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JULY 46

Science Fiction

JULY 1946
25 CENTS

COLD FRONT

By Hal Clement

Bright about his business...

DUMB about his Dandruff!

Pityrosporum ovale, the strange "bottle bacillus" regarded by many leading authorities as a causative agent of infectious dandruff.

Don't Ignore Nature's Warning! It may be the Infectious Type!

Funny, isn't it, that the man who overlooks nothing when it comes to getting ahead in business, and who gets upset about the slightest rattle in his motor, is often the same bird who pooh-poohs that telltale shower of flakes and scales on his coat shoulder?

The first thing he knows he may be in for a mean and troublesome case of infectious dandruff...*and can it be mean and troublesome!*

Listerine Antiseptic—Quick!

Don't scorn Nature's warnings! Persistent flakes and scales and itching often indicate the presence of infectious dandruff. Get started at once with Listerine Antiseptic and fingertip massage... the easy, delightful home treatment that has helped so many. It tackles an infectious problem as infections should be tackled—with antiseptic action.

Make it a part of your regular shampoo and, if you do not see rapid improvement, follow the treatment twice a day, or oftener. The same treatment, used twice a day in clinical tests, brought complete disappearance of, or marked improvement in, symptoms of dandruff to 76% of dandruff sufferers within 30 days.

Kills "Bottle Bacillus"

Listerine Antiseptic gives scalp and hair a cool, antiseptic bath which kills millions of germs, including the stubborn "bottle bacillus".

This tough, hard-to-kill customer is looked upon by many a noted dermatologist as a causative agent of infectious dandruff.

You'll be delighted when you see how rapidly those embarrassing flakes and scales begin to disappear. Your scalp feels better... your hair looks better... all without grease, mess, fuss or bother. Listerine is the same antiseptic that has been America's standby for oral hygiene for over 60 years.

LAMBERT PHARMACAL COMPANY, *St. Louis, Mo.*

the tested treatment **LISTERINE ANTISEPTIC** *and* **MASSAGE**

All in favor raise right hands ... *with wallets*

Naturally we want our boys home.

But how much are we willing to do about it?

Are we willing to pay for bringing them back? If we are, we'll buy *extra* Bonds in the Victory Loan.

And after these fellows get home—what then?

We want to take care of the injured ones, of course. We want to give our boys a chance to finish their education. We want to see that there are plenty of decent jobs for them.

How much are we willing to do about that?

If we're really serious about wanting to see that our men get what they have so richly earned, we'll buy *extra* Bonds in the Victory Loan.

Now's the time. Let's have a show of hands—with wallets—to prove how much we really want to hear that familiar voice yelling "It's *me!*" Let's prove, with pocketbooks, that we can do our job as well as they did theirs.

THEY FINISHED THEIR JOB—
LET'S FINISH OURS!

VICTORY LOAN

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Denatured Atoms

There are reports that plutonium can be "denatured"—made non-explosive. But details aren't available as of now.

Some decades hence, we may know enough about nuclear structure to be able to alter the nature of atomic nuclei in such fashion as to produce synthetic nuclei of inordinate stability; at that time it could, conceivably, be possible to produce Plutonium 239 in an altered form which was incapable of explosive fission. It's a very safe bet, however, that we can't do that now; Pu-239 is an explosively fissionable nucleus. The effort to alter that fact will result in alteration all right—by bringing about that fission. The plutonium nucleus can not be denatured.

But no bank vault is burglar-proof either; given time, and free access to the vault walls, there is always a way to get in. Bank vaults aren't intended to resist a week-long campaign of attack, with powerful machinery, explosives, and pneumatic drills. A series of bazooka shells could eventually penetrate. The whole point of the vault walls is to make the effort at penetration slow and spectacularly obvious; the vault walls don't stop the attack, the police force does. The vault walls simply force the attackers to employ such drastic, large-scale methods that the existence of the attack becomes evident.

If the fissionable isotope of plutonium, Pu-239, is mixed with a nonfissionable isotope, say Pu-238 and if that happens to be a nonfissionable type, the resultant mixture of plutonium isotopes would have the same general properties as natural uranium. Natural uranium can be "burned" in the atomic pile, but it can not be made to react explosively. Only after elaborate processing has extracted the U-235 from the mixed U-238 and U-235 found in nature can an explosively rapid nuclear reaction be started.

At Oak Ridge, U-235 is separated from the mixed natural uranium by diffusion through barriers plus mass spectroscopic methods. That same plant, without change of anything more important than a few adjustment controls, will equally separate any mixture of plutonium isotopes. It would, incidentally, separate isotopes of any element that could be obtained in a gaseous form, or had formed a gaseous compound.

But Oak Ridge is not the sort of thing you can set up in secrecy; it never was a secret, actually, and even its purpose was not an actual secret, the Army's boasts to the contrary notwithstanding. Every major trade-journal publishing company in the country knew Oak Ridge was being built, and knew fairly well what its intended purpose was. Consider the position of

an editor of an electrical contracting journal; it is his business, and the business of his staff, to know where major electrical contracting jobs are being done, who's doing them, and what sort of work it is. A general contracting journal has similar aims. If the reportorial staff of such trade journals are specifically excluded from certain fields of information—why, that in itself blocks out the silhouette of the hidden knowledge well enough! A plumbing journal would be interested in where the enormous quantities of special pipe were going. A metallurgical journal would be interested in the fact that immense quantities of the finest, corrosion-resistant alloys were going somewhere in secret. Not just ordinary "in secret," but super secret.

Finally, the story goes that a Swiss watch exporter guessed the purpose of the Oak Ridge installations because of the sudden and terrific demand for special non-magnetic watch movements.

Nothing that size can be really secret—any more than an attack on the walls of a bank vault can be carried out in silence. It isn't that adding a nonfissionable plutonium isotope to Pu-239 makes it impossible to produce from the mixture a fissionable Pu-239 bomb; the point is that that denaturing process makes necessary a perfectly tremendous plant for the separation of the isotopes. The bank vault isn't intended to stop the burglars; it's intended to make the burglar's actions necessarily so obvious that the police can spot the crime-in-process and stop it.

It is a fine, sound idea. There are two possible loopholes, however. First, natural uranium used in a pile produces the fissionable Pu-239; if atomic piles are to be permitted as sources of atomic energy for industrial uses, they automatically produce plutonium. The fissionable-explosive kind. Second, the bank-vault trick works so long as the police force is ready and willing to sail in and arrest the criminals.

So long as national executives can protect themselves against *criminal charges as individuals* by deflecting the attack from themselves to the nation which they are so illy serving, making the defense against the charge that *they as individuals* gave orders contrary to international law a claim of *national* honor, the police force on the international scale will be ineffective.

One thing the atomic age seems to require is a new concept of national-international law. Set up, as a basic premise this philosophy: "No *nation* can, under any circumstances whatever, act in any manner. Only individuals act. Therefore no *nation* can be dishonorable, or criminal. If a criminal act is performed, it is done by a dishonoroble executive (or executives) of an honorable nation." Acceptance of that view would make it simple to try an individual who ordered the breaking of international law, instead of the terrible task of defeating a nation in war.

The Editor.

Cold Front

by HAL CLEMENT

The Master Salesman's job was to find out what the people of that new world wanted and needed, and how best to supply it. What they needed was easy; decent weather. But supplying it—even though Earth knew how to control weather—wasn't so easy!

Master Salesman Alf Vickers walked slowly along the beach behind his companion, and pondered. He was never quite sure how to begin his talks. If it had been a question of selling, alone, he would have had no worries, even though it was necessary to employ careful reasoning rather than emotional high-pressure when one was not too well acquainted with the emotional build-up of an alien race; but when the selling had to be done to an entire people, and there was a moral certainty of reprimand and perhaps of disrating if the Federation Government caught him, he began to think of the consequences of his errors, before he made them.

The people, at least, were a peaceful seeming lot for such a rugged planet; that was some relief. The frowning, almost sheer six thousand feet of Observatory Hill, at whose foot he now stood, had

made him think uncomfortably of the wilder mountain tribes of history and legend on Earth. Big as they were, he reflected, gazing at the specimen walking ahead of him, the few he had met were almost painfully polite. It had made easy the task of revealing nothing of himself or his mission until he had acquired a good control of their language; but courteous or not, Vickers felt that the explanation could not be put off much longer.

Serrnak Deg, who had devoted so much time to teaching his speech to the Earthman, was plainly curious; and there was only one plausible reason for his insisting that morning that they drive alone to the beach at the foot of the mountain. Plainly, he was willing to keep Vickers' secrets from his compatriots, if Vickers so wished; but he had definite intentions of learning them himself.

Vickers braced himself as Deg stopped walking and turned to face him. As the man stopped beside him, the Heklan began to talk.

"I have asked you no questions since you first intimated a desire not to answer them. I have taken you on trust, on what seemed to me a thin excuse—that you feared the results of possible misunderstanding caused by your ignorance of our language. I think my expenditure of time and effort merits some reward in the shape of satisfied curiosity."

"The excuse was not thin," replied Vickers in the Heklan language. "More than one man in my position has suffered injury or death as a result of just such misunderstandings. It is important that you get no false ideas from me about my people, the world from which I come, and the other races and worlds which are depending on my success. It is my intention to tell not only you, but eventually all your people, my full story; but I am depending on you for assurance that I can make myself clear, and I also want to hear your impression of what I say before it is transmitted to the rest of the planet or to that part of it on which you are on friendly terms."

He stopped to gather his thoughts. The surroundings were not quite what he would have chosen—a rocky beach at the foot of a nearly perpendicular cliff, pounded by breakers from an ocean that was tinted a curiously disconcerting pink. The sky was a slightly deeper shade, and suspended in it was the hardly visible disk of a giant red sun.

The audience would have been more d i s c o n c e r t i n g than the environment, to one less accustomed than Vickers to nonhuman beings. Serrnak Deg had no need of the heavy jacket with which Vickers warded off the stiff breeze. He was protected by a layer of fat which must have accounted for half of his weight; and the fur that covered his body was thick enough to hide the straps supporting his only garment—a pair of trunks whose primary function was to contain pockets. His face, with its enormous eyeballs and almost non-

existent nose, reminded Vickers of a spectral tarsier; but the well-developed skull behind the grotesque features had already shown itself to contain a keen brain.

"One of our mapping vessels noted some time ago that this planet was inhabited by intelligent creatures," Vickers went on. "There is a standard procedure in such cases. We learned long ago not to make immediate, open contact with the bulk of the world's population. It is a mathematical certainty that there will be enough objection to contact with aliens, to result in violence."

"I find that hard to believe," interjected Serrnak. "Why should there be objection?"

The Earthman creased his brows and tried to remember Deg's word for "superstition," but the concept had never arisen in their conversation.

"There have been many reasons," he finally answered. "The one that leaps to my mind I am still unable to express in your language. I am afraid you will have to be content with my assurance that it is so. For that reason, a single agent is always sent to contact the smallest, practicable group of individuals, to become acquainted with them and through them with their people, and with their help to accustom the race gradually to the existence, appearance, and company of natives of other worlds. Make no mistake; it is a delicate task, and an error can have really ghastly results. I hope you don't find that out first hand."

"I don't know about your business, but errors can be pretty serious in mine," said Deg. "What consequence, other than this planet's failure to join the organization you refer to as 'We,' can arise from mistakes of yours? I take it that you are the agent responsible for us."

"I am; I'm sorry if I am not giving my explanations in proper order. It is my business to convince you and your fellows at this place that the Federation can do your people untold good, and to enlist your help in persuading your race, or at least your nation, to the same effect."

"Why should persuasion be necessary?" asked Serrnak. "It seems obvious that good would result from such an action. Contact between groups living on different parts of this one world has always produced beneficial exchanges of ideas and natural products, and I should imagine that this would be even more true of interplanetary commerce. Some planets, I suppose, would have more than enough metals, for example—that occurred to me because that is one of our most serious lacks; and certainly, if you have solved the secret of interstellar travel, there is much we can learn from you. Do you really mean to imply that some races have actually refused to benefit by such a chance?"

Vickers nodded solemnly.

"Too many," he said. "A certain suspicion of strangers, a doubt as to our intentions, is natural of course.

We expect and allow for it; our work is to allay it, and prove that we have no intention of dealing unfairly with anybody. Your attitude is encouraging; I hope a majority of your people share it. Do you suppose they will, Deg?"

The answer was slow and hesitant.

"I can't be sure—naturally. I have already given you my feelings on the matter, but I cannot answer for everyone. I will test my coworkers here, as I suppose you want me to, bearing your warnings carefully in mind. Will that be satisfactory?"

"That will be excellent. I can't find the words to thank you, but I'll try to give any help in my power if you have undesirable reactions. I admit I have worried a good deal about the outcome of this meeting; one can never be sure of having chosen the right person for the first advances."

Deg nodded.

"I understand why you wanted privacy as much as possible for our conversations. You chose a good place to land on this world; we are about as isolated a group as you could have found, except perhaps for the stations in the far interior of this continent. The cities are mostly located in the larger islands of the equatorial zone—I suppose you observed that, before landing. If I may ask, how did you find this station? It is not particularly easy to mark from the air, according to my experience."

"It was found by accident, on a photograph," replied Vickers. "We decided that, if it were not deserted, it should prove a good place to start operations. We were not sure of its purpose; I still don't know what you do here, but it had the desired isolation, and the presence of someone with authority seemed probable. Are you in very close touch with any of the cities?"

"We have to be. This is a weather station, and is tied into a tight communication network linking all the observatories on this continent with one of the cities. The constant flow of reports is received there, and integrated into a master weather map of the continent; and an intercity net further combines these maps into a world map in one of the largest population centers. The information and world forecasts are there made available to any who have need of them—including the original stations; we require the total picture for long-range local forecasting. All the exact sciences have a similar network for co-ordination and exchange of informa tion."

"That sounds efficient," remarked Vickers. "We have similar organization on and between the worlds of the Union. There is a great deal of written information on such matters in my ship; I shall be glad to translate for you, any time you care to come aboard. The more you understand about our civilization, the better."

"I shall take advantage of that offer presently," returned Deg. "At the moment, I fear I have ignored my duties too long. There will be several hours' observation records

in my office, and one of the computing machines has been behaving suspiciously. If it goes out altogether it may be more than our technician can handle, and I'd hate the thought of doing much of that computation manually. Would you care to visit my office? I can show you something of the station on the way, and you can return the favor when I visit your ship."

Vickers had been hoping for such an offer. He had not wanted to make the suggestion himself, but up to now he had acquired very little idea of the state of technical advancement of these people. A look at any sort of laboratory would give him a good idea of their science in general, for no field of knowledge progresses far without corresponding development in the others. He gladly accepted Serrnak's offer.

They had been walking as they conversed, toward the point where the giant breakers flung themselves against the stone rampart of the lowest terrace. Now the meteorologist turned back toward the hill, the Earthman following. Parked against the face of the cliff was Deg's car, a four-wheeled vehicle with enormous balloon tires. Its owner vaulted easily over the side into the driver's seat; Vickers clambered in more slowly, hampered by the sixty pounds that Hekla's gravity added to his normal weight.

Deg set the car in motion, picking his way between rockfalls. Vickers constantly expected to see the tires cut through by the sharp-edged fragments of slate littering the way, but the tough treads remained intact; and presently the stones disappeared, as the mountain was left behind. After a quarter of an hour, Deg was able to turn inland, and a little later there began to be signs of a narrow road, which led in a rather steep climb back toward the hill. Here they were able to put on more speed, although Deg was bothered part of the time by the sun shining in his eyes. Vickers was able to look directly at the hazy, mottled crimson disk without much discomfort.

About a quarter of the way up, the road skirted a small pocket in the hillside, covering perhaps a quarter of an acre. It was covered with regular rows of purplish vegetation, and a small, low-roofed stone building stood between it and the road. Deg stopped the car and entered the building, indicating that Vickers should wait. The Earthman heard conversation through the open door, but was unable to distinguish any words. The Heklan emerged after a moment, and the ride continued. Vickers had seen several of the little gardens on the way down the mountain, but Deg did not offer to explain them on either trip.

The rest of the drive was uneventful, and the car presently emerged from the road—now almost a tunnel—on to a nearly flat space two or three hundred yards across, beyond which the hill rose sharply to its real summit two hundred feet above. At the base of this final peak, an opening fifty yards across and half as high led into the hill;

and from the opening, and equally wide, a paved, level strip ran across the flat space to its very edge. Vickers had assumed this to be a landing runway for aircraft; and the silvery hull of his own little ship lay now to one side of it.

The car drove straight on into the cavern, through it, and into a smaller chamber beyond, in which a number of the vehicles were parked. Leaving the vehicle here, the men proceeded through two narrow hallways. Along both sides of the second were a number of doors; Deg opened one of these, to reveal an elevator, into which he motioned the Earthman. It was similar to the terrestrial elevator, controlled by the passenger. Vickers counted the buttons, trying to get some idea of the extent of the station. There were forty-five of them, indicating that there were at least that many levels to the observatory.

Deg touched one of the highest buttons with the horny tip of a finger, and they were carried smoothly upwards. Vickers could not tell the number of levels they passed, but the ride was comparatively short. They emerged directly into a large room, which Deg described as the local integration and prediction laboratory.

It was about one hundred feet square. Its most prominent feature was a set of six five-foot globes, spaced equally along one wall, and representing the first maps Vickers had seen of Hekla. Each was covered with a complicated network of lines and symbols: the Earthman assumed that these were the equivalents of the isobars, fronts, cloud symbols and other data with which meteorologists habitually decorate their work. They meant little to Vickers. He was able to tell, from his recollection of the planet's surface as viewed from space, that the deep purple areas represented water, while land was white. The globes were evidently of some translucent material like frosted glass, and were lighted from within.

At the base of each globe was a desk, at which an operator sat. Some were working small computing machines; others were busy with the incomprehensible diagrams and graphs of their profession. On the rest of the floor space were a number of larger computers, some manned and active, others deserted. Across the room from the globes four more of the machines, far larger and more complex than their fellows, were set at the four sides of a large table whose top was a map, evidently of the region centering about the observatory, set up and lighted in similar fashion to the world maps. The operators of these calculators were grouped about the keyboard nearest to Vickers and Deg; and with a word of apology, the Heklan stepped over to them, to listen to their conversation.

Vickers waited for him, gazing around at the ordered efficiency represented in the activity of the laboratory. It pleased him; everything he saw bespoke a high culture, considerable progress in the physical sciences, mechanical skill, and an apparent tendency toward inter-

national co-operation — a smoothly working planet-wide weather system could scarcely be maintained in the face of strained international relationships. He also noted an apparent lack of metal: it was used only where necessary, as in electric conductors. Wood and synthetics were used almost entirely.

He was not too surprised; he had known of the low density of the planet before leaving the big interstellar flyer which had brought him and his smaller ship to the neighborhood of R Coronae. Hekla had nearly twice the diameter of Earth, but its surface gravity was only forty percent higher. The forty percent, he reflected, was plenty; his legs were aching perpetually, and he had been getting — and needing — twelve hours' sleep out of twenty-four. Hekla's thirty-two hour day complicated his schedule; day or night, he had to sleep after twelve or fourteen hours of activity. The Heklans, even when the proportionate length of their day was considered, got along with unbelievably little rest; Deg, Vickers had learned, counted on four to five hours of sleep, which he got as soon after sunset as his work permitted.

Vickers' reflections were interrupted by Serrnak's return.

"I am very sorry," the Heklan said, "but I cannot show you more of our station at the moment. The main integrator is definitely making mistakes, and I shall have to help carry out alternate procedure with the smaller machines until the technical section can correct the trouble. I shall send someone to show you the way back to your ship, unless you wish to do something else until I can rejoin you."

"I will return to the ship, for a while at-least," replied Vickers. "I can find my own way, if you will tell me the level at which I should stop the elevator. I saw no means of telling the number of the floor from which we started."

"The flight ramp and road exit are on the thirtieth level," Deg informed him. "The control buttons in the cage are in order. I regret being so abrupt, but there is nothing else to be done. I will come to your ship when I am again free."

Vickers nodded, touched Serrnak's hand in the standard Heklan gesture of farewell, and entered the elevator. It was lit by a source which would have reminded the Earthman of an old carbon filament bulb, if he had ever seen such a thing, but the reddish glow was sufficient to enable him to count off thirty buttons. He pressed the thirtieth, and felt the cage sink slowly downwards. The ride, as before, was brief, and the door opened automatically at its termination.

He stepped into the corridor, turned right—and stopped short. The hallway should have extended for twenty yards and been crossed by another at that point. Instead, only a few paces from the elevator it opened directly into a room almost as large as the integration laboratory above. Electrical equipment, as unfamiliar as any other scientific apparatus to Vickers, crowded the floor; and among the installations

sat or stood fully a score of Heklans, all apparently busily occupied. Vickers stood gazing into the chamber for several moments, until one of the workers chanced to glance up. His big eyes blinked once; then he took a pair of earphones from his head, rose from his seat, and approached the Earthman.

"Your ship is out on the landing ramp, which is on the thirtieth level," he said. "Can I help you in locating it?"

"I thought I had reached the thirtieth level," replied Vickers. "Serrnak Deg told me that the elevator buttons were in order, and I certainly pressed the thirtieth." The Heklan looked steadily at him for several seconds, and blinked once more. Then he nodded his head violently.

"I think I see what must have happened," he said. "You counted upward from the bottom of the panel. You are now on the sixteenth of the forty-five levels. The station was dug downwards from the top of the mountain, and it was natural to number in that direction. Do your people normally number from the ground up?"

