banqueted and honored at a gathering of scientists and interested people. He was honored for his achievement in extending our knowledge in physics in a brilliant piece of work. After the meeting was over and the man in question had retired to his hotel room a reporter knocked at his door to request permission for an interview for the publication of the physicist's personal story.

Invited into the room, the reporter said that he felt very timid in the presence of such a great genius. The physicist replied that if the reporter intended to use the word "genius" he would withhold his permission to publish. The reporter agreed to the request.

He told the reporter that while conducting his experiments for his PhD thesis he noticed a strange phenomenon unconnected with the purpose of the thesis. He became so interested in this situation that his adviser warned him that he had better "get back on the track" or his time would run out and he would not be granted his degree. Heeding his adviser's warning he went back to work, completed his assignment successfully and was granted his degree.

Taking a position on the faculty of a university he was permitted to continue his work on his unexplained phenomenon. He told the reporter that he had spent something like five hours every day thinking, experimenting and studying. There were a succession of failures and new efforts. Finally, after many years, the pieces of the puzzle fit together and he published his findings. His classical comment: "If I had been a genius I could have solved the problem in a day. . . "

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Solar economics

In their paper on solar power (February, page 44), the Meinels state: "The central problem is economics." Perhaps because it was intended to emphasize physics, they devote only one rather confusing paragraph to the economics. I have attempted to work their problem "backwards" but come to some conclusions that do not agree with theirs.

Solar input to one square meter is one kilowatt when the collector is normal to the sun's rays on a clear day. Assuming use of tracking mechanisms on the collectors, about eight hours of such collection can be achieved per day. Using the Meinels' figure of 330 clear days per year, the annual average input per square meter is 0.3 kW. At their assumed efficiency of 30%, this produces 0.1 kW of electric power. At $60 per square meter, the cost of the collecting system is $600/kW, about twice that of nuclear plant using a light-water moderated reactor. The cost of the steam generator, the turbo-generator, and the steam condensing and recycle equipment must be added to this. This would run about $200/kW more. We thus have about $800/kW total capital costs. With the Meinels' economic ground rules, this comes to 10.5 mills/kWh for the power cost at the generator. The cost of the collector-storage system alone would be 8 mills, somewhat more than the 5.3 mills taken as a target.

The actual situation may be considerably worse than this. J. E. Rink and J. G. Hewitt (*Proceedings 1971 Intersociety Energy Conversion Engineering Conference*, Boston, Mass. pp. 15–22, August 1971) by an examination of Arizona weather records concluded that, because of the successive cloudy days that would be encountered during winter, the collection area and energy storage capacity should be increased by a factor of 8.8 rather than the 3.3 used in the analysis above. In this case, the collector-storage system cost would rise to $1600/kW of electric power and the contribution to the power cost would be 21 mills/kWh.

It would be interesting to know what the cost of a collector-storage system would be if it were built today. How much improvement will be required to meet the Meinels's target cost, or the even lower costs that may be required in view of the above?

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THE AUTHORS COMMENT: Paul Gast focuses upon several points that in brevity were either omitted or only briefly discussed. The costs we quote refer to "fuel" costs, since only the source of energy has been changed. Our figure of 5.5 mills/kWh should therefore be compared to 5.0 mills/kWh for the cost of natural gas when used as fuel for a power plant. The cost of the generating equipment and heat exchangers are common to both energy fuels and additive to the final bus-bar cost of the power. Our cost figures say that solar power will cost not twice that of a nuclear plant, but more like three times as much at a unit cost of 60 $/m^2.

As for the winter-weather situation, if one makes the size of the solar collector large enough to meet the winter power demand there are three consequences:

- Increased collector area
- Increased thermal storage capacity
- The need for a rapid recovery of the energy in storage (before the next cloudy period occur), which also amplifies the

continued on page 50

letters

continued from page 15

first point.

If one meets these problems by increasing the collector area, one is faced with a very large excess energy capacity most of the year. In our more sophisticated system model we compromise on collector size, so that the summer excess power can produce just enough storable chemical fuel for supplemental winter use. We have explored novel chemical fuels such as granular aluminum, burning it in winter and re-electrolyzing the collected aluminum-oxide ash back into aluminum the following summer. In fact there are quite a few options that need to be explored in the area of recyclable storable chemical reserve fuels.

We have proposed construction of a test loop of sufficient size to answer some of the engineering and economic questions raised by Gast and hope to see this done in the next year.

Obviously our proposal for solar power farms will benefit from more study. Already the input from many people has contributed to maturing of the concept. We are encouraged to think that either solar power will soon become a reality or laid aside as one of the few dreams of mankind that will forever remain a dream.

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Union threat

Physicists have always shrunk in horror from the idea of becoming "union labor" with its obvious limitations on a profession, such as equal pay for unequal ability. What is less often discussed is that the union's bargaining power does not begin to be felt in a market where plenty of nonunion labor is available. The British and American Medical Associations have for many years maintained an active interest in limiting their own total intake of qualified practitioners and in enforcing "union" membership without damage to their image of being dedicated to the interest of Mankind. In America they have also achieved this without enforcing a uniform pay scale. They continue to restrict their numbers despite a national shortage of doctors.

Although I am still personally opposed to this idea, I am wondering when we physicists and engineers will wake up to the fact that this kind of action is necessary for our survival. Without control over our own numbers we have become overpopulated, and now have the public image of being unnecessary. I was provoked into writing by a letter that appeared in last year's June issue of the (British) *Physics Bulletin*, reproduced below:

"We would like to bring to the notice of readers a situation which has arisen in a Northeastern firm, C. A. Parsons, employing many graduates in both the sciences and engineering. The company has an agreement with Draughtsmen and Allied Technicians Union in which the majority of graduate staff will be compelled to join DATA as a condition of employment. If they refuse, their employment will be terminated. This agreement was reached contrary to the wishes of the staff mentioned, without consultation as to level of eligibility and was in fact as a '*fait accompli*'.

"This action will take effect before the Industrial Relations Bill becomes law, and thus the staff concerned have no protection. Surely it is time the scientific institutes did something to protect the rights of their members."

D. Brown, D. Hall, A. Nag, H. Newell, M. Sheehan and D. Tonks
Grubb Parsons
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I wonder if this sort of situation could arise in this country. My only experience of union interference so far has been in the area of "demarcation disputes." Actually to call them "disputes" is not correct, as the unprotected physicist has no say in the matter. For example a colleage of mine in Ohio has a PhD and immense experience in the use of vacuum equipment. He is not now permitted to assemble, dismantle or clean any of the vacuum equipment assigned to his research projects. The only labor available to him for this purpose is in the nature of a fitter. Because my colleague has no strong union to support him he is the automatic loser in any such disputes. I have had similar experiences. It seems that such intrusions into our profession can only be prevented by an organization with influence equal to that of the A.M.A.

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Corrections

February, page 53—Review caption mistakenly identified the publisher of *Physical Processes in Geology*. The correct name is Freeman-Cooper, not Freeman.

March, page 101—Column 3, third line from bottom read: "In 1965, 15% of the graduates who chose employment found jobs in industry." The figure should have been 51%. □