards	**0.25**	**4.7**	**0.4**

TABLE 1*

***These values obtained using the 1970 Federal Test Procedure.**

BASIC DESIGN DATA—Zinc Die Castings vs. Plastics

Tensile Strength



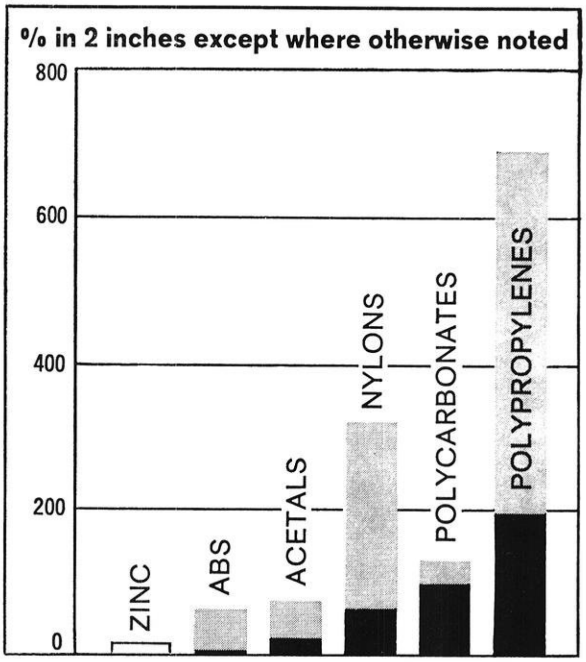
ZINC DIE CASTINGS	TENSILE STRENGTH—psi	
	As Cast	After 20 yrs.
Alloy SAE903, ASTM AG40A, No. 3	41,000(1)	32,000(2)

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	TENSILE STRENGTH(3)—psi	
	As Molded	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3,500- 8,800	Not Available
ACETALS { Homopolymer, Copolymer	8,800-10,000	Not Available
NYLON (Type 6, 6/6, 6/10)	7,000-12,400	Not Available
POLYCARBONATE (Unfilled)	8,000- 9,500	Not Available
POLYPROPYLENES (Unmodified Copolymer)	2,900- 5,500	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

Elongation



ZINC DIE CASTINGS	% ELONGATION 2 in.	
	As Cast(1)	After 20 yrs.(2)
Alloy SAE903, ASTM AG40A, No. 3	10	14

Source (1) ASTM B86 (2) Reports of ASTM Comm.

SOME PLASTICS USED FOR INJECTION MOLDING	% ELONGATION 2 in.	
	As Molded(3)	After 20 yrs.
ABS { High Impact, High Heat Resistant, Medium Impact	3—60	Not Available
ACETALS { Homopolymer, Copolymer	25—75	Not Available
NYLON (Type 6, 6/6, 6/10)	60—330	Not Available
POLYCARBONATE (Unfilled)	100—130	Not Available
POLYPROPYLENES (Unmodified Copolymer)	200—700	Not Available

Source (3) Modern Plastics Encyclopedia- 1969-70

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Or, better yet, a noisy one.

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