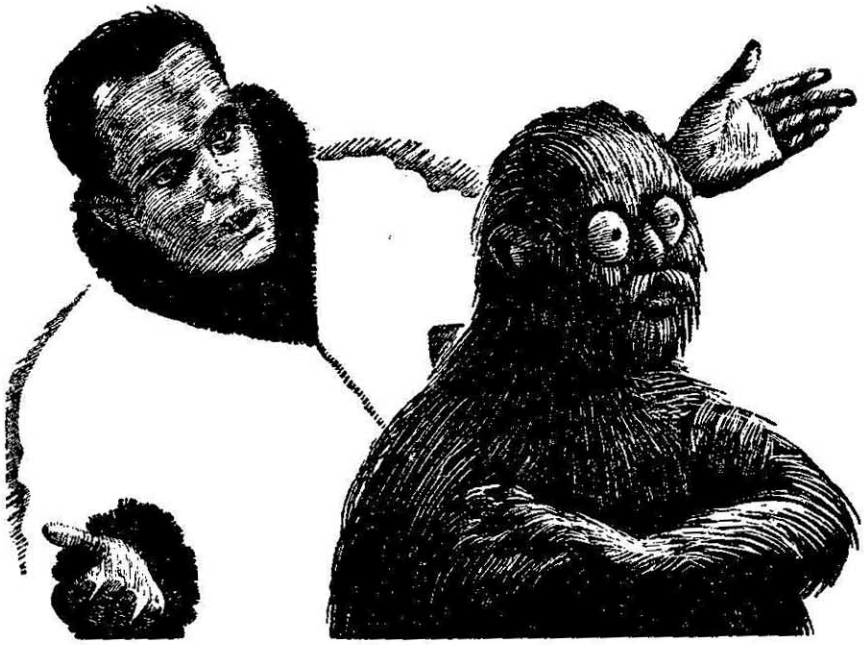
"Yes, we do, on buildings above ground level; but if I had stopped to recall that this place is underground I should at least have asked Deg whether you counted up or down. It is a silly error on my part. Now that I am here, however, do you mind my seeing your department? I will try to keep out of the way of any activity?"

The big eyes blinked again, as their owner hesitated. Vickers decided that the expression on the grotesque face denoted discomfort.

"I dislike to appear discourteous," the answer finally came, "but the trouble in the computing department has thrown a heavy load on us. We are all extremely busy, so that I can neither guide you around our section myself, nor provide another to do so. Some of the equipment is too dangerous to permit your examining it unattended. I am extremely sorry, but there is nothing I can do to grant your request. Do you think you can find the way back to your ship from here? If not, I can show you to the landing stage."

He started to move toward the elevator before Vickers could answer him; but the Earthman declined the offer of guidance. The Heklan pointed out the proper button—they were labeled in Heklan characters, but the numbers happened not to stand out very clearly to blue-sensitive eyes—and returned to the chamber of electrical devices, leaving an elevator with a decidedly thoughtful occupant.

Vickers retraced his original way from the ship without further misadventure, passed through the air lock, still pondering. Until the time he had left Serrnak in his laboratory, everything had appeared to be proceeding favorably. The meteorologist had evidently been convinced of his sincerity—Vickers chalked up another point in favor of the policy of sticking to the truth as much as possible; but the technician on the sixteenth level had been patently



anxious to get rid of him. The creature had said the entire force was too busy to show him around the department, and in the same breath had offered to guide him back to the spaceship. A personal dislike, or actual physical repugnance to a member of an alien race might be responsible, of course; but the apparently genuine effort at courtesy suggested some other cause.

Vickers settled down in a well padded chair—his ship was a converted lifeboat, and he had personally fitted it with items of luxury seldom found on such a craft—and gave his mind to the problem. In the first place, no Heklan except Serrnak Deg had had opportunity to become acquainted with him; during the three months in which he had learned the language of this race, Vickers had confined his attention to that one individual, and had caught no more than fleeting glimpses of the other inhabitants of the station. It seemed, therefore, that the Heklan on the sixteenth level had either formed an instantaneous dislike of the Earthman, had acquired one from Deg, or had been ordered by the same individual not to permit Vickers to examine that level. The first possibility the man had already dismissed as unlikely; and the other two posed the same question—to wit, what had he done or said to arouse the Heklan's suspicion or dislike? Deg must be a fine actor, if Vickers' opinion of his own ability to judge the expres-

sion of the Heklan face was not overrated; for no suggestion of any emotion save friendly interest had been apparent to the man in Serrnak's attitude.

The conversation of the last hour or two was the most probable source of trouble. Vickers reviewed his words, with the aid of a nearly eidetic memory. He had, in the first place, adhered strictly to the truth in describing the Federation and its method of establishing contact with "new" races. He had described himself as an agent of the Federation, which was his only serious departure from scrupulous verity; but the lie should not have been obvious to Deg. He had answered the Heklan's questions plausibly—and truthfully, as he recalled. He had known more than one Federation ambassador, and knew their usual troubles.

It was at this point that a recollection of the nature of Deg's questions suddenly stood out in Vickers' mind. There had been only one of importance, though he had asked it more than once, and in a variety of ways. The Heklan had been unable to understand why membership in or dealings with the Federation had been refused by some races; and—had he been entirely unmoved by Vickers' speech, "A certain suspicion of strangers is natural"? A moment later he had said that "naturally" he could not answer for the attitude of the rest of his people; had the inflection of his voice as he uttered that word denoted sarcasm, or some other emotion—or was Vickers' imagination adding to the picture painted by memory?

The man had not learned so much as he had meant to of the living conditions on Hekla. If the population were small and conditions hard, an instinct of co-operation rather than competition might be dominant; such cases were not unknown. If this were true of Hekla, Deg and his people would not be merely reluctant to have dealings with outsiders; they would be terrified at the mere thought, after the impression the meteorologist must have gained from what Vickers had considered "natural."

The theory made Vickers extremely uncomfortable, but long cogitation produced no other. He berated himself for giving so much information without obtaining any in return; but there was no use reviving a dead issue. He determined to return to the observatory, both to check his theory and to obtain some of the missing information. He arose, opened the air lock, and walked across the small plateau toward the great entry way.

Twenty minutes later, a very thoughtful man, he was sitting in his control room. He had met four Heklans inside the entrance; they had been extremely polite; but he had not reached the elevator. Something was decidedly wrong. He had learned nothing new or helpful on the second trip, but it seemed pretty certain that action was required.

Action was not Vickers' strong point, and none knew the fact better than he. Where a good personality and a working knowledge of practical persuasion were required, he

shone; but if there were need of a more specialized field of knowledge, he knew when to call for help.

He turned to the panel below the outer vision screens, and pulled a small section out and down to form a shelf. On this was mounted a small medium-crystal unit. Such a transmitter was standard lifeboat equipment, but this set's crystal had been recharged, removing it from the universal distress medium, and matched to only one other unit, which was in the interstellar ship now resting on Hekla's innermost satellite. The set was keyed, as the high-frequency interrupter which permitted voice and, later, vision to be sent and received even by a ship in second-order flight had not at that time been developed.

Vickers checked the tiny green light which assured him that heat or stray static charges had not altered the crystal's medium; then, at a very fair speed, he began rapping out a message. He had to wait several minutes for an acknowledgment, but finally a brief series of long and short flashes blinked from a second bulb above the key, and he closed the unit, satisfied.

There was nothing more he could do at the moment. He had been active since mid-morning, and it was now well after noon; he suddenly realized that his legs and back were aching fiercely from the unaccustomed walking under Heklan gravity. Vickers rose, closed and secured the inner air lock door, and dropped thankfully onto his bunk.

When he awoke, the sun was quite low in the west. Its enormous disk, ill-defined at the best of times, was nearly hidden in haze; the western half of the sky was tinted a deep blood-red never approached by a terrestrial sunset. The daily cumulous cloud was still above the mountain, its top streaming away inland and forming a crimson-lit finger pointing at Observatory Hill. Vickers, looking at it, was reminded to turn on the homing transmitter in his ship, in case his help should have difficulty in locating him.

He spent more than an hour at the board, using all his radio equipment in every combination and on every band he could reach, in an effort to pick up Heklan communications. On the entire electromagnetic spectrum, except the bands of too high frequency for communication beyond the horizon, static was strong and constant; frequency modulation did little to help, and brought nothing that might have been an intelligent message. He considered charging a spare crystal, but realized that no unit so far energized on any Federation world had chanced on the medium of a widely separated crystal, and the chances against doing so had been computed as something like the number of electrons in the universe. Two crystals had to be charged in physical contact to respond to each other across what, for want of a better name, was called a "medium." Even if Heklan science had reached such a point, there was no hope of discovering the fact by searching the legions of possible media. Vickers took that for granted, and after some time at the radios was pre-

pared to state that they had no other means of long-range communication.

He had given up the search and was eating, when a second lifeboat settled down beside his own. Vickers failed to notice it for several minutes; when he did, he immediately snapped on the standard communicator and tuned to the frequency his crew normally used on such occasions. He gave the set a moment to warm, and then called.

"Hello, Dave! Is everything all right?" The answer came back at once.

"This is Macklin. Rodin is here, all right. He's in the air lock, compressing; I'm afraid he's a little annoyed at you. Why in the name of common sense didn't you let us know that you had an atmospheric pressure of forty pounds on this blasted hilltop? He could have ridden all the way in the lock, building up gradually. He'll be over there as soon as possible; as soon as he opens the lock, you'd better trot over and help him. He had enough stuff to set up in business for himself. All right?"

"All serene. Can you stay with us, or do they want the boat back in a hurry?"

"I have to go back. I don't know what they want with this can, and I'm much too modest to suppose they'd need me, but them's the orders. You'd better watch for Dave; the lock pressure is nearly forty now."

"All right. Don't get lost."

Vickers snapped off the set, and opened the inner lock door. A glance through the control room port showed that the other ship was still sealed, but he strolled out onto the landing stage and waited there for Rodin to emerge. He noted with a shiver that the temperature at the top of the hill had not increased perceptibly since morning.

He had only a few moments to wait; the lock of the visiting ship opened silently, and its occupant hailed him.

"Hello, Alf! What have you messed up this time?"

"Don't take so much for granted, cloud-chaser," returned Vickers. "As a matter of fact, I'm not quite sure what, if anything, has been botched. I'm just a little doubtful of the attitude I aroused in the lad who runs this place. It's a weather station, and he's a member of your honored and ancient profession, so I called on you to stand by and assist in further negotiations."

"You would. I'd just gotten back on a more or less human eating and sleeping schedule. Will you help me get my stuff over to your ship? Mack is probably getting tired of waiting." Vickers nodded and they set to work; Rodin continued to talk, commenting unfavorably on Hekla's atmospheric pressure, gravity—this as he tried to lift a piece of apparatus normally well within his strength—temperature, and various other characteristics. He did not mention its weather, except to say that it looked interesting from an academic viewpoint.

The equipment had been transferred, and the men were settled in the warmth of Vickers' ship before

Rodin asked for details of the situation. Vickers gave a report of the last three months, pointing out that he had refused either to give an explanation of himself or request information of his hosts until he was sure of his ability to use their language; that Serrnak Deg, the only Heklan with whom he had come into more than momentary contact during this time, had seemed both friendly and interested until exchange of information had begun; and that Vickers had given much more information than he had received. He stressed the fact that the Heklan's behavior had not become openly hostile; they were carefully keeping him away from anything in the observatory that might do him good, but they were being very polite about it. Rodin asked a question at this point.

"If they don't want you, who aren't a scientist, wandering around the place, what good will I do? Don't you want them to know I'm a meteorologist?"

"I don't want to wander. Deg said he'd call for me as soon as his emergency had passed—which may merely mean when he's made the place safe for inspection by a suspicious alien. I'll introduce you to him as a fellow meteorologist. Your inability to speak his language will take care of any risk there might be of your saying the wrong thing. I don't know how advanced their metro is—the lab I saw looked quite imposing, but they may not be up to us. That's one thing I'd like you to pass judgment on. If they're behind us, we'll try to make you helpful to them in as many ways as possible—generally produce a good impression. If they know more than you, we'll decide on some other course of action."

"You're the boss. You must have learned something about these folks, and formed some plans, so I'll follow your lead. I don't suppose you noticed anything pertinent about the climate and local weather, did you? I know it's summer, of course; but is this a representative temperature? How's the lapse rate? Did you notice anything of the prevailing winds and general cloud forms? Don't answer—I can tell by your expression. I have my work cut out for me. Can you get hold of any locally produced weather maps, or even a decent relief map either of the continent or the whole planet?" Vickers pursed his lips doubtfully.

"The only weather maps I've seen are those big globes in the integration laboratory, unless the screens of those computing machines could be called maps. I think they put out their answers in terms of the squiggles you fellows deface paper with. If Deg will let us into that laboratory again, you can judge that for yourself; but I wouldn't count on that happening. I don't know about printed maps or charts; I've seen books, bound like ours, but I haven't even tried to read their language, and haven't seen how their books are illustrated. They undoubtedly have relief maps; if you need them in meteorology, I suppose they do too, and should have them around; but getting hold of one is something you'll just have to pray for."

Rodin nodded, and dropped the subject. They discussed the physical appearance of the Heklans, speculating on their probable evolutionary history; the doings on Hekla's satellite during Vickers' three-month absence from the interstellar ship; and every subject that occurred to them. They had plenty of time, for two of Hekla's long days had rolled by and the sun was again in the west before Serrnak Deg appeared outside the air lock.

Vickers heard him slap the outer door with the flat of his hand, and immediately opened the lock. The pudgy being walked—in spite of his build, his motion was nothing like a fat man's waddle—into the control room, where Rodin was waiting. The tarsierlike face showed no surprise as the big eyes took in the two Earthmen. Vickers forestalled any remarks by speaking himself.

"This is David Rodin, a meteorologist from the crew of the ship that brought me to this planetary system," he said. "I called for him after I left you two days ago. If I had known the nature of this place, I would have arranged to have him accompany me when I came, and learn your language at the same time. I imagine you would find a member of your own profession a more interesting conversationalist than I. I shall do my best to make up for my failure by acting as interpreter—I shall have to learn more of your meteorological terms, as well as our own, if you start to talk shop. Rodin would like to see your observatory with us, if you are ready to show the rest of it to me."

"We noticed your friend's arrival," replied Deg. "I regret being kept busy for so long. I will gladly show him the integration room if you wish it—perhaps he will understand our simple installations without explanation. I should be grateful for any improvements he might suggest. Do you wish to come now, or would you rather show me some of the photographic material you promised to let me see the next time I visited you?"

Vickers felt slightly nonplussed, and admitted to himself that Deg, if he were trying to be an unobtrusive hindrance to further human exploration of his observatory, could scarcely have done better. He gave the only possible answer.

"By all means stay and see the material. Dave's arrival had driven it from my mind. The pictures are accompanied by much printed information which you won't be able to read; but we can probably make up for that. Rodin has traveled even more than I, and can give first-hand explanations of much that you will see. The atlases are in the library to the rear of the ship."

Vickers took care to hide his annoyance as the two men and the Heklan examined and discussed the records of the dozens of worlds that made up the Federation and the human, near-human, and completely unhuman beings that peopled them. Deg expressed surprise that his own world, so comparatively close to Earth and Thanno, the principal Federation planets, had remained

overlooked while Federation sway had reached across the Galaxy and beyond to its sprawling satellites, the Magellanic Clouds. The men pointed out the vast number of stars, which rendered surveys either cursory in nature or prohibitively long in duration. A sun was likely to be investigated closely enough to detect its planets, if any, only if there were something intrinsically peculiar about the star itself, as was the case with R Coronae. Privately, Vickers wondered how soon the Federation actually would become interested enough in the giant variable to give it a close looking over.

Deg remained until sunset. By that time both the human beings were again badly in need of sleep, and the Heklan had gathered about as much knowledge of other races of the Galaxy as any one could without first-hand experience.

Vickers watched his guest through the control room port as he vanished into the still faintly crimson-lit gloom. A general glumness permeated the atmosphere of the room. Rodin waited for his companion to make some remark, but Vickers remained silent for several minutes. To the meteorologist's disappointment, he finally retired without saying anything about the problem in hand.

Sunrise, after the five and a half hours of darkness which prevailed at this season, found both men awake, though not entirely refreshed. Rodin, owing to his brief residence on Hekla, was in rather better condition than Vickers, but even he was beginning to feel and show the effects of the excess gravity. Both men ate an enormous breakfast—Vickers' stores were far from exhausted—and then the "diplomat" led the way out of the ship, turning purposefully toward the great entrance in the rock.

"If I don't get in this time, I think I'll give it up as a bad job," he remarked as they approached the opening. "I'm beginning to think Deg is a little too smooth for me. I wish I were more certain of what cooled him so toward us; my present idea is just a working hypothesis, and goodness knows when it may stop working."

The men passed into the shadowy hangar, in which Vickers had never yet seen an aircraft. No one was there; the tunnels opening into the great cavern yawned dimly lighted and empty. Vickers led the way toward the elevator, without stopping to wonder where the Heklans might be. He knew the natives would meet them before they got far.

He was right. As they turned the last corner, bringing them in sight of the elevator, a Heklan stepped from the cage. Vickers was not sure whether or not it was one of the individuals whom he had already encountered—his comparative isolation with Deg while he was learning the Heklan language had given him no opportunity to study facial or other differences between members of that race—but this specimen was far too tall to be Deg himself. His eyes were almost on a level with those of the Earthmen, while his general build was in normal Heklan

proportion. He must have weighed, on Hekla, between four and five hundred pounds.

The tremendous native listened politely to Vickers' request to see Serrnak Deg, and nodded when the man finished speaking.

"I was coming to see you," he said. "Deg has asked me to act as your guide. He will be glad to see you whenever you particularly wish it, but routine duties of his position, which he has been rather neglecting for the past few months, prevent him from spending all his time with you from now on. He asks me to apologize for any seeming discourtesy, but I am sure you understand his difficulties. In what way can I help you now?"

"My friend is a meteorologist, and would be interested in seeing the integration laboratory Deg showed me, as well as your observing apparatus. I understand perfectly why Deg cannot be with us, and I thank you for granting your time. Perhaps if we went first to the integration laboratory, and you explained your weather maps and their symbols to Rodin, he could comprehend the rest of your system more easily. He has been eager to see that laboratory ever since I described it to him. Does that meet with your approval?" Vickers had ideas of his own about the assignment of this enormous individual as their host, but determined to make the best of the situation.

"Whatever you wish," returned the guide. "My name, by the way, is Marn Trangero—either name is acceptable as a form of address, as you probably gathered from Deg. We will go up to the integration room, then, if you are ready; as a matter of fact, Deg is probably there himself, just now, so if there is something you particularly wished to discuss with him, you will have a chance to do so."

Vickers nodded understanding as they entered the dimly-lit elevator. The Heklan pressed the button—Vickers examined carefully the faint character beside it, as he did so—and they slid gently upward.

The laboratory was as Vickers remembered it; the globes, the computing machines, the operating personnel. The big central machine was active this time, with the four operators in their seats on each side. Marn pointed out one of these individuals.

"Deg is here, as I thought," he said. "Did you particularly wish to speak to him?"

"Not if he is busy," replied Vickers. "Could you explain these devices to us? I will translate to Rodin as well as I can, though you will probably have to explain most of your scientific terms with simpler words. What is the connection between those globes and the computers beneath them?"

"The globes are weather maps. The computers handle observed values of air pressure, temperature, humidity, and similar factors, setting them up as isopleths on the globes and calculating their individual trends. Each of the machines handles one such variable and its individual characteristics. The results

of these computations are fed to the intermediate machines, and finally to the master computer, which is supposed to give a complete weather picture. All the factors at once could be shown on the main screen, but it would make a very confusing picture. The trouble, of course, is that each factor is dependent on all the others, and the integration has to be fed back to the individual machines to correct their values for each few minutes of a prediction. It is really a very clumsy system; a single computer capable of tracking all the variables at once would be far speedier and more convenient. Such a machine is being designed at one of our research centers, but it is so far much too bulky, complex, and tricky for an outpost such as this. I should like a chance at it myself, as you can well imagine."

Vickers could imagine; he recalled scientist friends of his own who would give ten years of their lives for six months' time at some particular laboratory, or machine, or in some fellow worker's company. He relayed the explanation to Rodin, who nodded in understanding and examined very closely each of the globes in turn. The meteorologist then spent several minutes carefully observing the operation of the keyboards of several of the machines. He finally asked for an illustration of the system's accuracy; Vickers relayed the question to Marn.

"Since I am not acquainted with your own progress in this field, I hesitate to call our work accurate," was the reply. "In meteorology, it is difficult to define accuracy, in any case. If you like, however, I can translate the machine's prediction of the next few hours' weather. From a cursory glance, it seems to me that it will be different enough from the local norm to afford you a fair check on our methods. If you will wait a few moments, I will interpret the records from the machine."

He left them, while Vickers explained his proposition to Rodin. The meteorologist approved strongly, and they waited expectantly for the Heklan's return. He was gone only a few minutes.

"You know," he began as he approached the men, "that this station is at the coast of a large continental area. You have undoubtedly noticed the stiff sea breeze which forms a normal part of our weather at this season. It is a direct cause of the cumulous cloud which builds up above this hill each day.

"Since your arrival, Vickers, the weather has departed only very slightly from the norm. Now, however, a weak warm front has developed to the southwest, and is moving in this direction. Its first symptoms, high thin clouds, will arrive about midday. They will lower rapidly, reaching the level of the station three and a half hours later, and precipitation will occur almost immediately after that. Winds will continue rising until the rain starts; thereafter they will decrease, and shift from south to west. I could give you numerical values for wind velocity, air pressure, temperature, and so forth; but they would have to be translated into your units, and

I don't believe either of us can do that. All clouds should disappear before sunset, including the cumulous head one usually sees over this point. Deg has just warned the gardeners on the lower slopes of the front, I see. It might be a good idea to move your ship into the hangar—though you know the strength of your own creations better than I; use your judgment. Winds sometimes become rather violent here at the hilltop."

"The ship is a pretty solid piece of machinery, and we can anchor to the mountain if necessary," replied Vickers. "Why do you warn the gardeners, if this is to be a weak front? And what is the nature of the gardens I saw on my drive with Deg a few days ago?"

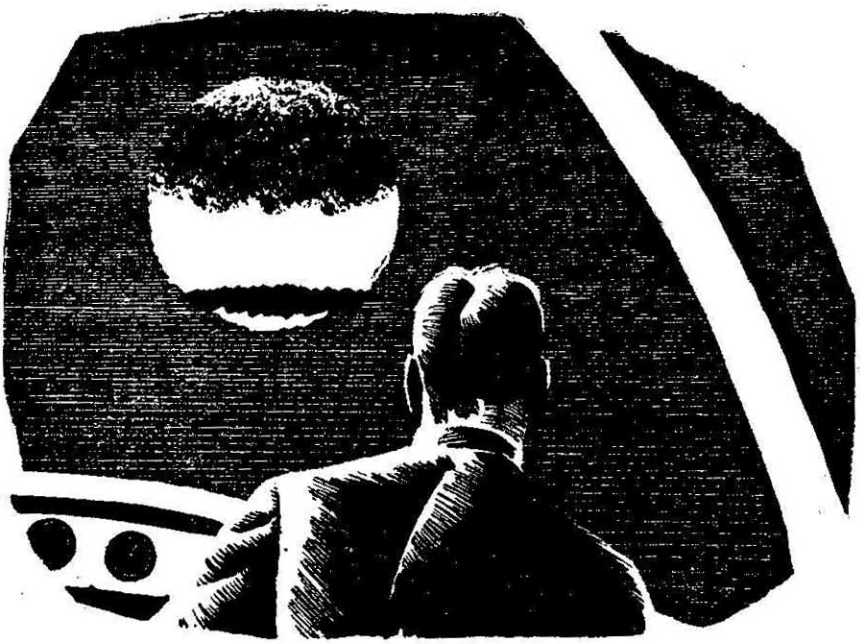
"The plants nourish a fermenting protozoan in their roots, and store alcohol in their stems and spore pods. The longer they grow, the higher the alcoholic content; but a strong wind ruptures the pods and frees the alcohol. Consequently, we try to harvest just before a wind. The local gardens are small; we simply produce enough to power the station. I believe there are efforts under way to modify the protozoans to produce better fuels, but if they have met with success we have yet to receive the benefits. Your arrival, of course, may obviate the need for further work along such lines; you certainly didn't cross interstellar space on combustion engines."

Vickers nodded absently at this remark, as he translated the gist of the forecast to Rodin. The latter listened carefully, making certain of details that seemed unimportant to his companion, and finally asked to see the observing portions of the station.

Trangero agreed instantly to this request, and turned back to the elevator. Once again they traveled upward, emerging this time into a small chamber from which half a dozen doors opened. The Heklan led them through one of these.

They found themselves on a flat area, only a few yards square, and obviously artificial, located only a dozen yards below the actual peak of Observatory Hill. A metal ladder led to the peak itself, which was topped by a slender but solid-looking tower. Part of the platform was walled with stone, and the rest guarded by a metal rail. Several instruments were mounted on the rail itself, and some larger devices on the rock just outside. The tower was topped by a tiny vane. Marn showed the men each of the instruments in turn, vaulting the rail easily to demonstrate those beyond it. Neither of the human beings enjoyed going outside its protection; the rock was smooth, and after the first few feet sloped very steeply toward the landing ramp sixty yards below. The ship was just visible from the safe side of the railing.

The instruments seemed normal enough to Vickers, and even Rodin had little to say about them. There were thermometers, precipitation gauges, and hygrometers, all connected electrically to recorders in the laboratories below. The vane on the tower was similarly connected to record wind direction, and it con-



tained a pitot head to measure velocity.

The few other devices were slight variants of standard—to Rodin—equipment; and the meteorologist felt rather let down at the end of the tour. He felt fairly sure that the Heklans, in spite of their efficient world net, were no further advanced in meteorology than any Federation planet; but he decided not to voice the opinion until after checking a fair number of their predictions. He awaited the approaching storm with interest.

He glanced occasionally to the southwest while they were at the summit, but the omnipresent haze of Hekla's dense atmosphere hid the horizon; and no signs of the approaching weather appeared before Marn shepherded the men back to the elevator. The other parts of the station, which the Heklan insisted on showing them, were connected with the maintenance of the place rather than with its primary function. The power plant was on the same level as the hangar; it consisted of six surprisingly small electric generators driven by equally diminutive internal-combustion engines, which, according to Marn, burned the alcohol produced by the gardens on the slopes of the hill. These units powered the elevator, supplied heat and light sufficient for the Heklans' small needs, and operated the numerous items of electrical equipment.

They spent fully three hours inspecting the station; if Marn had been ordered to tire the men out on

nonessential details, he was doing splendidly. Rodin lost interest after leaving the roof. Vickers kept up a good front, but eventually even he had to call a halt for rest. Perhaps his fatigue can be blamed for causing him to forget an issue he had planned to force—the room full of electric equipment from which he had been diverted two days before, and which Marn had skipped by accident or design. Vickers did forget it, made his excuses to the Heklan, and was back in the ship before he recalled the matter. By that time he was nearly asleep, settled back in one of the chairs in the ship's library.

He slept four or five hours. Rodin remained awake for some time, but was asleep when Vickers awoke; by the time both had finished sleeping, eating, and talking over the morning's events, the sun was well up in the sky. So far the weather appeared normal, though Vickers, who had been around long enough to be used to it, thought the breeze was less strong and the cumulous banner less well developed than usual. Marn's weather was not jumping the gun, at any rate.

It was not late, either. A few minutes before noon—as nearly as they could judge the time—Rodin detected the first wisps of cirrus, high above. They must have been above the horizon for some time, invisible in the haze. As the men were on the landward—and consequently the leeward—side of the hill, the change in wind direction was not noticeable for some time; but its strength mounted rapidly as the clouds thickened and dropped closer to the hilltop. Rodin, stepping outside the ship for a moment, was taken by surprise and knocked over by a gust that eddied around the rock shoulder. He got to his feet immediately, bracing himself against the metal hull, and looked around. Toward the west, the haze had thickened so that it was now impossible to make out details on the plateau inland. Two or three thousand feet overhead, the scud raced along parallel to the coast. On Earth, under similar circumstances, the cloud layers would have been gray; but the fainter, red light of R Coronae here gave them an indescribably eerie pinkish color. All traces of the sky had by now disappeared. Rodin could actually feel in his ears the change in air pressure as other eddies swirled by him. It was still cold; the frontal surface, of course, had not yet come down to his level.

He returned to the control room, thinking. If Vickers had translated correctly, Marn had forecast a weak front; and this outside weather could already be called violent without stretching facts. Either the Heklan prediction was inaccurate, or Rodin would have to revise his ideas of what constituted a violent storm. In three months of residence, Vickers had noticed nothing extraordinary about the weather; and it seemed probable that if Heklan atmospheric phenomena were built to a different scale, the fact would have become apparent in that time. Rodin, thinking the matter over,

adopted his usual course of withholding an opinion.

The wind increased, and as the clouds thickened the pinkish light faded into total darkness. Rain began to beat against the metal hull, and the light from the control room window penetrated only a few feet into the murk. The clouds had reached the level of the hilltop. Rodin cautiously opened the outer air lock door again; fortunately it was power-operated, or he would have been unable to close it. Several times the ship shuddered from end to end under the blast. Vickers charged the anchoring fields along the keel after the first tremor, but evidently the rock itself was quivering; an occasional vibration could still be felt during the heaviest gusts of wind. There would be more shattered rock on the terraces when the weather cleared.

The time passed slowly. Rodin kept watching the clock, trying to figure the time of Heklan day on the twenty-four hour dial in order to keep check on Marn's prediction. Vickers read and thought, while the storm reached and passed its height. Twice the men were disturbed by an odd, crackling sound, and looked up to see ghostly fingers of fire crawling about the transparent ports. The meteorologist blinked at the sight; he was accustomed to electrical activity in storms with strong vertical development, but to get it with strictly horizontal winds somewhat surprised him. He wondered what velocity the wind must have reached to ionize the raindrops. Vickers felt thankful for the metallic construction of the ship.

Slowly the shuddering diminished, the howling of the wind died, and the dense fog grew once more pinkly luminous. The men ventured outside again, finding that the wind was still strong, but no longer savage. The fog was thinning, and the wind, true to prediction, was blowing from inland, bringing even to this height odors from the vast plains and hills of the great continent.

Rodin stood looking, as the view cleared, at the reappearing sun and the vaguely visible landscape, sniffing the odd smells, and gradually acquiring a puzzled expression. Vickers noted it, and started to ask the nature of the trouble; but he changed his mind, knowing that he was unlikely to get an answer, and went into the ship instead. He found himself shivering, as usual on Hekla, so he picked up the jacket he had discarded after the morning's inspection tour. Attired in this, he went outside again.

Rodin was waiting for him, the expression of puzzlement still on his face. He caught sight of Vickers, and beckoned to him.

"Let's go back to the station," he said. "I want to pick a bone with Marn, or with Deg, if necessary. There are one or two things going on that I don't fully understand. These friends of yours don't have to sleep half the day like a couple of poor Earthmen, do they?"

"They should still be active,"

Vickers replied, looking at the sun. "It's a couple of hours till sundown, if what I can see of the sun and what I can guess of the horizon's position aren't combining to fool me. These fellows sleep for a few hours each night from habit, and I guess they can do without that for quite a time. There should be no trouble in finding Marn, if he's supposed to be looking after us."

There was no trouble. They did not meet Trangero the moment they entered the station, but the first Heklan who saw them made it his business to deliver them into the proper custody, and led them to an office on a floor two or three levels below the integration room. Marn raised his enormous bulk from behind a desk as they entered. Vickers thought fleetingly of the curious similarity between human and Heklan forms of courtesy; then he turned his attention to the task of interpreting for the two weather men. Rodin opened the conversation with a question.

"Did I understand correctly that you were basing the prediction for the last few hours upon the passage of a warm front?"

"That is correct. I was several minutes off on the time of passage; but that is not included explicitly in the machine solutions that are recorded, and I did not occupy a machine with the detailed problem."

"Then a front actually did pass? Why is it that there is no perceptible temperature change? I expected it to be a good deal warmer, from the amount of water vapor that was condensed at the frontal surface."

"I can only suppose that you are working from acquaintance with a different set of conditions. The temperature change was slight, I agree—I said the front was weak. I should have given you numerical values if we had had any measuring system in common. We must remedy that situation as soon as possible, by the way. The condensation and precipitation which seems abnormal to you agreed as usual with the predictions, as did the winds."

Rodin pondered for several moments before replying to this.

"There's a good deal I don't understand even yet," he finally said. "I'd better start from the beginning and learn your units. Then I might try following some of your computations manually. If that doesn't clear me up, nothing will. Can you spare the time?"

Vickers hesitated before translating this. He hated the thought of using so much time as Rodin's proposal would require; the months he had spent on the alien language seemed more than enough. There seemed, however, no alternative; so he transmitted the meteorologist's request. Marn agreed, as he had expected; and what was worse, the energetic giant plunged immediately into the task, and kept at it for nearly four hours. The translation of units of distance, temperature, weight, angle, and so forth was not in itself a difficult problem; but it was complicated enormously by Vickers' lack of scientific vocabulary. By the time Rodin had acquired a table of Heklan numerals and a series of conversion graphs,

both Earthmen were in a sadly irritated frame of mind.

Vickers was more than willing to call it a day when they returned to the ship but the meteorologist seemed to partake of the determination displayed by his Heklan fellow. He settled down with his written material, which included one of the maps made during the recent frontal passage, and began working. Vickers wanted to remain awake to hear his conclusions, and settled into a chair in the cramped library; but sheets of used paper began to litter the place, and Rodin, whenever he had to probe among them to check some previous figures, plainly considered his friend to be rather in the way. Vickers finally gave up and went to bed—a habit into which he was falling more and more deeply. The weather man labored on.

He was a red-eyed scarecrow, hunched over the little desk, as he expounded his results the next morning. His words were slow and careful; he had evidently spent a long time on Vickers' problem after obtaining a satisfactory solution of his own.

"There is one fact that I think will help you greatly," he said. "This planet is in an ice age—we could tell that from space. In this hemisphere, where it is now two Earth years past midsummer, the ice cap extends more than thirty degrees from the pole. In the other, the large island and continental masses possess glacial sheets scores of feet in thickness to within forty degrees of the equator; and heavy snow fields reach to less than twenty degrees south latitude in spots. On smaller islands, whose temperatures should be fairly well stabilized by the ocean, there appears to be much snow at very low latitudes.

"I suppose, though that's outside my line, that these people developed their civilization as a result of the period of glaciation, just as the races of Earth, Thanno, and a lot of the other Federation planets seem to have. Now, however, they have the situation of a growing race cramped into the equatorial regions of a planet—admittedly a large one, but with most of its land area in the middle latitudes.

"On Earth we pushed the isotherms fifteen degrees further from the equator, and benefited greatly thereby. How about selling the same idea to the Heklans, if you really want a convincing example of what we can do for them?"

"Two questions, please," returned Vickers. "First, what's this about changing the Earth's weather? I don't recall ever having heard of such a thing. In the second place, I'm afraid we'll have to sell the Heklans a little more than possible advantages. Our working theory, remember, is that I inadvertently got them leery of the combative and competitive elements of Federation culture. How would curbing their ice age, if you can do it, help that? Also, and most important, how does it help us to get a corner on the metal trade here before a real Federation agent steps in and opens the place up? Once that happens, every company from Regulus to Vega will

have trading ships on Hekla; and we want Belt Metals to be solidly established here by that time. How about that?"

"To answer your first point, we didn't change Earth's weather, but it's climate. There'd be no point in trying to explain the difference to you, I guess. They stepped up the CO_2 content of the atmosphere, producing an increased blanketing effect. At first the equatorial regions were uncomfortably hot as a result; but when the thing stabilized again a lot of the polar caps had melted, and a lot of formerly desert land in the torrid zones, which had been canalized for the purpose, had flooded in consequence. The net result was an increased evaporation surface and, through a lot of steps a little too technical for the present discussion, a shallower temperature drop toward the poles. The general public has forgotten it, I know, but I thought it was still taught in history. Surely you heard of it sometime during your formative years."

"Perhaps I did. However, that doesn't answer the other question."

"That's your problem, at least for the details. I should say, however, that their acceptance of that proposition would entail the purchase of a lot of machinery by the Heklans. A genius like you can probably take the idea on from there."

Vickers pursed his lips silently, and thought. There seemed to be some elements of value in Rodin's idea; elements from which, with a little cerebration, something might be built.

"If they were to accept such a proposition, how long would it take to get the thing under way?" he asked finally.

"The general plans could be obtained directly from the records, and apparatus set up in a few months, I imagine," was the answer. "It would depend to some extent on the nature and location of Hekla's volcanic areas—they are the best source of carbon dioxide, I believe; they were used on Earth. I imagine the *Alula* would require quite a few round trips to Sol to transport enough apparatus for this planet."

"How soon could we promise results to the Heklans? Remember, we want to establish ourselves solidly with them before competition gets too heavy. If a Federation agent gets here before any agreements are reached, trade of any sort will be frozen until the diplomats finish shaking hands. Until one does arrive, they can't touch us legally for entering into contracts with the Heklans, though they may frown slightly at the company's failure to report the discovery of civilization here."

"I'm afraid it would be a couple of decades—half a year or so, here—before the change in climate would be really noticeable. However, the theory would be clear enough to people like Deg; and they would begin to notice results on their maps almost immediately."

"How much increase in CO_2 would be needed to produce a useful result? And would that much be harmful to the Heklans? I imagine we would have to show Deg

some solid figures to overcome his suspicions enough even to consider the proposal."

"I've done a little figuring in that direction, but I can't give you a precise answer to the first question until I have more accurate and detailed knowledge of the present composition of Hekla's atmosphere. You'll have to do some investigating of your own for the second; I have no idea of the physical limitations of these people. That fellow Trangero looks rugged enough to take an awful beating from almost anything."

"The question is not whether they can stand it, but whether it will cause them discomfort. That would be plenty to squash the whole idea, unless they have a collective personality appallingly different from ours. In any case, the proposition will have to be presented delicately. We shall hold more discussions with Marn or Deg or any one else who will listen to us, provided he is a meteorologist; and I think it will be possible to build up to the subject, while describing our mechanical abilities and history and so on, in such a way as to make him think it's his own idea. The plan certainly has possibilities, Dave. We'll eat, and you'd better sleep, and then we'll have another session in the observatory. Sound all right?"

Rodin agreed that it sounded all right. It was just bad luck that Marn Trangero didn't.

The conversations seemed to steer themselves in the way Vickers desired, for several hours. They ran from subject to subject, dealing with matters connected with the Federation whenever Trangero held the conversational initiative, and veering back to things Heklan when Vickers could get control. The Earthmen learned of the lives of the half billion Heklans scattered among the equatorial islands of their planet; of their commerce, their science, their arts — but nothing of their wars, except against their environment. Casual references to feats of physical strength and resistance to cold, heat, and hunger, made the human beings blink, but partly reassured them of the creatures' ability to stand slight modifications of their atmosphere.

The Heklan learned of the doings of the natives of the scores of worlds whose co-operating governments called themselves the Federation. Vickers censored carefully the more drastic reference to strife, though he did try to make clear the more harmless aspects of a competitive culture. If he had known the mechanics of atomic converters and second-order drive units, Marn would probably have wormed the information from him; the creature was at least as acute a questioner as Vickers. The man was slowly realizing this fact, though he had originally believed that the giant had been chosen as their companion principally for his physical qualities. He wondered, as he strove to lead the talk to climate and the possibility of Federation science's improving it for Hekla, whether the bulky being were not laughing silently at his attempts. It was a demoralizing

suspicion, which success did nothing to allay; for the "success" came with suspicious rapidity after he set to work in earnest.

He had introduced the story Rodin had told him of the undertaking to modify the climate of their home planet; and Marn had appeared extremely interested, asking for a description of the results. Then he asked for a comparison of normal climates of Earth and Hekla. It was this request that Vickers misconstrued as success for his efforts. With rather good salesmanship, he decided to break off the discussion at this point, pleading the usual fatigue—they had been talking for several hours. Marn, he felt, had conceived the desired idea and should grow more enthusiastic if allowed to mull it over for a few hours. Vickers had become enthusiastic himself, which was a pity.

When they next met, Vickers felt happier than ever; for Marn's first words were a request for the method the Earthmen had employed to modify their climate. He asked, politely enough not to give offense, that Vickers translate Rodin's explanation rather than attempt to give one of his own; evidently he wanted precision. Vickers assented gladly. Rodin had found some details of the operation in Vickers' library, and was able to add much more from his own memory; so for half an hour he and Vickers alternated relation and translation, while the absorbed Heklan listened silently, his round face showing no expression that Vickers could interpret.

"An absorbing tale," Trangero said when the Earthmen had finished. "I applaud the ingenuity of your meteorologists and astronomers. I have seen no maps of your planet, but I gathered that much of its land area is in the middle latitudes, as is the case with Hekla. An operation such as you have described would open to us millions of square miles of land areas which at present we can use only in summer and autumn, if at all. It is a pity that it would not be effective on this planet."

For a moment Vickers sat, stunned by the Heklan's matter-of-fact remark.

"Why would it not work here?" he finally asked. "I have gathered that carbon dioxide is no more dangerous to you than to us; and it should be as effective a blanketing agent here. I realize the enormous thickness and extent of your ice caps, but even they would eventually yield to a general increase in temperature."

"Undoubtedly they would," replied Marn. "Unfortunately, your plan remains unworkable. In the first place, the atmosphere of this planet already contains approximately one and a half percent of carbon dioxide. More would not harm us, but neither would it help. You have forgotten something, which Rodin should have remembered if he knows as much of astronomy as our science requires. Our sun is much redder than yours; and an increase in the atmospheric content of any infrared opaque gas such as carbon dioxide, ozone, or

water vapor would cut out nearly as much additional incident radiation as it would retain the natural heat. I admit there would be some gain, but to make it enough to be a real help would demand a radical change in our atmosphere. You are working under different conditions here than you met on your own world, and your meteorology will not help us."

Vickers thought furiously as the Heklan fell silent. Rodin, who had not understood a word of the last conversation, realized from his friend's expression that something had gone seriously wrong. He tapped Vickers' shoulder to gain his attention, and asked for an explanation. It was given to him.

"Is he right, Dave?" asked Vickers, at the end. "Surely there is some modification of that trick that would work for this world. I have to give up that idea."

"I can't, on the spur of the moment, think of anything that would serve," replied Rodin, "but it seems to me that there must be some fairly simple solution. If necessary, we can call in one of the physics or chemistry boys, though I don't like to do that. I'd advise you not to appear too perturbed about the matter—after all, this was supposed to be one of Marn's suggestions. Just let the conversation ride on for an hour or two, and we can talk it over at dinner."

Vickers recognized the soundness of this bit of advice, and endeavored to abide by it. He was never sure that Marn had not noticed and interpreted the symptoms of annoyance the Earthman must have shown; but the creature never gave any indication of realizing what had occurred.. The rest of the morning was spent in answering his questions about beings and events beyond the R Coronae system.

In spite of his promise, Rodin said practically nothing at dinner; and immediately after the meal he repaired to the library. Vickers followed, and occupied a seat well out of the meteorologist's way. Silence ensued, broken only by the rustling of paper and the occasional scratch of a stylus in Rodin's hand. Vickers neither wrote nor read; he sat and thought, while his friend worked. In his own way, he also was working.

Presently Rodin looked up. "Marn is a bright specimen, no doubt," he said, "but he went a little too far when he implied that our knowledge of meteorology would not be helpful here. There are plenty of ways to alter climate in any direction you please, and some of them must be applicable to this planet. Of course, we want methods which will require the use of plenty of heavy machinery, so that we can sell them the equipment; but that doesn't narrow the field much, when one is working on a world-wide scale.

"The problem works down to a reasonably simple root. With a given solar constant, there are a number of things that can happen to the incoming energy. A certain percentage is reflected, and a

certain percentage absorbed. Modification of that ratio offers one means of climate control; that, in effect, is what we suggested to Marn. It may yet be possible, but the nature of R Coronae's radiation makes it difficult.

"If you take the absorbed energy as it is, the next point is distribution. Currents in the atmosphere and hydrosphere normally take care of that business; and both of those are subject to interference and consequently to control. Ocean currents, of course, are easier to direct; and it might be worth while to examine more closely the distribution of land and water areas of this planet, with that thought in mind. Distribution by air currents is modified by the height, friction values, existing temperature, and Heaven knows what other characteristics of the land over which they flow; that's the sad fact that makes meteorology more of a nightmare than a science, at times.

"I should say that redirection of ocean currents offered your best bet; we can try it on Marn, anyway. It will depend a lot on Hekla's geography, but he will realize that as well as I and will be able to pass judgment. That's the best I have to offer at the moment."

At least, Vickers realized, there was still hope even from his point of view. The construction work that would be required by such a plan meant plenty of heavy machinery. He agreed with Rodin on the subject of working the plan into the next conversation with Marn.

The Heklan readily agreed to show Rodin something of the geography of his world, when the meteorologist put the question up to him. He left the Earthmen for a moment, and returned with a heavy book, which proved to be an atlas. Inside its front cover was a folded leaf which opened into a map, several feet square, of the planet. It was on a projection similar to Goode's homalosine and showed the entire surface of the world; but only a few scattered areas in the arctic and antarctic regions showed anything like the detail displayed on the settled, tropical islands. The Heklans had done little exploring of their own polar caps; Marn said that such regions as the maps showed in detail were in the neighborhood of meteorological stations similar to the one on Observatory Hill.

Rodin, however, was not particularly interested in the polar caps. He examined closely the sea which extended entirely around the globe in the equatorial regions, broken only by the large islands and archipelagos on which most of Marn's race dwelt. In both the northern and southern hemispheres there lay enormous continental masses divided by relatively narrow arms of sea; and the more the meteorologist looked at these, the more confidence he felt in the practicability of diverting warm currents up those arms.

"I see that you have settlements near the equatorial coasts of these land masses," he finally said to

Marn. "Why is it not possible to spread further inland?"

"The extremes of temperature in the continental interiors not only make settled life there impossible, but cause violent and uncomfortable weather at the coast settlements and on the nearer islands," was the answer, as Rodin had expected. "The polar caps never melt entirely down to the ground over more than a tiny fraction of their area. They are too thick; and any gains made in the warm seasons are lost in the cold ones—quite evenly; the planet has reached a state of near equilibrium in that respect. It is unfortunate from the point of view of living space requirements; but I hate to picture the results of a major change which would interfere with that stability."

"Why should that be serious?" asked Rodin. "I had been considering that angle ever since our last talk; and it seems to me that sea walls could be designed to deflect the currents which now run around the planet in the equatorial ocean, into these arms of the sea which reach up between the continents. If this were done, it should result in an earlier melting of the ice to the east of the water, permitting the bare ground to absorb more radiant heat. That should gradually operate to get you ahead of the melting-freezing cycle, and the new equilibrium point should give you a good deal of livable land space."

Marn appeared interested.

"Could you go into a little more detail on that plan? I should like to hear how completely you have been able to handle the situation."

Rodin bent over the map, and began to indicate what he considered the best location and design for the sea walls, working as well as he could from a memory of the current-control installations on Vega V. Marn was unable to give him much data on ocean depth, but that was not too important. The coasts of the continents involved had a more direct bearing on the situation, and Marn was well informed on their nature. Rodin once more began to feel hopeful. He finished his exposition with the words, "If you feel that the undertaking is practical, any or all of the peoples of the Federation will be glad to help you with experience and equipment."

Marn did not answer for several moments, and the expectations of the Earthmen mounted with each second of delay. They should have known better by this time.

"It is a well thought out program; better planned, I think, than your first," the Heklan finally said. "Of course, you are under a handicap in that you are so completely ignorant of Heklan conditions. Your ingenuity and evident experience, however, have started me hoping that perhaps some of your Federation scientists could perform this feat, which seems to me impossible. I hope you will present the problem to your colleagues of the Federation, and that some of them will see fit to give their attention to the matter." He paused, as though to give Vickers a chance

to translate this speech; but before the man could do so, he appeared to have a further idea. "I think it would do no harm to let my people know of your presence, Vickers," he said. "I am sure they would be fascinated by the possibilities you have unfolded to me; and I don't believe your reason for wanting secrecy is valid any longer."

Vickers found himself in the hot part of a pincer movement, and thought furiously as he translated Trangero's speech to Rodin. "I guess we can let him broadcast if he wants to," he concluded, "but please do some fast talking on this weather business. He hasn't told me why your sea walls won't work; just takes it for granted."

"I don't believe he would tell me; and I believe it would work," answered the meteorologist. "He's keeping something up his sleeve, and we'll never worm it out of him. I think we'd better get out of here, and take a little trip. That would give us a chance to check my idea for ourselves—he's quite right in saying that I don't know enough about this planet. It might also present us with a better opportunity to do our work than this weather station seems to offer. Why not let these fellows announce our presence, and use the occasion to make a tour of the planet?"

Vickers could think of nothing better, and Marn seemed agreeable. So did Serrnak Deg, when the matter was broached to him. And so it was that the little lifeboat rose from Observatory Hill on what proved to be one of the most trying journeys either man had ever made. Serrnak Deg and Marn Trangero watched the sliver of metal vanish to the south; then they looked at each other, with almost human grins wrinkling their grotesque features. They left the tiny platform from which they had been watching, and entered the elevator. Marn got off at the level on which his office was situated, but Deg went on down; and Vickers would have been interested to note that the Heklan proceeded directly to the room from which the Earthman had been so carefully kept.

But Vickers had no opportunity to note this fact. He watched the cumulous banner above the hill fade into the haze astern; and when it was out of sight, he gave his attention to the landscape unfolding below them. It seemed a sufficiently pleasant country, of forested hills and open plains; but a close inspection of the forests showed great tree-ferns and fungi rather than normal trees, and Vickers knew that in Hekla's ten or twelve years of winter even this coastal strip was a howling, blizzard-racked desert of snow and ice; and just out of sight to the right as they followed the seacoast southward was the remnant of a giant ice cap where the heights were still snow-capped even at this season.

Rodin was only moderately interested in the view, until the coast began to curve gently westward.

Then he began to make careful checks, using one of the maps he had obtained at the weather station. Several times he lowered the ship to the water, checking its depth and temperature: frequently he cruised as low as was safe among the hills and above the trees, examining Vickers knew not what characteristic of the planet's surface. The meteorologist's pile of notes and computations grew in thickness, while Vickers did little save look on and enjoy himself.

Southward they drove, breaking away from the coast and moving far out over a broad stretch of sea, until the geodet told them they were nearly above the equator; then westward, still dropping occasionally for Rodin's perpetual measurements, over more water, interrupted at times by islands. Twice they saw what were evidently Heklan communities; each time they were small, but each boasted a landing strip similar to, but much longer than, the one on Observatory Hill. Several winged aircraft were parked in the open near each strip, and a single machine, similar in exterior design to the terrestrian lifeboat. Vickers was curious about its method of propulsion, since the Heklans were without atomic power, but he did not bother to descend to investigate.

For ninety hours they chased the sun, veering far enough to right and left to examine the near shores of most of the continental masses. Each time they did so, Rodin expressed greater confidence in his plan; and as the geodet told them that they were again approaching the longitude of Observatory Hill, he swung the ship northward, prepared to argue its merits to the limit.

Vickers took over the controls for a time, to let the meteorologist straighten out the last of his paper work. It was a token job, since the automatic controls were holding the craft on course and at a constant pressure altitude. They were cruising at a very moderate speed, since Rodin wanted time for his work; they were, Vickers calculated, about an hour and a half from the observatory. The usual layer of haze was overhead—thicker than normal, Vickers decided; the red sunlight pouring through the upper ports seemed less intense than usual.

He did not see the clouds until they were less than twenty miles ahead. It was the first extensive cumulus development he had seen on Hekla, and he debated calling Rodin; but he decided such clouds could not be too unusual, and failed to do so. He simply sat and watched the wall of vapor grow more distinct as the little ship approached it. It extended as far as he could see on either side and—up. An airplane pilot of an earlier century would not have come within miles of that angry black barrier; Rodin might have decided to go over it; but Vickers let the automatic controls carry the tiny machine straight into its heart. Even then, if the altitude control had been connected to the radio

altimeter, no harm might have been done; unfortunately, Vickers had tied it in to the atmospheric pressure gauge, in anticipation of reaching land.

The initial turbulence made no impression on ship or occupants; but five seconds after the sun had faded from sight the ship stuck its nose into the low pressure of an updraft, and Vickers left his seat. For several seconds he was dazed by the force with which his head struck the ceiling. In those few seconds the ship lost six thousand feet of altitude as the automatic controls sought a level of pressure equal to that at which they had been set. Before they succeeded, and before Vickers could regain his feet and the manual controls, the updraft was passed; and he was pressed helplessly against the deck as the ship plunged upward again. As it slowed, he seized the back of his chair and tried to brace himself against the sickening motion. For a moment he was partially successful, and he dared to let go with one hand in order to reach once more for the controls. As he touched them, there was a violent sideward lurch; and his hand, instead of striking the toggle controlling the altitude mechanism, opened the bar switch handling the sensation currents from the attitude gyros on the automatic pilot.

The ship could not have been out of control more than three or four minutes altogether; but those minutes were more than enough. Without the gyros, she no longer held an even keel, but pitched, yawed, rolled completely over again and again, still striving to follow the dictates of the altitude control. That barometer was sensitive enough for control in the upper stratosphere of planets like Earth and Thanno; and in the tremendous pressure changes accompanying turbulence in Hekla's dense atmosphere the little device went mad. Vickers, dazed and bleeding, bouncing from floor to ceiling and wall to wall of the control room, finally managed to hold on to the board long enough and firmly enough to set the selector at zero pressure. Still bucking and rolling, the ship went shooting upwards, and at last broke out into the crimson sunlight—more than thirty kilometers above the ocean, if the radio altimeter could be believed. The air was calmer here, and the ship quieted down enough for Vickers to level it by manual control, reset the toppled attitude gyros, and cut them in again.

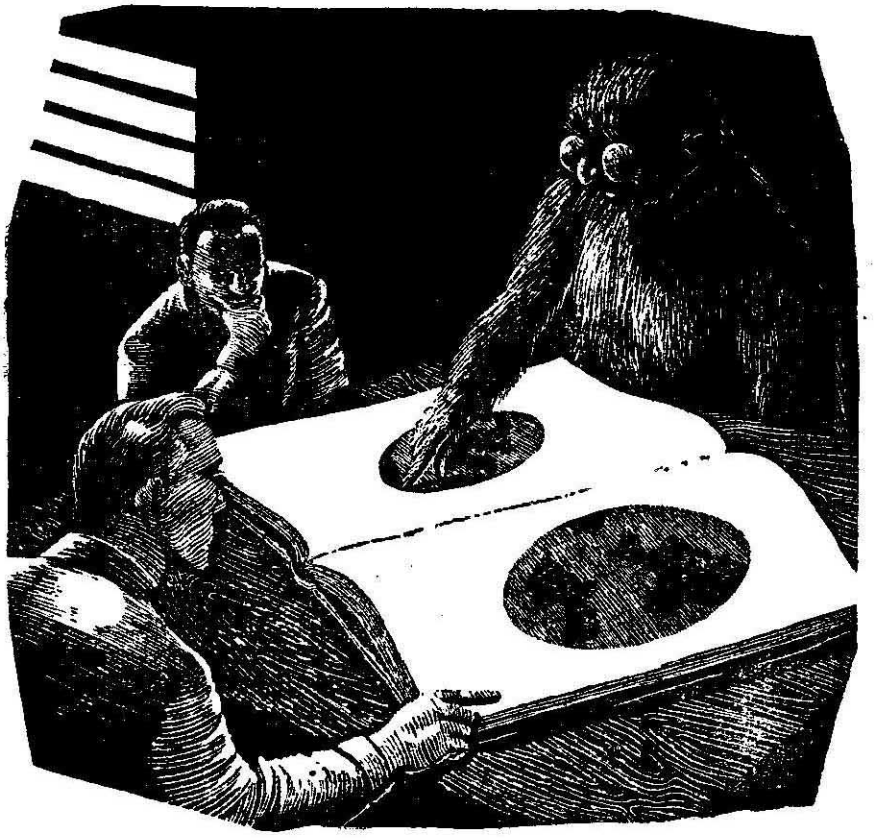
With a steady deck once more under his feet, he staggered back to the library where Rodin had been working. The meteorologist had taken a beating, but had suffered less damage than Vickers, owing chiefly to the fact that the library furniture was for the most part heavily upholstered. He made acrid inquiry into the cause of the disturbance, and was not particularly sympathetic with Vickers' injuries. They went forward to the control room together, and Vickers gazed through the port at the innocent looking, fluffy pink mass be-

low them while Rodin applied antiseptic and dressings to his contusions. When he had finished this job, the meteorologist began to observe, too.

Vickers had halted the ship when he had regained control, and they were hanging motionless above the wall of vapor. They were still in sight of the edge where they had entered it; and when Rodin set the ship in motion again they ran within a few minutes into an almost equally sharp termination on the other side. The front was only thirty or forty miles wide; and this, together with the altitude of the cumulous barrier, indicated a frontal slope that made Rodin whistle. Then he stopped to think; and the more he thought the less he was able to understand how a mass of cold air of such size and, apparently, extreme low temperature, could have wandered so far from the pole in midsummer. Then he remembered the violence which had resulted from a very slight temperature change, during the warm front he had watched at Observatory Hill; and he took the ship down on the cold side of the front to the altitude at which they had been flying when they ran into trouble, and compared temperatures. The difference was not great, but it was far greater than had been the case on the other occasion; and considering the density and other peculiarities of Hekla's atmosphere, it could account for such a violent front. It remained to account for the air mass. Rodin began to think out loud, as he considered this problem.

"This stuff appears to be of polar continental origin, judging by its temperature and dryness," he said. "It's not extremely cold, but in Hekla's atmosphere it could still have formed over the polar ice cap, and probably did. On Earth, such a mass couldn't come anything like this far south in summer. The normal surface circulation is too strong for it, and remains too strong as long as the ground is receiving much solar energy. However, it could be forced down like this if we supposed another, still colder, mass to the east of its source region, against which it was carried by the normal trade circulation and thence deflected southward. Also, a general cooling of the continental areas to the south of the source region might permit it to be carried down here around a normal cyclone.

"Either supposition demands a decrease in ground surface temperature comparable to that experienced at the onset of winter. I can't imagine any large area waiting until this late in the summer to become covered by snow; but I can't see any other means of dropping the temperature of a large area to any great extent, unless the axis of the planet shifts enough to decrease insolation in this hemisphere." He grinned wryly as he made that remark; he realized perfectly well that the application of sufficient force to shift the axis of a major planet would buckle its



crust at the very least, and more probably disrupt the world.

"How about night cooling?" asked Vickers. "This planet rotates more slowly than Earth."

"Not enough; in summer the nights are short anyway; and why would it wait until now, fully two Earth years after midsummer, to take effect?"

"Then how about this mist that seems to have been cutting off some of the sunlight of the last day or two? You must have noticed it—it appears to be above any level at which we've flown, so it can't be very dense; but it seems to be practically planet-wide, and cuts off enough light for me to notice without instruments."

"I hadn't noticed it particularly," said Rodin thoughtfully. "A high layer of water vapor or dust would have a blanketing effect, and would actually increase surface temperature, even though it cut off some visible light. However, there's something to the idea; the stuff might just possibly have a high reflecting power, I suppose. It

won't hurt us to go up and find this layer, anyway."

Rodin went back to the controls, and started the ship climbing slowly. Then he started the recorder of the radiograph he had set up at one of the portholes when he had first arrived, and waited while they rose through the thinning atmosphere to a level at which the outside pressure was no longer detectable. There he stopped ship and recorder, and removed the graph from the latter. The haze layer, if it existed, should have betrayed its presence by a more or less sharp break in the curve—or rather, a change in its slope—at the proper level; but Rodin, to his disgust, was unable to find anything of the sort by visual inspection. He was beginning to check the instrument for flaws that would affect its sensitivity, when Vickers remarked that the sun seemed still to be rather weaker than usual—rather as Sol would appear from Earth during a partial eclipse, allowing for the difference in their intrinsic luminosities.

"An eclipse?" queried Rodin. "Hekla has only two satellites big enough and near enough to produce a respectable eclipse; and even the partial phase would only last a few hours. You noticed this dimness a couple of days ago."

He went to the port and looked up at the sun. From Hekla's surface the human eye could bear to look directly at R Coronae's immense disk, but here above the atmosphere it was a little too bright for comfort. He rummaged in a drawer under the control panel, found a pair of shielded goggles; with these he approached the port again, and looked long and earnestly at the fuzzy crimson blot hanging in the blackness of space. At last he called Vickers, gave him the goggles, and asked him to look, describe, and if possible explain what he saw. Vickers obediently donned the eye shields and went to the port.

He had seen red giant suns before—who hasn't? He was familiar with the brilliant crimson or orange disks, with brightness fading rapidly toward the ill-defined edges, bordered by a faintly luminous rim of atmosphere that faded rapidly outward against the star-shot background of the Galaxy. R Coronae should have been the same.

Perhaps it was, he thought at last. Perhaps it did have a normal disk; but he couldn't see it—at least, not all of it. The lower quarter was visible, fading as it should and equipped with a normal atmosphere rim. A short distance up from this lower edge, however, a black line was etched across the crimson, projecting on each side. Where it appeared against the background of space, it glowed very faintly red. Above the line the stellar disk was hidden almost completely, as though by a cloud whose edge was represented by the border of black. The cloud, if it was a cloud, apparently grew thinner toward the top; for the upper side of the disk was faintly

visible through it. Vickers slid the goggles up on his forehead and took a quick look at the sun without them. He could see the foggy disk, and was just able to make out the dark line. Evidently the "cloud" actually cut off less light than the view through the shields indicated; but if, as it appeared, the appendage were attached to the star rather than to Hekla itself, a drop in temperature was not very surprising. He turned away from the port and addressed Rodin, who was waiting impatiently.

"If clouds are possible in a star's atmosphere, I'd say you had something on R Coronae quite similar to this cold front of yours right below us," he said. "If it happens very often, I suppose it's the explanation of the star's variability." He made this statement, so staggering to the meteorologist, in such a matter-of-fact tone that it was several seconds before Rodin could find voice. Finally he half-spoke, half-choked:

"You . . . you mean you have known all along that this star is a variable, and didn't think it worth while to tell me? You mean—" he sputtered, and lost voice again; and Vickers realized that the color of his face was not entirely due to the sunlight.

"Of course I knew it was a variable; didn't you? Most of the red giants are, to a slight extent, but it doesn't particularly bother the planets of Betelgeuse and Antares. I remembered that, and looked up this star in the type index before we arrived. It gave a C. I. and size about the same as the giants I mentioned, and was marked 'V' as they were, so I supposed it was the same sort of business here."

Rodin did not answer, but turned on his heel and strode back to the library, Vickers close behind. He found the index Vickers had used, checked its source of information, and located the indicated volume on the shelves. He thumbed through this for a moment, stopped, and read silently for a minute or two; then he handed the tome to Vickers and indicated the proper section. Vickers read, and slowly understood.

"'R Coronae Borealis is the name-star of a group of suns characterized photometrically by a light-curve of the form shown, and spectroscopically by the presence of strong carbon indications. It was suggested long before interstellar travel was achieved that the light variations were caused by temporary condensations of carbon vapor in the stellar atmospheres; and the correctness of this assumption was shown in the excellent series of photographs made by the Galactic Survey ship *Zenith*, which follow the formation of masses of carbon clouds through a full cycle from the beginning of condensation to complete dispersal. The actual mechanism and processes involved have not been closely studied, but it has been suggested that such a study should be conducted by a composite board of astrophysicists and meteorologists, as the phenomena seem to bear strong resem-

blance to those of planetary weather.

" 'The *Zenith* noted the presence of two planets in a cursory photographic sweep of the R Coronae system, but they were not closely examined, nor was the possibility of the presence of others eliminated.' "

Rodin nodded slowly as Vickers finished his reading.

"You called the shot very nicely a few minutes ago," he said, "when you called that black line a cold front. I should say that you were one hundred percent right. Blast it, to be a meteorologist in this system I'd have to know more astrophysics than a lot of Federation professors. You've certainly let me make an awful idiot of myself in front of those Heklans."

"Do you really think so?" asked Vickers seriously. "I don't see how they could expect you to know any better. You're a meteorologist, not an astronomer, as you said."

"On this planet, the distinction is probably narrow to the point of invisibility. Their weather men would *have* to be first-rate solar physicists. I must have seemed to them like a self-opinionated, bungling, incompetent—insisting time after time on the feasibility of a plan whose greatest flaw would have been obvious to a Heklan layman. I don't want to go back to that station, Alf—I couldn't face one of those people now."

"I'm afraid you'll have to," replied Vickers. "I sympathize with you, and am extremely sorry for your sake that it turned out this way; but from my point of view it's the best thing that could have happened. I hoped for something good to eventuate from your visit, but I didn't dare hope for this much."

Rodin's interjection at this point was of an interrogative and profane nature. Vickers smiled slightly, set the ship in motion once again toward Observatory Hill, and began to explain.

"I told you at the time of your arrival," he said, "that I feared I had unwittingly aroused in our hosts a fear of the competitive aspects of our Federation culture. That was quite true and correct, so far as it went. There was a little more than that to the situation, however. The Heklans had appreciated a still more fundamental fact about us. With interplanetary and interstellar travel, an already existing and working form of interworld government, with our knowledge of space and time and matter which cropped up occasionally and inevitably in my conversations with Serrnak Deg, it was glaringly obvious to them that our civilization was materially far in advance of theirs; that their achievements, compared to ours, were childish. As that realization sank in, they began to react in a fashion too painfully human not to be recognized.

"If something weren't done about that reaction, Hekla would not only refuse the minor dealing with us such as our attempt to sell

them metal and machines represents —they would, for their own protection, refuse to have anything whatever to do with the Federation and its component races. You know what has happened on other planets when a culturally and mentally inferior race was forced into contact with their betters. They died out, rapidly, and the cause was not deliberate extermination. In many cases, strenuous efforts were made to preserve them. Such things happened on Earth long before man left the planet; and it has happened all over the Galaxy since then.

"The Heklans are not our mental inferiors; they are intelligent enough to recognize a danger which must have been completely new to them, and to act on it in the only possible way—although that way is not a very good one, even from their own viewpoint. They may get rid of us, but they would have a hard time forgetting us."

"Are you sure they recognize the danger?" interjected Rodin.

"Reasonably sure; and even if they don't, it is none the less real—*and our making fools of ourselves is just as good a cure.* We showed them a field—probably not the only one, but certainly the most obvious—in which they are not merely our equals but have advanced far beyond us. We showed them in a way that will penetrate —their sense of humor seems to be as well developed as ours; and we showed them at the relatively minor price of your reputation—and mine, of course." The last phrase was an afterthought inspired by Rodin's attitude. The meteorologist calmed himself again with an effort, and asked a question.

"When did you realize what was happening to them, and what led you to that belief?"

"After my first long conversation with Serrnak Deg, I started to return to the ship alone. By an error, I stopped the elevator at the wrong level, and saw a room full of electrical machinery. I am not a scientist, but I think I know a teletype keyboard when I see it. Before I could see more, I was hustled out of the room. When I got back to the ship, I spent quite a while searching the frequency bands we have found practical for communication. I heard nothing, and yet the station was obviously in constant contact with the rest of the planet—even I know that a weather map can't be kept up to date otherwise. Disregarding the remote chance that they had either medium transmitters or a means of radiant communication undreamed of by us, it seemed obvious that the station was actually connected by metallic cables with other centers of communication. The method is primitive as even you will admit; why should they conceal the installation from me, if they were not ashamed of its simplicity?

"Later, when they showed us around the station, and failed to hide any of the other primitive equipment such as internal combustion engines, I was sure they had decided to give up the attempt to

conceal the inferiority they felt in the face of our apparatus. Deg had visited the lifeboat by then, remember. They were planning then, and must have been planning until we started this trip, to break with us completely.

"You can see why I didn't tell you this before. I'm not sure I should have told you now, because it will be necessary for you to go back to that station and not only admit your ignorance to Marn and Deg, but put the capping stone on the business by asking for enlightenment. I hope you have the intestinal fortitude to do it."

Rodin smiled wryly.

"I guess I can't let you down, since you've gone this far. Perhaps I can make up the face I've lost here by staying a while, learning some Heklan meteorology, and publishing a few papers for the benefit of the rest of the Galaxy. I can be the first *non*-Heklan stellar meteorologist, anyway, which ought to have some weight with my beloved colleagues. All right, Alf, I'll try it."

Vickers nodded and smiled slightly, as he altered the course slightly to bear toward the cloud banner of Observatory Hill, now vaguely visible in the distance.

"I was sure you would. After all, reputation or no scientific reputation, you have a job for which you get paid, same as I. Just don't lose any chance of building up to the Heklans the importance of their contributions to the meteorological knowledge of the Federation races."

"I won't," answered Rodin, "and it won't need much of my help. They really have something that will drive some of my friends wild, and will probably rock the astronomers slightly in their seats.

"But speaking of jobs, you also have one; and how does your proving to all concerned that it is impractical to work on Hekla's climate fit in with a program supposed to sell large quantities of metal?"

Vickers set the ship gently down on the ramp before turning to face his friend.

"That was solved some time ago. My motives in assuring successful relations with this race were not entirely humanitarian, though of course I don't regret the good I'm doing. My personal problem, of sales, was solved long ago, as I say; but without any Heklans the solution would be somewhat impractical. Hence the call for your invaluable assistance. Tell me, Dave, what you do if the landlord won't repair the air conditioner in your apartment?" He smiled at the look of comprehension on the other's face. "Of course. Granting the availability of other quarters, you move.

"There are certainly other quarters available for the Heklans, even if they are restricted to the systems of red giant stars; and the Federation can undoubtedly find a number of suitable worlds in a very few years, even if they are not already known.

"Any race that goes in for

colonization in a big way, Dave, is going to need spaceships in considerable numbers; and I am sure that Belt Metals will be only too glad to provide them. In fact, I think we might both draw a very comfortable bonus on such a transaction; and I plan, at the first opportune moment, to put the proposition to Serrnak Deg."

Vickers rose from the control seat, touching as he did so the switch that opened the inner air lock door.

"I think that covers all the problems of the moment," he said, as he struggled into a heavy jacket. "Now come on into that station with me, Dave. I want to see you eat humble pie!"

THE END.

IN TIMES TO COME

Coming up next month is the first half of a short novel by Arthur Leo Zagat—an author we haven't heard from in a long, long time. He has an extremely important basic idea—and an interesting yarn based around it.

It's seemed to me for some time that world peace can be assured in one way only; when there is only one man on the planet, there will be no need to worry about war. Short of that—some means is needed to keep high emotional levels from causing distortion of reason—and war.

It has also been pointed out that any mechanism—mechanism in its broadest sense, either a philosophy, a science of psychology, or an actual machine—capable of controlling human emotion invites certain other forms of disaster.

Next month's yarn is entitled "Slaves of the Lamp"—not the brass-polishing summoned type of slave, or a brass lamp, but the Hoskins Lamp, the basic mechanism of a truly effective peace organization. A thing that can keep the peace—if only Peace can keep the Lamps! The one thing they can't do, of course, is assure that the keepers of the peace-keeping mechanism won't go to warring amongst themselves. And when they do. . . .

Then Zagat gets a yarn—

Rain Check

by

LEWIS PADGETT

***It wasn't** human, or even remotely human. The race that created it had given it great powers. But one power it desperately wanted was denied it—*

The thing that seemed to be in the transparent block came from the past, not the future, and its alienage was due more to environment than to heredity. It had no heredity, except by proxy. The iGlann—which is not a typographical error but a pre-paleolithic race—created it when the glaciers began to grind down on the Valley. However, the iGlann died anyway, and, partly because they weren't human, none of their artifacts was ever found by later cultures of homo sapiens.

The iGlann were sapiens but they weren't homo. So the thing they made during their last desperately experimental days was a super-iGlann. It wasn't a superman, or probably Sam Fessier couldn't even have communicated with it when he found the transparent cube.

This happened a little before World War II.

Fessier came back to his apartment in a dither. He was a thin, red-haired man of twenty-eight, with blue eyes, a harassed expression, and at the moment a great longing for a drink. After he had had one, he discovered that company was even more desirable, so he went out, bought a fifth, and went to see Sue Daley.

Sue was a pretty little blonde who wanted to be a career woman. She worked for an advertising firm, a position which Fessier loudly scorned. He himself was a gag cartoonist, one of that band who habitually see the world through slightly cockeyed glasses. The passing of years had changed his allegiance from Winsor McCay to such mad modern Titians as Partch and Addams. (Titian is not a typographical error either, but the second i may be omitted without altering the sense.)

"I'm going to change my name," Fessier said after the third cocktail. "You can call me Aladdin from now on. Gad!"

Sue tried to scowl. "Don't use that ridiculous word."

Fessier said sadly, "Can I help it if most of my publishers are hypersensitive about blasphemy? I've got to be so careful about what I put in my captions that I've started talking that way. Anyhow, you missed the point. I said I'm going to change my name to Aladdin."

Sue picked up the cocktail shaker and made it tinkle. "Two more," she said. "One apiece. Drink up and then tell me the gag."

Fessier pushed her away as she tried to pour. "I suppose I'll meet this skepticism everywhere from now on. No, really, Sue. Something's happened."

She sobered. "Really, Sam? If this is one of your—"

"It isn't," he said desperately. "The hell of it is, it'll sound like a gag. But I can prove it. Remember that. Sue, I went into an auction sale today and bought something. A glass block, about as big as your head."

"Indeed," Sue said.

Fessier, oblivious to feminine nuances, plunged on. "There was a little mannikin or something in the block. The reason I bought it—" He slowed and stopped.

"It looked at me," Fessier said lamely. "It opened its beady little eyes and looked at me."

"Of course it did," Sue encouraged, pouring the man a drink. "Out of its beady little eyes, did it? This had better be good."

Fessier got up and went out into the hall. He came back with a paper-wrapped parcel, about as large as Sue's head. He sat down again, the bundle on his knees, and began to unwrap it.

"I was curious, that's all," he said. "Or . . . well, I was curious."

"Maybe its beady little eyes hypnotized you into buying it," Sue suggested, looking at him innocently over the rim of her glass.

Fessier's hands stilled on the knots. "Yeah," he said, and presently continued his task. There emerged a transparent cube, about nine inches to a side, with a man-

drake embedded in the substance. At any rate, it looked like a mandrake, or what the Chinese call a ginseng root. It was roughly man-shaped, with well-defined limbs and head, but so brown and wrinkled that it might easily have been merely an oddly-shaped root. Its beady little eyes, however, were not open.

Sue said, "How much did you pay for that thing?"

"Oh, ten bucks."

"Then you were hypnotized. Still, it's unusual. Is it for me?"

Fessier said "No" very abruptly. The girl looked at him.

"Got another wench on your string? I know. She lives in a mausoleum. Instead of giving her flowers, you bring her nasty little—"

"Wait a minute," Fessier said. "I think it's going to open its eyes."

Sue stared first at the block and then at Fessier. When nothing happened, she put out an exploratory hand, but Fessier shook his head warningly.

"Wait a minute, Sue. When I first saw the thing in that auctioneer's, it was all dusty. I rubbed it. That's when it opened its eyes. Then when I got it home, I rubbed it again."

"Just like Aladdin, huh?" Sue said.

"It was talking to me," Fessier murmured.

Night had begun to darken the city. Outside the windows grayness had turned into shadow. Electric signs were glowing in the distance, but they did not impinge: like the sounds that came up softly from the street below, they were impersonal. It is as easy to be alone in New York as it is in Montana, and that aloneness is somewhat less friendly. Perhaps that is because a great city is an extremely intricate, complicated social mechanism, and the moment one gets out of step with the machine, the immensity of the city makes itself sensed. It is overwhelming.

For the mandrake had opened its eyes. As Fessier had said, they were both small and beady.

When Sue became conscious of herself again, she thought that the creature had been talking for quite a while. It was purely telepathic, of course. Sound waves could not penetrate that nearly impermeable block. She was surprised to find that she wasn't surprised.

". . . but surprise and incredulity are the common human reactions," it said. "Even a thousand years ago that was true. People of your race at that time said they believed in witches and werewolves, but that's a different matter from actually encountering a concrete example of the supernormal. I charted the neural reactions—the chain progressing from incredulity to credulity by the logical process of demonstrative empirical proof, and worked out a convenient short cut. It's been a long time since I wasted energy unnecessarily. Take it for granted that you're convinced. I did it with something you might call psychic radiation. I can influence emotion that way, but unfortunately mnemonic control is

impossible for me. Your race is insatiably curious. Next will come the questions."

"Next will come a drink," Fessier said. "Sue, where did you put that bottle I brought up?"

"In the kitchen," she said. "I'll get it." But they went out together. Leaning against the sink, they looked at each other wide-eyed.

"The strange part is that I'm not a bit skeptical," Fessier said. "That thing might as well be the law of gravitation for all the reaction I get."

"But what is it?"

"I dunno. I just know it's . . . real. I'm convinced."

"Psychic radiation."

Fessier said quietly, "Are you afraid?"

The girl stared out the window. "Look, Sam. We believe in gravitation, too, but we don't lean out that window too far."

"Uh. There are two things we can do. One is to go out the back door and never come back. The other—"

"If it can juggle psychic radiation like ping-pong balls, it could kill us or . . . or turn us into brass monkeys," Sue remarked.

"Yeah. We *could* go out the back door, but I hate to think of our being chased down Lexington by a glass cube with a root in it. What am I standing here thinking for? Give me that." Fessier took possession of the bottle and used it efficiently. After a few snorts, it seemed logical that they should return to their prize.

Fessier said, "W-what are you, anyhow?"

It said, "I told you the questions would come next. I know your race. Perpetually curious. Perhaps, some day—"

"Are you dangerous?"

"Many have blessed me. I am old. I am a legend. You spoke of the tale of Aladdin. I am the prototype of the jinni in the bottle. And the lamp, and the prophetic mandrake, and the homunculus, and the Sybil, and a hundred other talismans that have survived in your legends. But I am none of these. I am the super-iGlann."

They stood before it, unconsciously holding hands. Sue said, "The what?"

"There was a race," it said, "not a human race. In the early days, there were many mutations. The iGlann were intelligent, but their minds were constructed along different patterns from yours. They might have survived, but the Ice Age destroyed them. Now. Your science has its blind spots, because you are human, and have human restrictions. You have only binocular vision, for example, and only six senses."

"Five," Fessier said.

"Six. The iGlann had their own limitations. In some respects they were more advanced than your race, in others less. They tried to find a method of survival, and worked at creating a life form that would be perfectly adaptable, perfectly invulnerable—and then changing their physical structure along such lines, so the Ice Age and other perils

would not destroy them. Man can create a superman, usually by genetic accident. The iGlann created a super-iGlann. Then they died."

"You're a superman?" Sue asked. She was slightly lost.

"No. I am the super-iGlann. It is a different line. A superman would theoretically have no human limitations. But a . . . let us say . . . a superdog would. I am a super-iGlann, with none of the iGlann's limitations; but there are things you can do that I cannot. Conversely, I am the legendary talisman, and I can grant your wishes."

"I wish I could be skeptical," Fessier said. "In fact, I am."

"You are not skeptical about my existence. Only about my powers. If you expect me to conjure up a palace overnight, you will be disappointed. But if you want a palace, I can tell you the easiest way of getting one."

Fessier said, "This is beginning to sound like "Acres of Diamonds." If you start telling me that pluck, luck and sweat will make me president, I'll start hoping I'm dreaming. Even in a dream, I don't like moralizing."

"You have binocular vision and only six senses," it said, "so you cannot visualize clearly the steps that lead up to a certain end. I can get, as it were, a bird's-eye view of your world and what goes on in it. I can see what streams lead to what rivers. Do you want a palace?"

They both said no.

"What do you want?"

"I'm not sure we want anything," Sue said. "Do we, dear? Fairy gold, remember."

It said, "Human moralizing, founded on jealousy and the sour grapes philosophy. Look at it realistically. Is evil always punished? And I am not evil, in any human sense. I am too old even to consider the validity of such terms. I can give you what you want, but I have my limitations. My vitality is low. At times I must rest and recuperate."

"Hibernation, you mean?" Fessier asked.

"It is not sleep," the mandrake said. "Sleep is something I do not know—"

Fessier said, "Everybody wants success in his field, I suppose. If—"

"Study Picasso and the Cretan artifacts." It named a few more artforms and mentioned a book Fessier had never heard of."

"Oh. I thought so. Pluck, luck, and sweat."

It said, "You have certain forces in you, and certain distinctive characteristics and talent. A spring can be analyzed qualitatively, but not by itself. I know what potentialities you have. Dam the spring at certain points, dig a new outlet, or let the spring erode it by itself. I told you I can't build a palace overnight."

Fessier was silent, but Sue leaned forward, her lips parted.

"Will . . . anybody be hurt by Sam's actions?"

"Undoubtedly some will."

She said, "I mean . . . somebody

won't die so Sam can step into his shoes?"

"Of course not. Probably fewer will be hurt by the altered course than if you had never met me. I believe one probability-likelihood is that eventually this man will contract a fatal disease and spread the contagion to dozens of others."

"Ouch," Fessier said. "Suppose I take your advice?"

"Then that won't happen."

"But something worse will?"

"I do not think so . . . no. From your viewpoint, the indications are that the results will be better for everyone concerned." And there was the whisper of a thought that said, "Even I."

Sue was following her own ideas. "Can I get in on this? I'd like to make a success out of my career."

"All I can do is show you how to avoid some of the natural obstacles that would ordinarily thwart you. Go to Chez Coq at ten next Wednesday night and wear a green hat."

"Is that all?"

"No. Get drunk. Now I must rest."

It closed its eyes and rested.

It had been to world beyond world. Time varied in various continua, and it could not tell now how many years or centuries or millennia had passed since the iGlann first gave it life. In the block it lay quiescent, to the human gaze. But it was not in the block. The block was merely the three-dimensional window through which it could gaze into the world it had first known.

A small, strange thing, less than a foot high, brown and wrinkled as a root, and as immobile. It rested, watching and waiting wearily.

But Fessier was reading an old book, and studying Picasso, Cretan art, and other matters. Thursday evening he was in his own apartment when the buzzer sounded and he got up to let Sue Daley in. She was pink and gay.

"Keep your fingers crossed," she said. "I've got an awful hangover, but it's been worth it. Where were you today? I phoned."

"Up at the Met," Fessier told her, putting out his cigarette. "I was making some sketches. What happened?"

Sue sat down and touched a book lying on a coffee table near her, a small volume with dozens of scraps of paper sticking out of it. "Is this . . . oh. Where's our talisman?"

"I locked it away in a closet. It's still asleep."

"It doesn't sleep," Sue said. "Remember? Anyway, I wanted to tell you what happened last night."

"Maybe you'd better. Since you wouldn't let me go along." Fessier sounded faintly jealous.

"It's just as well. I met a man. A funny little fat man who's incredibly sentimental."

"Uh-huh. And is he going to give you a million dollars?"

"Not quite," Sue said. "He was drunk as a lord. So was I, or I wouldn't have talked to him. He came over to my table and introduced himself. It seems he liked

my hat—the green one. It's a symbol to him. Back in the Twenties, Arlen's "Green Hat" was the fashion, and his wife was wearing one when he met her. They're divorced now, but Tubby practically carries around a bucket to cry into when he remembers the good old days."

"Tubby?"

"I can't help it," Sue said, gurgling. "He is. Very. His name's Robert Cowan Cook, and he's just bought into some business that does things with chemicals. Ink eradicator or something. It's all much too complicated, but Tubby wants to open an advertising account for his new firm, and when he found out I was in that business, he decided I was Heaven's blessing to Robert Cowan Cook. He saw the boss today, and I gather something's going to come of it."

"Swell," Fessier said, in a markedly half-hearted tone. Sue hastily got up and kissed him.

"Oh, Sam. Don't act that way."

"I know," he said, relaxing into a grin. "You'll become rich and famous, and I'll have to marry you for your money."

"Well, won't you?"

"Sure. But I'd rather—"

"You'll be rich and famous, too. Remember? What are we talking about?" Sue ended. "It's all coincidence. It must be."

Fessier made marks on a sketch pad with a charcoal pencil. "I suppose so. I believe in our . . . little critter, but not in his good works. Not yet. He forgot to convince me about those."

"Maybe he couldn't. He's limited, you know."

"Poor old fellow," Sue said. "He'd be hell on wheels with the iGlanns, but he *is* handicapped here. Humans must seem strange to him."

"Everything human is alien—to him." Fessier drew a curve, rubbed it out, and tried again. Sue craned.

"What's that? Oh." She squinted. "Something new?"

"I don't know. I've been getting some ideas. That book our talisman recommended—"

"Is this it? 'Tristram Shandy.' I never read it."

"Neither did I," Fessier said. "It's a curious book. The author wrote it just the way he wanted to. He had a cockeyed sort of view of the world. It's . . . funny."

He got up abruptly, unlocked a closet, and took out the transparent cube. He placed it on the coffee table.

Sue said, "He . . . it's asleep."

"You said it couldn't sleep."

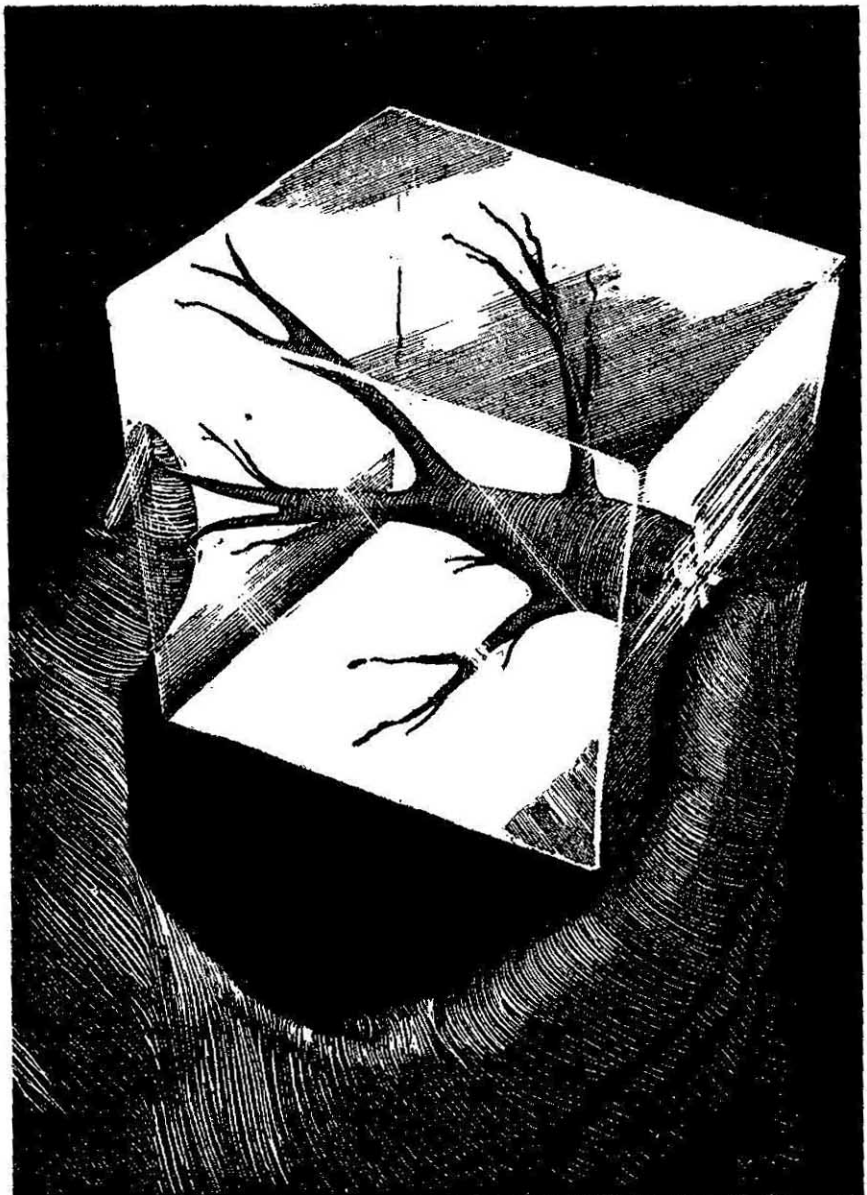
"Well, it's resting."

Fessier rubbed the cube. The mannikin didn't stir.

After a while he said, "Pluck, luck, and sweat eh? O.K. I'll respect the DO NOT DISTURB sign."

The super-iGlann went back into the closet—for a while.

Tubby, or Robert Cowan Cook, took a great, though platonic, interest in Sue. The girl saw to that. Cook Chemicals, Inc., was a new firm, and needed advertising. Tubby had decided that Sue was the only one who could carry out his ideas,



and so he had insisted that she be put in complete charge of his campaign. This irritated Sue's boss, but the account was too big to be lost through lack of diplomacy. Besides, he thought he could keep Sue in line.

But he couldn't. Sue planned her campaign along unorthodox lines, working out ideas that had built up in her scrapbook for years. She had an excellent mind for advertising, and, given a free hand, she did things that made her boss long to be twenty years younger so he could tear his hair. Robert Cowan Cook beamed, approved everything Sue did, and felt his business acumen justified when the response made itself known. Sue Daley was obviously going places, and realized that when other agencies began to bid for her services.

And Sam Fessier had begun to find his way, too. There was always a small, uneasy, nagging doubt inside him, intensified when he looked at what he kept in his closet, but a publisher wanted to make a book of his collected cartoons. Not his early ones, and there weren't enough of the new ones yet to fill a volume, but he had no difficulty in turning them out. He had established a new *genre*.

Neither the drawing or the caption alone could have accounted for the humor factor in Fessier's cartoons. His drawings and the ideas behind them were singularly funny. He had developed a new viewpoint, and found a new way of expressing it, both in line and in caption. It was derivative, of course, but the result was a synthesis that was peculiarly Fessier's own. It was not Tristram Shandy's viewpoint, but that of Tristram Shandy mingled with Fessier's, emerging in a cockeyed style of line drawing that made people laugh. Humor has its formulae. The spring had found a new outlet, and Fessier had discovered the right vehicle for his mind and the creative energy in it.

Six months later Fessier threw a party. He and Sue were getting married the next day, and this presupposed quite a binge. His apartment wasn't large enough, so they used Tubby's, and within two hours everyone was joyously tight. Fessier found himself with a wild-eyed chemist who worked for Cook Chemicals, Inc.

"Perfect solvent," said the chemist, whose name was MacIntyre. "Dissolves everything. Meaningless, meaningless."

Fessier, wet-nursing a highball on his knee, tried to look solemn. "Why?"

"Impractical. Not my job to think up a use for it. Plugging that new stink-remover Keister worked out. Heavy advertising for that. Don't want to release anything new to compete with it. Told me to wait. I got it patented, though. I mean the company did. Perfect solvent."

"It dissolves everything?" Fessier inquired.

"You're crazy," MacIntyre said, shocked. "What could you keep a perfect solvent in? Perfect solvent for some materials, I said. Clean,

quick, accurate. Lots of uses. Pour it on. *Pfffst!* Gone."

"I don't believe it," Fessier said.

They ended in MacIntyre's laboratory in the Cook works at Long Island. Perhaps Fessier wouldn't have walked out on the party if a movie actor, who was present, hadn't been rushing Sue violently. As it was, Fessier decided that Sue would be sorry when she found him dead, and went unsteadily to Long Island with the argumentative chemist. There was one disadvantage, they found. The laboratory had MacIntyre's solvent in it, and plenty of other materials, but no liquor at all. The next logical step was obvious. Fessier forgot about the party and headed like a homing bird for his own apartment, trailing MacIntyre.

"Perfect solvent for some things, anyhow," MacIntyre insisted, spoiling Fessier's coffee table by spilling some of the magic liquid on it. "There, see? It eats right through."

"Didn't hurt the metal, though," Fessier said.

"You're crazy. No such thing as a perfect solvent. What would you keep the stuff in?"

"A perfect insolvent," Fessier suggested, "I was, six months ago. All I had to do was change my name to Aladdin. Why not call your stuff Aladdin Mixture."

"That's a lousy idea," MacIntyre said disgustedly. "A very lousy idea." He got up and wandered around, spilling his perfect solvent here and there.

Fessier was feeling very sorry for himself and wanted to talk. He told MacIntyre all about the mandrake. MacIntyre was worse than skeptical; he was disinterested. "I only said it was perfect for some things," he explained. "Silicon, too. See? *Pfffst!*"

"But—"

"Gone. Oops. Maybe you needed that window, after all. Catch me."

Fessier was opening the closet, and MacIntyre managed to recover his balance through his own efforts. The transparent block came out and was exhibited on the damaged coffee table.

"Go on, convince this dumb lug," Fessier urged. "Wake up, pal."

Nothing happened. Fessier disgustedly took another drink. After a time he was surprised to find himself sitting at the other end of the room, not quite awake, watching MacIntyre examine the crystal block.

The chemist poured some of his perfect solvent on it.

Sobriety suddenly chilled Fessier. He jumped up, staggered, oriented himself, and sprang at MacIntyre. He pushed the man violently away. MacIntyre sat down on the couch, holding an empty metal vial in his hand, looking surprised. "I couldn't help it!" he was saying dazedly.

"No," Fessier said thickly. "No. *No!*"

The transparent substance around the mannikin was melting away. The solvent was swiftly eating through, working down to the gnarled little root-figure that stood motionless in the block. It was no longer a block, however. It was a

jagged, irregular stone, crumbling and crumbling.

And then it began to build up again.

Facet by shining facet, crystal grew around the mannikin. It didn't take long. The glittering translucence shimmered and faded, and the original transparent block stood on the coffee table, apparently unchanged, the mandrake figure fixed within it.

On the tiny, wizened face was—rage. Incandescent rage that made the little eyes hot crimson for a moment. The red glance swept from the unsteady MacIntyre to Fessier, and then to MacIntyre again. The rage flickered and faded. The small eyes dulled; the mandrake body went passive that had for a moment seemed to quiver with a dreadful aliveness.

The thought of the super-iGlann moved sluggishly through Fessier's mind "Failure," was that thought. "Failure again. It will have to be quicker than that, when the time comes again. Unless I am destroyed very fast, before I have time to adapt, I cannot be destroyed at all."

There was another thought after that, slow and calmer than before. "You may forget," it said. "You have failed me, but I grant you forgetfulness."

Petronius tells of a Sybilline oracle kept in a glass bottle. She was very, very old. When the schoolboys of that time gathered around and rapped on the bottle, they would ask, "Sybil, what wouldst thou?" And the Sybil answered, "I would die."

The super-iGlann was a racial failure. The iGlann had made it invulnerable and adaptable in the highest degree they knew, but the iGlann were not homo sapiens. They could not give it powers they did not possess themselves. They could give it only intensifications of their own talents.

They were not imaginative. They were not creatively intelligent. And perhaps, subconsciously, they died because they did not want to find a way to live. No one will ever know that.

In the super-iGlann's unconscious mind was firmly fixed the instinct for self-preservation, a trigger reaction that would enable it to use

its adaptability in the face of personal danger. *In spite of itself*—

It was old, this withered little brown mandrake root, and it could not create, even in its own mind. It would die. In other continua to which it had access, and through Earth's history, it had sought a weapon it could turn against itself. It could not sleep. The Sybil in the bottle was very, very old.

But its powers were limited. Among iGlann it might have turned that exotic race to its own purposes, but it was not superhuman. It could only chart the probabilities of human progress, and try to place itself in a position where a weapon would strike at it.

And it had tried. Time after endless time it had tried. All created things it had tried. Now it sought the new, and sought it deviously, among the devious paths of human relationship. The web it had woven for Sue and Fessier was only one of many webs, each separate thread anchored carefully to some point of apparent inconsequence. But when the web was complete, then a tug at the outermost edge set the whole structure quivering and the pattern rose clearly out of its tangle—

Sue must wear a green hat and write outrageous copy and borrow Tubby Cook's apartment for a party. Fessier must strike a perfect balance that his work might put him on a financial parallel with Sue's work, for without that equality the betrothal party could never have been. Fessier would not marry a woman more successful than himself. Fessier must be present to meet MacIntyre, and so must the movie actor be present, to drive Fessier out. And the end and purpose of all this devious contriving was—

Failure again.

Long ago the contriving had ceased to have value as amusement. Long ago, when those who were puppets to the super-iGlann's manipulations still wore skin cloaks and woad, or carried bronze eagles along the roads of Rome. But the puppets went on, and the super-iGlann went on, and the end was not yet.

For the seed was too deep in the unconscious mind that controlled that mandrake body, and could not control its own dark places. The action was pure reflex that set up an adaptive defense against whatever weapon was turned against it. A man may wish to commit suicide, but shrink instinctively from the knife's edge. And the super-iGlann's reaction was far more efficient than that.

It could invent no effective weapon for suicide, because it was not creative. It could only wait, while men studied and worked out their technologies—and when a new death was to be found, the little brown rootlet made deviously certain it would be in the path of that destruction.

By now the effort in itself was reflex that sent the crystal block which was a window into new nuclei of death. World after world it had tried, and returned at last as it must always return to press as close as it could come against this

window into the world the iGlann once knew. Here, if anywhere—it had told itself time after time. Here, if anywhere—

A flicker of a new scheme began to move through the timeless mind of the super-iGlann. Somewhere, the hope of a new doorway to success began to glimmer. And if that, too, failed—

The spring flowed on without ceasing. It could not make basic changes, but it could alter a little, here and there, through one Aladdin or another, so that new channels were opened, so that it might sometime, somehow, somewhere, cease to be.

They had been married for a week. Sue leaned on the parapet of the roof garden and said, "This is better than taking a trip. I mean, we can fix up our honeymoon to suit ourselves, right here in New York."

Fessier put his arm about her. "Sure. But it's only a rain check. We'll take a real honeymoon later, when your work lets up. Just the same, some day you're going to quit your job."

She smiled at the night. "Oh, let me be a career woman for a while longer. There's no hurry about a rain check."

"Of course not," he said. He put his hands on her shoulders and kissed her gently. "No hurry at all. We've always got our talisman, anyhow."

Sue frowned a little. "Oh. We don't, any more. Didn't I tell you?"

Fessier said, "Eh? What do you mean, Sue?"

"I shipped it off today to some museum. As a gift."

"You . . . did what? Shipped off the—"

She opened her mouth. "I . . . oh, Sam! I must be insane! I sent it away—gave it away . . . I *couldn't* have!"

Fessier said quietly, "It's all right, darling. But tell me just what happened."

"I don't know. I mean, I do know, but I'm just realizing now how crazy I was. I looked up a museum in the library, wrapped up the . . . our talisman, and mailed it there. But—I don't know why I did it!"

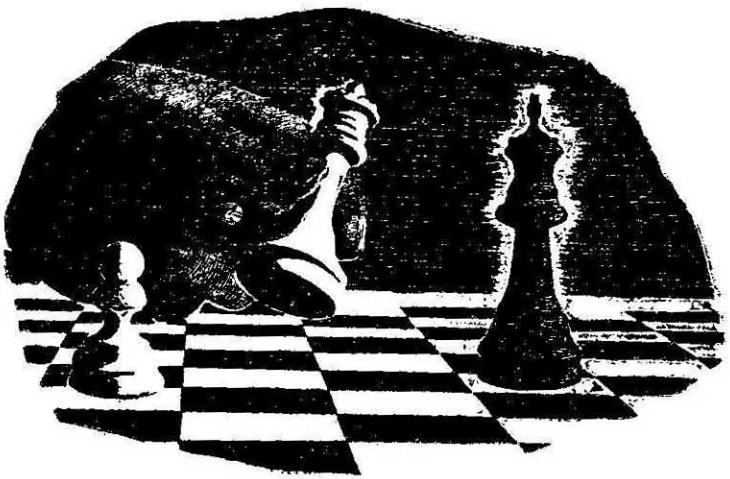
Fessier said, "Maybe you were hypnotized. What museum was it?"

She came closer, shivering, and they stood together there between the ancient incandescence of the stars and the fragile lights of the city below. "I'd never heard of it before," she said. "Some museum in Japan. Is there a place called Hiroshima?"

THE END.

Trouble

by GEORGE O. SMITH



"It takes two to make a quarrel" doesn't mean two different people, really—just two different viewpoints!

Tom Lionel, Consulting Engineer, awoke with a shake of his head. At once, he was out of bed. He consulted first the calendar and then the clock. The thought struck him funny. He hadn't been drinking, but the idea of looking at a calendar upon awakening might be construed as an admission that he didn't know what *time* of what *day* it was.

Or mayhap what month.

"Ding it," he grunted. "I've been away again."

He dressed by stages. At the trousers department, Tom wandered out into the living room and stood over a chessboard, studying the setup. The opponent had moved the queen to the rook's fourth, menacing his bishop. Tom smiled and moved his knight to his knight's sixth and checked the opponent's king on the rook's first, and the queen simultaneously. He slid the drawer below the table open and removed a little

standing sign that said, in red, block letters:

CHECK!

"Let him try that one, will he?" laughed Tom. The move was basic; in checking the king and menacing the queen simultaneously, Tom had —or would upon the next move— collect himself his opponent's queen with no great loss.

At the shirt and necktie stage, Tom Lionel stood teetering on his heels before the bookcase on the right of the fireplace. He took from the case a slim volume and read the title with considerable distaste:

"Theory of Monomolecular Films in Fission-Reaction"
By
A. G. Rodan, Ph.D., M.M., LL.D.

"Yipe!" exploded Tom as he opened the book and glanced at the price: $9.50. With ease he prorated the price against the thickness of the volume and came to the estimate that the book had cost approximately nineteen dollars per inch excluding covers. He riffled through the pages and paused here and there to read, but the pages themselves were a good average of four lines of text to the rest of the page full of nuclear equations.

Tom Lionel snorted. He ran down through one of the arguments and followed it to conclusion.

"Why can't he get something worth reading?" he yawned, putting the book back in its place. "Darned impractical stuff." As usual with a man who spends much time in his own company, Tom Lionel talked aloud to himself—and occasionally was known to answer himself back. "The whole trouble with the entire tribe of physicists per se is the fact that once, someone told one of them that he was a theorist, an idealist, and a dealer in the abstract. Now the bunch of them are afraid to do anything practical because they're afraid if they do, people won't know they're physicists. Physicists are a sort of necessary, end-product evil."

During the breakfast section of Tom's morning duties, Tom read the latest copy of the "Proceedings of the I.R.E." with some relish. A paper on the "Crystallographic Generation of Microwaves" complete with plainly manipulated differential calculus and engineering data occupied most of his time. The rest of the time through coffee he was making marks on the tablecloth with the egg-laden end of his fork and trying to fit the crystallographic generation of microwaves into a problem that made the article most timely; the solution for which he had been seeking for a week.

The mail arrived. Three household bills were filed in the desk to await the first of the month. Two advertisements were filed into the wastebasket. One thick letter addressed to Thomas Lionel, Ph.D., M.M., was taken carefully between thumb and forefinger and deposited in a letter file.

Tom then inspected the other letter file and found two letters addressed to Tom Lionel, Consulting Engineer, which he opened and read. One was from a concern in Cedar

Rapids that wanted some information on a method of induction heating glued joints selectively without waiting for the normal drying time. The other was a letter from a medium-sized town in Illinois pertaining to some difficulty they were having with police-radio coverage of that area.

Both letters meant money, and Tom Lionel set the first aside while he started to work on the second. From the engineering data supplied by the local engineer, Tom decided that a change in antenna height and a conversion from quarter-wave current fed to a one and one quarter-wave current fed antenna would give the desired coverage. He concluded his letter with four pages of calc, seven diagrams, and as a last measure dropped a photograph of a similar installation in the envelope.

He gloated. That would net him a pretty penny. The guy who hung that antenna on top of the water tank thought he was smart, getting all that height. But the roof was metal, and therefore the radiation angle took off from the rooftop as a basis rather than the true ground a hundred feet below.

The tank top was greater than three wave lengths in diameter, and conical to boot. Tom grinned at the maze of mathematics that solved it —and as far as he was concerned it was solved, for Tom Lionel was a top-flight engineer.

He checked on his calendar. Metal for the sonic job was not due for a week yet; a minute casting was still being held up for the foundry's pleasure; and the life-test of the bearing-jewel for the Watson Instrument Corporation was still on. Good jewel that. No sign of freeze-up or wear-out after twenty-seven million cycles.

"Theory of Monomolecular Films be hanged," he snorted. "He's the kind of a guy that would try to analyze the brew that MacBeth's three witches were cooking up. And don't ask why!"

What he objected to most was the other's unconcern at spending money. Nine bucks and fifty cents for a book of the most questionable theory —and nine fifty that the other didn't really earn. It was getting worse. The other was really beginning to obtrude. He hadn't minded, particularly, except for the mental anguish. He'd become reconciled to it by sheer rationalization. Way, way down deep in his heart he knew that he'd have enjoyed being a physicist himself. But physicists were not particularly practical, and money was made with practical things. He knew, and recognized, that his retreat from being a physicist himself had given him a dislike for the breed, especially when he knew that solution of a problem was theirs, but reduction to practice was his. He was continuously being forced to take some physicist's wild-haired scheme and making it cook meat, open cans, or dig post holes. The physicist had all the fun of standing on the threshold and delving into phenomena that abounded just over the line. And then instead of working on the suggestion that the physicist had located in the wilder-

ness, the physicist just tossed it over his shoulder into Lionel's lap and went on digging.

Obviously it must be fun to dig in the unknown, but why in the name of sense—

"Theory of Monomolecular Films in Fission-Reaction," scowled Tom Lionel. "A hypothesis on a theory for an idea, based upon a practical impossibility, and directed at a problem solvable only by concentrated masses. He should be working in a negative universe where nonmatter repels nonmatter disproportionately to the nonmass and inversely disproportional to the not-square of the not-distance between. Holy Entropy."

Tom Lionel went out of the house, mentally tinkering with the glue-joint heating problem. That shouldn't be hard, he thought, high-frequency heating was no trick, though the furniture company probably had no one in the place that knew what high frequency really meant.

He'd take a chair, rip it apart at the joints, and start tinkering with the big radio-frequency heater in the lab. . Another fat consulting fee —eminently practical and satisfying—from the simple engineering of a means to accelerate the drying of glue by electronics.

Eminently practi—*hell!*

Lionel stared. The door closed slowly behind him as he walked ever so slowly across the floor of the lab. There was his radio-frequency heater, all right. But it was not in its usual place. It was across the room nuzzling up against another piece of equipment—the latter new, shining, and absolutely alien to the lab.

Tom went over to the set-up and inspected it with critical derision.

The alien piece of equipment had been a standard model of mass spectrograph. Its sleek sides were gaping open, and the high-frequency heater was permanently wired—piped—into the very heart of the spectrograph. Peering into the maze of one-inch copper tubing that led from the output of the high-frequency heater to the insides of the spectrograph, Lionel saw at once what the reason was.

The spectrograph had been overhauled by the physicist. It now contained a pair of "D" chambers.

Operating on the cyclotron principle, the spectrograph was using the output of the high-frequency heater to energize the D chambers. Lionel nodded. The frequency was about right; could be adjusted to the proper value without any trouble at all. He felt an infinitesimally short twitch of admiration for the idea before he started to roar in anguish.

His first impulse was to rip the gadget apart so that he could go to work on something practical. But the engineer's admiration for the idea stopped him.

But this was getting thick.

It had been getting thicker for a long time. It was getting intolerable. He didn't mind too much having volumes of utterly cock-eyed theory about the place, but when the physicist starts to appropriate equip-

ment for his screwball ideas, it was time to call a halt.

Lionel left the laboratory, returned to his house, and called a psychiatrist.

An hour later he was in Dr. Hamilton's office.

"Why are you here?" asked Hamilton pleasantly.

"I want to get rid of a physicist."

"Tell him to go away."

"Can't. Impossible."

"Nothing is impossible."

"Look, doctor, have you ever tried to light a safety match on a wet bar of soap?"

"Suppose you tell me about it, then."

Tom Lionel was more than talkative for a half hour.

"A clear-cut case of split-personality. A most remarkable cleavage."

Lionel muttered something.

"What did you say?"

"I'd rather not repeat it," said Tom.

"Please—it may have a bearing on your case."

"I was merely thinking of an hypothetical case. Says the doctor to his associate: 'Doctor, look at this magnificent tumor,' and his buddy answers: 'Lovely, but you should see my case of angina; it's positively beautiful.'"

"Oh?"

"So I'm a most remarkable case, huh?"

"You are. There seems to be a deep-seated liking for one another that has been barred psychologically by certain factors in your youth. You play chess. You respect one another's property—"

"That's what you say. The other bird just screwed up my dielectric heater to fiddle up a cyclotronic spectrograph."

"Might try putting it to work," observed Hamilton.

"Oh, I will. After all, he can't get ahead of *me*."

"Then why the outcry?"

"Because who knows what he'll do next."

"He's appropriated things before?"

"Only to the extent of buying books?"

"What manner of books?"

"The last one he purchased was entitled 'The Theory of Monomolecular Films in Fission-Reaction.'"

"Mind explaining that? It sounds like Greek to me."

Lionel smiled tolerantly. "If you have a flat table and a pile of kid's toy blocks, you can either build a structure or lay 'em on the table in a single layer. Since molecules are often called the building-blocks of the universe, the analogy is quite clear. The blocks in a single layer form a monomolecular layer. Fission reaction is a self-sustaining nuclear reaction."

"Sounds quite erudite."

"In the first place, no one with any sense would try to make use of it. It is the type of volume that a physicist would write in the hope that he will get letters pro and con on the subject which will be useful in forming a later theory."

"Then it is not a complete waste of time."

"Any time I lay out nine bucks for a half-inch of paper—"

"Expensive, isn't it?" asked the doctor.

"Sure. Those things are not best sellers, usually. The publisher puts it out in the name of science and must at least get his printing cost out of the very limited edition."

"I see. And you want to get rid of this physicist?"

"Who wouldn't. After all, I had this body first. He's an interloper."

"Seems that way."

"It is—and it's annoying."

"We may be able to do something about it," said the psychiatrist. "Permit me to think about this for a few days. We'll have another consultation in a week. We may require another one before I make a decision. But it seems to me that you are both intelligent, useful citizens. Neither of you is irresponsible or dangerous. You have enough money to afford schizophrenia for a while. Especially if the personality B dreams up things that personality A makes practical, financially advantageous use of. Ergo you need fear nothing for a few weeks."

"Ugh. Means I'll have to go out and buy another high-frequency heater. O. K., doctor. I'll lay low."

Thomas Lionel, Ph.D., M.M., awoke with a shake of his head. At once, he was out of bed. He consulted first the calendar and then the clock. The thought struck him funny. He hadn't been drinking, but the idea of looking at a calendar upon awakening might be construed as an admission that he didn't know what time of what day it was.

Or mayhap what month.

"I've been away again," he grunted.

He dressed by stages. At the trousers department, Thomas wandered out into the living room and stood over the chessboard, studying the set-up.

He removed the little sign that said:

CHECK!

and dropped it into the drawer again. He moved his king aside with a contemplative smile. His queen was gone on the next move, he knew. So he had lost a major piece. So that other bird thought that losing a major piece was bad, huh? Well, winning battles does not count—it is a matter of who wins the last one.

He found the volume on the theory of monomolecular films and started to read with relish. Over coffee, at breakfast, Thomas made notations on the margin of the book with a pencil; checked some of the equations and though he found them balanced properly, the author was amiss in not considering the lattice-effect in his presumptions. No monomolecular film could follow that type of reaction simply because—well, it could follow it,

but since the thing was to take place in a monomolecular film, the fission-reaction and the radiation by-products that cause the self-sustaining nature could only be effective in a plane of molecular thickness. That meant a .999999% loss, since the radiation went off spherically. Fission-reaction might take place, but it would be most ineffective. Besides, the equations should have taken that into account.

He stopped by the desk and wrote for a half hour, filling seventeen pages full of text and mathematics, explaining the error in the author's presumption.

He sealed it up and mailed it with some relish. No doubt that letter would start a fight.

He found his letter in the letter file and read it. It was a request to indulge in some basic research at a fancy figure, but Thomas was not particularly interested. He was thinking of another particular line of endeavor. He dropped the letter into the wastebasket.

He went into the lab and took a look at his cyclotronic spectrograph. There was a letter hung on the front. Thomas opened it and read:

Dear Isaac Newton:

I don't particularly mind your laying out thirty-five hundred bucks for a mass spectograph.

Appropriating my high-frequency generator didn't bother me too much.

Nor did your unsymmetrical wiring and haywire peregrinations in and about the two of them annoy (too acutely) my sense of mechanical and electrical precision.

But the idea of your using the ##&&%!! spectrograph only once—just for pre-change calibration—makes me madder than mad!

Sincerely,
Tom Lionel,
Consulting Engineer

Thomas grinned boyishly and picked up the notebook on top of the high-frequency heater. It was Tom's, and the physicist riffled through it to the last-used pages. He found considerable in the way of notes and sketches on the cyclotronic spectrograph. Cut in size by about one quarter, the thing would be not only a research instrument of value, but would be of a price low enough to make it available to schools, small laboratories, and perhaps production-lines—if Tom Lionel could find a use for a mass spectrograph on a production line.

Thomas grinned again. If it were possible, Tom would certainly have it included on *some* production line, somewhere.

He looked the spectrograph over and decided that it was a fine piece of apparatus. So it wasn't the shining piece of commercial panel and gleaming meters. The high-frequency plumbing in it had the touch of a one-thumbed plumber's apprentice after ten days' drinking and the D plates were soldered together with a heavy hand. But it did work—and that's all he cared. The knobs and dials he had added were sticking out at all angles, but they functioned.

And the line-voltage ripple present in the high-frequency generator made a particular mess out of the

spectrograph separation. But electronic heaters do not normally come luxuriously equipped with rectifiers and filters so that the generator tubes were served with pure direct current—the circuit was self-rectified which would give a raucous signal if used as a radio transmitter. That generated a ripple-varied signal for the D plates and it screwed up the dispersion. The omission of refinement satisfied Thomas. So it wasn't perfect. It would be by the time Tom Lionel got through with it.

And for the time being, Thomas would leave it alone. No use trying to make it work until Tom made an engineering model out of the physicist's experiment.

Smiling to himself, Thomas went to work in the laboratory. He ignored Tom's experiments and started a few of his own accord.

Some hours later, the doorbell rang and Thomas went to the door to find a letter, addressed to Thomas Lionel, Ph.D. It was from an Arthur Hamilton, M.D.

"Hm-m-m," said Thomas. "Is there something the matter with me?" He slit the envelope and removed a bill for consultation.

"Consultation? Consultation? What in the name of all that's unholy is he consulting a doctor about? Or is the doctor consulting —no, the bill is rendered in the wrong direction. I know my consulting engineer."

The physicist put on his hat and headed forth. It was not much later that he was sitting again in the same chair, facing Hamilton.

"You're back."

"Nope," smiled Thomas. "I'm here, not back."

"But you were here last week."

"That was another fellow. Look, Hamilton, I think I require your assistance. I have an engineer that is no end of bother."

"Want to get rid of him, huh?" answered Hamilton. The suppressed smile fought valiantly and won, and the doctor's face beamed and then he broke into laughter. "What am I, anyway? Man, I can't take money from both sides. That's . . . that's . . . barratry, or something."

"I'm the same man."

"Nope. You are not."

"Well, by and large, I thought it might be of interest to you to hear both sides. It might be that I am a useful citizen in spite of what the engineer says."

"The engineer's opinion is that no physicist is worth an unprintable."

"The physicist's opinion is that all engineers are frustrated physicists."

"Might challenge him to a fight."

"Have. But chess isn't too satisfying. I want blood."

"It's your blood."

"That's the annoying part of it all. He seems entirely a different fellow."

"The cleavage is perfect. You would think him a separate entity." Hamilton paused, "But neither of you refer to the other by name.

That indicates a psychological block that may be important evidence."

"O. K., what do we do?"

"I must discover the reason for the split personality."

"I can give you that reason. The engineer was forced into being a practical man because money lies in that direction. Upon getting out of college, there was a heavy debt. It was paid off by hard work—a habit formed and never broken. Bad habits, you know, are hard to break."

"Interesting."

"Well, the desire to delve into the physicist's realm stayed with the engineer, but people who had heavy purses were not interested in new ways to measure the ether-drift or the effect of cosmic radiation on the physical properties of carbon. Money wants more perfect pencil sharpeners, ways of automatically shelling peas, and efficient methods of de-gassing oil. All these things are merely applications in practice of phenomena that some physicist has uncovered and revealed and put on record so that some engineer can use the effect to serve his ends.

"At any rate, the desire to be a physicist is strong, strong enough to cause schizophrenia. I, Dr. Hamilton, am a living, breathing, talking example that an engineer is but a frustrated physicist. He is the troubled one—I am the stable personality. I am happy, well-adjusted, and healthy."

"I see. Yet he has his point. You, like other physicists, are not interested in making money. How, then, do you propose to live?"

"A physicist—or an engineer—can always make out well. The bank account at the last sitting was something like ninety-four thousand, six hundred seventeen dollars and thirty-four cents."

"That's quite a lot of money."

"The engineer considers it a business backlog," said Thomas. "Equipment is costly. Ergo—see?"

"I see. Seems you laid out a large sum of money for a mass spectrograph."

"I did."

"And what did he do?"

"He made notes on it and is going to peddle it as a commercial product. He'll probably make fifty thousand dollars out of it."

"I suggested that," admitted the psychiatrist.

"That's all right. I don't mind. It sort of tickles me, basically. I do things constantly that make him roar with anguish. And then his only rebuttal is to take it and make something practical out of it."

"I see."

"That, you understand, is the game that has been going on for some time between all physicists and engineers."

If you'd leave one another alone, you'd all be better off," said Hamilton. "From what I've heard, the trouble lies in the fact that physicists are not too interested in the practical details, whilst the engineer resents the physicist's insistance upon getting that last point

zero two percent of performance."

"Are you willing to give me my answer?"

"What answer?"

"How do I get rid of the engineer? One of us has got to go, and being the stable, happy one, I feel that all in all I am the best adjusted and therefore the most likely to succeed. After all, I am the ideal personality according to the other one. He'd like to be me. That's why he is, from time to time."

"Sort of a figment of your own imagination."

"That's me."

"Then I wonder— Yet, I did accept his case, not yours."

"Whose case?"

"Um . . . ah . . . I— Look, if you frustrate him to the extreme, he'll retreat into you more and more until he does not appear. Follow?"

"I get it. O. K., doctor. He'll be the most frustrated engineer in the world. And I am just the guy to do it."

Tom Lionel, Consulting Engineer, looked foolishly at the claw hammer in one hand and wondered

about it. About him in the laboratory were stacks of huge packing cases.

Unpacked already were several monstrous bits of equipment. Lionel shook his head. Where had this mess come from? He hadn't ordered it—

Or,

Had he?

Lionel left the laboratory on the dead run. He tripped once and fell flat on his face and as he started up again, the top of his head came with a sharp bang against the unyielding bottom of a ruling engine.

"A grating engine," yelled Tom.

On the desk, in plain sight, was a pile of bills-of-lading. Tom riffled through them, consulted packing lists, and a catalog of ordered equipment. In his own handwriting, too.

Grand total outlay $94,617.34; balance to be paid within thirty days: $16,750.00.

"Not only broke," grunted Tom, "but bleeding too."

His handwriting was his handwriting. Not a chance in the world of refuting the order, or packing the stuff up and sending it back. He was stuck with it.

But the conglomeration that Thomas had picked out. A sort of aggregation of large and small parts that would have made a small college laboratory figuratively drool at the thought; but which would only grow dust, rust, and corrosion in any manufacturing plant.

With the possible exception, of course, of a manufacturer of scientific equipment for colleges and laboratories.

What production line could make use of a ruling engine?

And if one could, could it use a micro-densitometer in the same process?

Of course, the micro-vacuum pump could be used in vacuum tube manufacture, in a pinch. Vacuum tube companies normally used large-volume pumps instead of the little super-efficient exhaustion pump that could take a few cubic centimeters down to a few millimicrons of mercury.

The electron microscope was a nice hunk of stuff, but the thing was not applicable to anything except research.

And the instantaneous X-ray gadget was tricky as the devil—and adapted mostly to the job of taking pictures of bullets under fire as they passed up through the rifling of a gun.

One pile of stuff was directed—according to Tom's designation—only at the problem of investigating the Earth's gravitational field as for strength, direction, and conflicting urges.

A transit. Now what in the name of sin would a radio engineer want with a transit? Nice piece of stuff, and far superior to the little dumpy-level that Tom used to lay out antenna arrays and directive antennas of one sort or another. But, a transit!

And so the list went. $111,367.34 worth of the most interesting, best

made, neatly assembled hunks of utterly impractical scientific machinery ever collected under one roof.

A solid vista of impracticality as far as the eye could reach.

The ton of bricks that broke the camel's back.

Tom roared through the house, took a look at the chessboard and with a savage movement, took the physicist's queen with his knight. He'd get even with that physicist if it took—

Well, almost anything.

Fifteen minutes later he was in Dr. Hamilton's office, pounding on the desk.

"Look," he roared, "that physicist just clipped me for my entire bankroll and then dropped me into debt by sixteen grand. I want him clipped!"

"Now take it easy," said the doctor. "Remember you are talking about yourself."

"Doc, if I commit suicide am I liable for murder?"

"Yup. Going to try?"

"Nope. Life is too interesting. My main regret with life is that I was born a hundred years too soon. My only compensation is that I may live to be a hundred, so that I can see what I've missed by being born too soon. Follow?"

"You sound mentally healthy enough."

"Thanks. But what about him? You've seen him."

"I have. He came to me about you."

"And what are you doing about it . . . us?"

Dr. Hamilton laughed. "Mind if I speak bluntly?"

"Not at all. I can take it."

"Then consider. Both you and your . . . physicist . . . are sensible, useful citizens. Both of you can contribute much to civilization. Both of you can and will be respectable people, for which other people will have admiration.

"I am in the middle," said the doctor. "I can be no more than a referee. I see both sides. I believe the cleavage came as a result of frustration on your part—you know the details—and as such, you become him when you are frustrated. The reason why he becomes you is also clear. Whenever he finds himself in straits due to the necessity of practical thought, the slip-over occurs. You awoke with a stripping hammer in your hand, unpacking scientific equipment that the physicist bought. He, obviously, became quite worried about the financial situation upon viewing the stuff he bought and could face it no more."

"Sounds reasonable."

"Now consider again. Neither of you is dangerous. You are both interesting and valuable to society. The only thing that is at all bothersome is the fact that you, per se, are not happy. You need an integration of personality. He needs the same. I might hope for a coalescing of you two, but at the moment—and possibly for all time—it is impossible. All I can tell you is the same thing that I told

him. Frustration to the extreme will exorcise the other personality. He tried it by running you into debt; by purchasing a laboratory full of things that you, as an engineer, can see no practical use for. You frustrated him—or tried to—by making something commercial out of his last experiment. That, unfortunately, was not frustration for him.

"You must—if you wish to freeze him out—develop something that will frustrate the physicist and still be possible to rationalize in your own personality."

"Um."

"An insolvable problem would do it—if you can shun the problem yourself."

"That might be difficult."

"Especially when the two of you are inclined to become the other when faced with a problem that does not fit in your psyche."

"The problem—I wonder."

"What do you do when you are faced with a tough or impossible problem in physics?"

"I don't get 'em, usually."

"Well, supposing some company required a casting of tungsten metal, for instance."

"I'd ask that they show me exactly why the tungsten couldn't be formed in another manner."

"Supposing they demanded that it be cast?"

"There isn't anything on God's green earth that could be used to handle molten tungsten. Tungsten metal can be shaped, forged, machined, or cold-rolled. But you can't cast it. Ergo, if I were offered that problem I'd merely ask why they needed it. If they require a tungsten shape, I'd recommend shaping or machining, for instance, depending upon how the shape is. If they merely want a tungsten casting for the sake of wanting a tungsten casting, I'd laugh at them and tell 'em it was impossible as I close the door behind them."

"And your physicist?"

"He wouldn't even consider it. To him, no real problem exists. He'd have no truck with a production department in the first place, and in the second, shaping metals isn't particularly of interest to a physicist, excepting when the shape itself is important. And then he doesn't give a howling hoot how it gets in that shape as long as it is shaped properly."

"Well, as I see it, you must evolve something that will frustrate the physicist while holding his interest. He must be compelled to consider this insolvable problem by sheer interest alone. It also must be something that you can see no interest in save as a problem for him, otherwise you may find yourself biting your mutual fingernails over your own devilish plan."

"Um—that's a large order."

"That's it," said Hamilton. "And in the meantime, I'd suggest that you tinker around with some of the stuff you bought. It will lessen the shock of your problem of the bankroll."

"That bank of junk might be the means to his own frustration," grinned Tom. "Every time I look

at it, I get a feeling of what can be done about it that is practical, and that may force him into existence and keep him there."

"Well, good luck. And remember, I am just a sort of referee. One of you will become the stronger. One will succeed. I can hope for coalescence, but I doubt that it will take place. Lacking that, all I can hope for is that eventually you will become reintegrated and that the lesser personality will be frozen out."

Tom Lionel returned home, thinking furiously.

"May the best man win, huh?"

It was seven solid weeks by the calendar. Seven solid weeks of hard, backbreaking work during which everything went fine and dandy for Tom Lionel, Consulting Engineer.

The balance of his debt was paid off when Americal Electric purchased the rights and royalties of the cyclotronic spectrograph. The equipment in Tom's laboratory had been kept in good shape, polished and even used occasionally. It was all connected for operation, and though the laboratory had changed from a spacious building into a place where aisles and areas abounded between banks of equipment, it did make an impressive sight.

Even the transit came into use.

And then at the end of the seventh week, Tom Lionel looked at his notebook and started to consider in all of its aspects the rather improbable phenomenon recorded there. He not only let it prey on his mind; he stopped hourly and invited his mind to consider the evidence. At first his mind rejected it on the basis that science was not equipped to consider it, and then as the evidence seemed definite and leading, his mind accepted the fact that this problem did exist and that it was a real and utterly baffling problem.

Then his mind rejected it on the basis of impracticality. It would be nice—but.

No known physical effect could possibly explain it in a satisfactory manner.

Tom went to sleep.

And Thomas Lionel, Ph.D., M.M., awoke. His first consideration was the chessboard. It baffled him. He didn't really think that the engineer would capture his queen. It was too easy. Obviously, there was more to the set-up than appeared. For offering the trap of the double-check and subsequent loss of his queen, Thomas had opened the row blocked by the knight. That left him in the desirable position of capturing the engineer's rook, after which if the engineer was not more than careful in his counterattack, he would find himself staring a checkmate in the face. Either the engineer was blind to the trap, or he had a more complicated trap to spring once the physicist started to move in.

He had time. He wanted to consider the whole thing. He was

going to be darned sure that he was right before he moved.

He dressed slowly, and as he entered his kitchenette to prepare breakfast, he saw a new notebook on the table. He picked it up, riffled the pages first, and then read the lettering on the front page.

PHYSICAL DATA AND OBSERVATIONS MADE ON THE OCCURRENCE OF THE MANIPULATION OF NATURAL FORCES WHICH HAVE NO EXPLANATION IN THE KNOWN REALM OF PHYSICS.

Contents:

173 pages of text.
77 pages of calculations.
48 tables of figures.
67 photographs.
13 statements made by unbiased—but not trained—observers.
7 similar incidents not given scientific attention.
29 graphs and curves
25 pages of description and data pertaining to:
- meteorological conditions.
- terran constants — gravity and magnetism.
- sunspot activity.
- chemical analyses of earth at discreet intervals near the occurrence.
- analysis of atmosphere during phenomena.

Accompanying information and data are samples of earth mentioned above. Atmospheric samples were contaminated during analysis and have therefore been destroyed.

"Little Tommy has been a busy lad," mused the physicist. "'No explanation' huh? That's a laugh. *Anything* can be explained. Well, my engineering friend, let's see what you have cooked up for me."

Thomas Lionel started to read the "173 pages of text" and got down as far as the bottom of the first page. He blinked, did a double take, and reread it.

"Great howling entropy," he grunted. "The unmitigated screwball has spent weeks in the compilation of data on his own, personal observations of a *poltergeist* in action!"

Thomas took the cigarette case from his pocket and extracted a cigarette. He snapped the lighter and was amazed to see the colors on the case. They were scintillating, iridescent, and beautiful. They danced and changed as he moved the lighter, and the swift play of color across the surface of the case caught his fancy.

It also caught his scientific sense. He looked at the case carefully and swore. Tom had been using the ruling engine. The surface of the cigarette case was a mirror-grating and it was as good a job as the ruling engine could produce.

Thomas fumed. The idea! And then he smiled a bit. For the engineer's use of the ruling engine to decorate a cigarette case was a sort of prostitution of the machine, but it had not harmed the engine in any way. And it was certainly no worse on the physicist's nerves than the irrelevant mixture of precision and utter sloppiness that characterized the physicist's work.

It was, the physicist admitted, beautiful.

He returned to the engineering data.

A poltergeist!

The "throwing-ghost" of the ancient lore and myth. The fearsome manifestation of unrealism. Superstition!

Sheer superstition!

The physicist's mind rejected it, at first. But that which made him the physicist prodded neatly and patiently and quietly. "Where there's smoke, there's fire," it said. And it mentioned situations where, though exact engineering data had not been taken, certainly the observers were not incompetent. They were not trained, but they did attempt to give a valid picture.

Well, so there might be something to it. So the poltergeist might be something.

This case was no flash in the pan. It was real and valid. For nine full days it had persisted. For nine full days, stones passed through the air at the direction of —the poltergeist. Pictures of the stones in full flight. A step-by-step, frame-by-frame sequence picture of a stone leaving the ground and speeding away gave Thomas a wriggly feeling up and down his spine.

Barometric pressure 29.77 inches, temperature 84.66 degrees, both rising slightly. A graph gave the pressure and temperature throughout the nine days. The total number of stones and the masses, individual and aggregate. The district, with a map of both the entire township and a close-up map-diagram of the area, with motion-traces across it, each labeled, notated, numbered, and keyed to the text.

Physical data on the gravitational field. Maps of the magnetic field, both transverse and vertical. Wind direction during each passage of the stones.

A faked report.

Couldn't be real. Absolutely impossible. Ridiculous, and the work of a frantic mind, working avidly to create a situation.

And yet the engineer was a good engineer. He couldn't—it was psychologically impossible for him —to present fake data.

Ergo this report must be real.

Thomas considered the reports of peculiar activity. Mostly the newspapers reported them as small boys throwing stones as a method of exerting their ability to be annoying to the police and duly constituted authority.

There were reports, he knew. About twelve authentic reports per year, which considering the possibility of having the poltergeist phenomena present when no observer was there—how many times had he heard small stones rattling from the roof or rattling noises of one sort or another—meant that the poltergeist was a rather common phenomenon. There were cases he recalled wherein earthquake temblor had been blamed for the upsetting of a grand piano. He'd wondered about that one—a grand piano is stable, positionwise —and how it could have been rolled across the room and dumped upside down.

Poltergeist phenomena.

Ah yes. It might be advisable to get slightly soused tonight. But Thomas was a physicist. He did not quail or get slightly panicky at the idea of the unknown, even though the unknown was known to have tossed a slab of marble—appropriately, a tombstone—several hundred feet through a caretaker's shed.

To be sure, it was slightly running against the grain to sit there in the broad daylight and read about things that according to all physics from Archimedes to Einstein claimed impossible, racial superstition, and old wives' tales. It was very disquieting to read of stones—dead, inert, lifeless, immobile bits of granite—that took off from Mother Earth with no visible means of support, to go whizzing through the thin daylight air at speeds that raised bruises, cut nicks in trees, and shattered windows. It bothered the sense of propriety. It was not right. It was like seeing Lake Louise in violent flame, or watching Niagara go tumbling up from the whirling pools to the ledge that flanked Goat Island. It was crushing chrome-vanadium test-bars between your fingers just after removal from a tensile strength machine that failed to fracture them at fifteen thousand pounds per square inch. It was watching phosphorus lying inert in an atmosphere of pure oxygen.

It was all wrong.

And yet, thought the physicist, what must the Ancient One have thought when he considered the act of fire melting hard metal? They did strange things, in those days. They invented phlogiston, and spent centuries trying to isolate it. Galileo and his telescope, looking through it to Jupiter, must have been startled at the concept as well as the sight of a planetary system in operation.

Science knew that the poltergeist was a problem—but like the man who does not care to go crazy because of the insoluble problem, science shrugged, admitted that it was stumped—intelligently enough, under the circumstances—and then remarked that after finding the next decimal place, it would, perhaps, take a look into the natural phenomena of things that were thrown by nothing.

Until that date, it could look the other way and claim that small boys were throwing stones.

Little boys that they could not see.

Little green men—

Uh-huh, well, here before Thomas Lionel was a veritable wealth of intelligent observations and data on the complete operation, including evidence to substantiate the fact that neither small boys or little green men were involved.

The evidence and engineering measurements were made with impersonal directness. The engineer, recognizing that he knew nothing of the cause, recorded the effect with court-stenographic impartiality. A stone of so many grams left point

A in a rising parabola and proceeded to point B where it landed and rolled to point C. It took X seconds, attained Y velocity at peak, and covered Z feet. Graph 1 represents acceleration and deceleration, and equation XXVII is the mathematical representation of the space-curve described by this stone of so many grams.

And bottle VQ contained the stone.

It was all wrong, but it was interesting. It pointed the way to madness—and unless it could be rationalized, the pathway to madness would be a one-way street. Thomas knew at that point that his feet were on that path. He could never retreat until he carried back with him an answer—and from the data presented, his answer must be right.

The engineer, he knew, had done it deliberately. As a means of frustration it was more than airright. It was perfect. Show a physicist something that floats between two plates, and he'll go crazy until he knows why. And the engineer had shown the physicist any number of things that floated—sped, indeed—through the air between heaven and earth, like Mohammed's coffin.

Without the benefit of mirrors.

Well, Thomas Lionel, are you licked?

He found a letter that removed all doubt as to the reason. He opened it and read:

Dear Archimedes:

Since you so gallantly presented me with this aggregation of things to measure the last three decimal places of everything, I have decided to put it to work. I have had some fun, thanks to you, in measuring things that I believe have never been set to music before. I have spent some time collecting and presenting data.

This data I do not pretend to understand. I don't intend to try. I am merely an impartial observer. To harness this power would be a boon to civilization. I can see a small truck full of equipment bearing the sign:

POLTERGEIST MOVING COMPANY

if you can only unravel the information contained in my data. You, as a physicist, surely must be able to explain the manifestation in terms that satisfy all and sundry. Once you decide what makes, I'll be interested. Until that date I am stumped, admit it, and happy that I am able to hand the problem to one who by all the evidence, has the personality and character that will not permit these pages of painstaking data to molder in the dust.

Please—old fellow, tell me what's with a poltergeist.

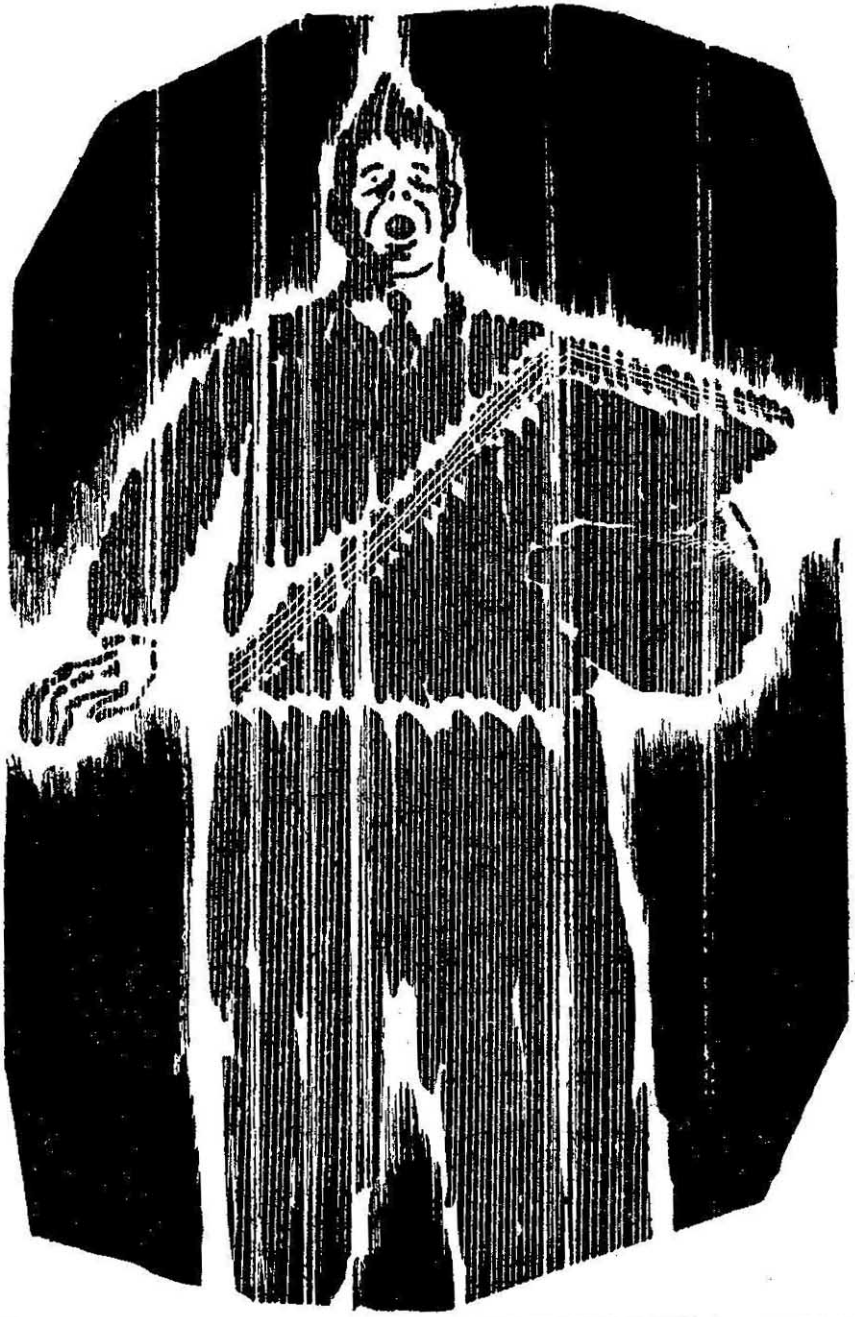
And don't refer vaguely to space warps or fourth dimensional animals. That's strictly for *Corny Stories* or *Vulturesome Tales.*

Interestedly,
Tom Lionel,
Consulting Engineer.

P.S. That junk you bought made it possible to make these measurements. Surely the same stuff should enable you to figure out the answer. You and your monomolecular films.

You and your monomolecular films, Thomas snorted.

That was the start. Then, for eight solid weeks, the laboratory lights burned by night, and the machinery turned at all and odd



hours of the clock. Measurements were conducted on all sorts of things; including at one instance, the astronomical data pertaining to planetary line-up of the solar system. That one was stamped with a large reject sign; not only it didn't apply, but it didn't make sense either. Trips to the library were frequent, and many's the ancient tome that Thomas read until his eyes burned.

The equations, graphs, and tabulations came in for their study and he located a percentage of dispersion in them. It was either experimental error or true dispersion of effect.

The engineer had done his work well. He had compiled his information, and then had presented it in such a manner that left no doubt. And it proved conclusively that something was there and at the same time pointed out that if there was something there, it could be analyzed, and possibly reproduced.

The physicist knew that no answer would be satisfactory until the phenomenon could be reproduced.

And both he and the engineer knew that the chances were more than possible that a high-order physical effect might be the basic cause. An effect for which mankind had no instruments; Radio as a natural phenomenon would be inexplicable to a race that had never discovered a means of detection; the mathematical prediction of radio occurred years before the original experiments.

So—

The physicist set his mind against frustration. To change over to the engineer without an answer would be an admission of defeat. At least without *some* satisfactory answer.

He mulled his problem by the hour, by the day, and by the week. He did take enough time out to consider the chess problem daily. He figured all the possible moves and finally, one night, he smiled, shrugged his shoulders and decided to plunge ahead.

He slid his rook down from one king row to the other through the square formerly covered by the knight which had been protected by a bishop. All the way across the board he went, and as he arrived at his opponent's king row, he took out the little sign and stood it on the center of the board.

Tom Lionel blinked and removed his finger from the pushbutton. He shook his head. This was all wrong. And, besides, what in the name of entropy was this little box? He didn't recall putting a finger on that button—but here he was, removing his hand after holding the button down.

It was a small metal box about eight by seven by four inches. The edges were all die-straight and the surfaces were as optically flat as Tom could determine without testing. The pushbutton was set flush with the surface, and made of the same metal as the box.

No other projection was evident.

But the button was accompanied

with engraving cut in the metal of the front surface. It said:

BE AN ENGINEER!

Away with imagination! Be practical! Dispense with theory! Do nothing that cannot be justified and explained to perfection.

To succed; to enjoy the wonderful practicality of the engineer—
PRESS HERE!
Poltergeist Conversion Co., Ltd.

Tom blinked and got the idea at once. The engineer knew. The physicist had dreamed up this thing; it must contain some sort of thing that caused the shift in personality at the physicist's will.

He took hold of it and lifted.

It slipped out of his fingers.

He set both hands on it and lifted. It stayed on the table. He grunted and strained, and succeeded in getting it off the table by several inches. Then he gave up and returned it slowly to the top again, fearing to drop it lest it damage the desk top.

Metal, huh?

Must be practically solid, then.

What metal?

Tom thought. Must be tougher than a battleship's nose, for if entry were easy, the physicist knew he'd be rebuilding the thing every time he wanted to use it.

He took a cold chisel, set the edge against one corner and walloped it with a hammer. The edge of the cold chisel turned back in a neat Vee. Tom took a file, set the cutting edge against one corner and filed. The file slipped across the corner of the box with all the bite of a solid, slick bar of smooth steel.

An atomic hydrogen cutting torch stood nearby. Tom fired up and set the ultra-hot flame against the same corner that had defied his previous efforts. Nothing much happened excepting that the box got hotter.

That spoiled Tom's fun for the moment. The desk below the box started to smoke and then burst into flame. Tom grabbed a carbon tetrachloride extinguisher but stopped before he played the stream on the hot metal. It was charring the desk through.

The desk was ruined anyway, so Tom ignored it for the moment. He ran a bucket of water and slid it underneath the desk just in time to catch the ultra-hot box just as it passed through the table.

While it was sizzling in the bucket of water and sending forth great clouds of vapor, Tom busied himself with the extinguisher, putting out the fire on the desk.

Tungsten!

Well, tungsten or not, it must be ruined after immersion in water after being red-hot all over. Nothing on God's green earth—

Holy entropy! He'd said that before. It presented a couple of large, bright red question marks.

One. That thing was apparently tungsten clear through. Therefore, how had the physicist cast it?

Two. Granted that thing had been cast—what in the name of howling rockets had the physicist used for the inside circuits?

And three. If running molten tungsten into the mold hadn't ruined the guts of the box, how could heat and water do anything at all?

And, disquieting thought, was the pushbutton waterproof?

With much difficulty, Tom moved the box out from its watery bath below the bench and hauled it over to the high-power X-ray machine. He looked at the fluoroscope and grunted in disgust.

Naturally, tungsten would be completely and utterly blank-faced to any X-ray manipulation. He wanted to kick it, but he knew that kicking a solid slab of tungsten would be damaging only to the kickee.

A means of casting tungsten—something that they'd been seeking ever since the stuff was isolated. He had it—or at least, the physicist had it.

Utter frustration.

Thomas Lionel looked at the box and grinned. He knew what had happened. The engineer hadn't been able to guess—

He pressed the button again—

Tom Lionel removed his finger from the button and swore. He used an engineer's ability to remember and then to improvise, and from there he took up the job of invention. His swearing did him good. At least he forgot to

worry about the tungsten box. He'd find that one out eventually, anyway.

And, furthermore, its trial by fire and water had damaged it in absolutely no way.

Q.E.D., here he was again!

He looked further. It was not like the physicist to just do this. There must be other information pertaining to the problem that the engineer had left. He went into the living room of his house and sought the desk. There was more of it, anyway.

The title page of the manuscript read:

MATHEMATICAL ANALYSIS OF OBSERVATIONAL DATA MADE DURING THE MANIFESTATION OF FORCES OPERATING IN A NEW FIELD OF PHYSICAL SCIENCE.

By Thomas Lionel, Ph.D., M.M.
Consulting Engineer.

Tom lifted the manuscript from the desk—

And he got the squeamish feeling of being dropped in an ultra-high speed elevator that was accelerating at a terrific rate. He instinctively dropped the manuscript and clutched the edge of the desk. When the manuscript hit the desk, it caused the phenomenon to stop.

Tom felt the top page, ran around it with his fingers, and then carefully slid his hand beneath the last page, found the button on the desk top, and held it down while he removed the manuscript.

He lifted. It gave him the screaming willies, and instinctively, Tom pressed hard on the button.

His elevator changed direction. It gave him the effect of being hit on the head with a sand bag. It was now accelerating upward at a violent rate.

He let the button up slowly. The feeling ceased as he reached a pressure about even to the weight of the manuscript; stopping all at once. He compensated by dropping an equal number of blank pages from the desk on the button and took the manuscript to his easy chair to read.

It was one of those things. It couldn't be denied. He was going to be *forced* into presenting this paper before the American Physical Society, using his full name and all of his degrees and the works. The physicist and his little tungsten box would see to it that he remained an engineer until the paper was presented, fully and completely. The physicist didn't have all the answers, of course, but he had solved some of the basic problems.

He finished the manuscript, and then found a letter. It said:

Dear Galileo:

The phenomenon of losing fifty pounds is the result of an antigravity field which I discovered from your data on the good old poltergeist. The trouble with the thing is simply this:

In order to make the thing function, it takes something like three tons of equipment to make the object within the field lose its fifty pounds.

I, as a physicist, do not care about the practicality of the device. I have made it

work. You, as an engineer, will appreciate the possibilities behind the perfection of this device. I offer you the chance to start your Poltergeist Moving Company, providing, of course, that you can make something of this effect.

Incidentally, I have been unable to get or to predict antigravitational forces of less than fifty pounds regardless of how the equipment is set up.

I don't care, I will leave the rest to you.

Sincerely,
Thomas Lionel, Ph.D., M.M.

Tungsten casting, antigravity, inefficiency and poltergeists! Tom's head whirled. With a last-hope gesture, he stalked over to the chessboard and studied the men.

It bothered him, he was completely frustrated. The room whirled a bit, despite Tom's fight against it. This was the last straw, this chess game.

Not that he himself was the absolute loser in this game of living chess. It was just that he had started something that threatened to boil over at the edges.

Fundamentally, he'd tried to exorcise the physicist. He'd gone to much trouble and effort to remove the low-down effect of physicist-thinking patterns from his immediate locale. Instead—by his supreme efforts to get rid of the theorist, aforementioned theorist had come up with a few problems of his own that tickled the imagination, offered all sorts of interesting problems, and—

Had basically shown how utterly impossibly foolish it would be to try and get rid of the physicist.

Thomas Lionel, PhD., M.M., knew too much to be immediately removed, obliterated, canceled, or even ignored.

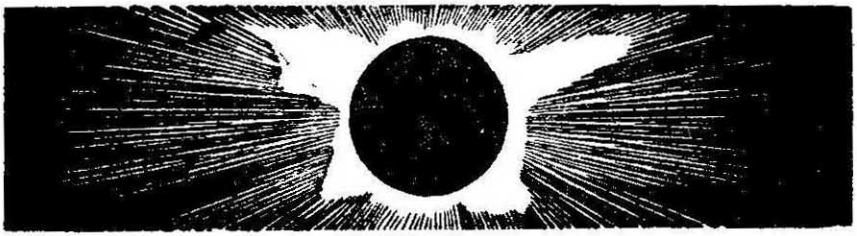
How do you cast tungsten? How do you make antigravity—even on an inefficient scale? And if a poltergeist is—and you know his address, as the physicist seemed to, can you hire the throwing-ghost? Brother, did he have a lot of problems to reduce to practice! He'd have little time for getting rid of his pal.

Tom Lionel snarled at the chessboard. He'd made his gambit, and instead of ridding himself of a rather powerful threat to his own security, he'd—well, he reread the significant sign that presided over the chessboard and began to growl like an insulted cocker spaniel.

The sign said:

CHECKMATE!

THE END.



The Blindness

by
PHILLIP
LATHAM

If, by some miracle, the full light of the Day Star could shine on man and his works—

*Isti mirantur stellam.**

It must have taken all of Blakeslee's self-control to leave the plate in the developer for the full eleven minutes.

If it had been my plate, I think I might have cheated a little on that eleventh minute, especially with an energetic developer like DQ-17. But Blakeslee rocked the tray methodically back and forth, up and down, with no more visible impatience than if it had been a snapshot of his aunt Mable. And then after the plate was in the hypo he waited another full eleven minutes before removing and rinsing.

"Now, Latham, if we may have the lights, please."

I snapped on the switch revealing

* Motto adopted by Cowell and Crommelin of the Royal Greenwich Observatory for their prize winning essay on "The Return of Halley's Comet in 1910." Its origin and significance are obscure; the reference will not be found in any of the standard anthologies of classical quotations.

Possible sources are: Shakespeare, "Venus and Adonis," line 813, "Look, how a bright star shooteth from the sky"; and Virgil, Georgics, Book 2 of Dryden's translation, "Give me the ways of wandering stars to know."

the immaculate interior of the 300-inch darkroom. Blakeslee tapped the eight-by-ten plate gently to detach a few lingering drops of water, then held it up before the blank white rectangle of the viewer. I caught my breath at the sight. A perfect negative! Exposure time, seeing, guiding, development—everything exactly right. The star trails were as sharp as if they had been etched by an engraver. But where was the object we were seeking? Of that I was unable to detect a trace.

Blakeslee was examining the region around 20 Geminorum with a low-power eyepiece. After several minutes of close scrutiny he handed the plate and eyepiece to me without a word. At first I could discern only the multitude of black and gray star trails with here and there a defect due to irregular clustering of silver grains. Then I found it! A hazy smudge. The merest trace of faint nebulosity with a tiny nucleus buried in the center.

A wave of emotion welled up within me such as I had never experienced before in my whole life. A sudden realization of the transientness of human existence and the eternity of space and time.

I returned the plate to Blakeslee with trembling hands. "It's back again," I whispered.

He smiled faintly. "Yes, back again. Halley's comet—back again after three-quarters of a century."

Blakeslee, having finished his second cup of coffee, lighted his old briar pipe and subsided into the battered armchair that faces the library windows toward the south. The discovery plate of Halley's comet was in the drying cabinet from where it would soon be transferred to the measuring machine upstairs. In the meantime, with the comet safely trapped, we could afford to relax in the luxurious contemplation of two years work brought to a triumphant conclusion. Gazing out through the library windows at the dim lights of the Horological Laboratory below us, I wondered how many others in the teeming scientific line of the Nucleus dared snatch a moment of quiet satisfaction.

When in 1951, the Congress of the United States passed an Act to "establish in the state of Arizona an institution for the investigation, exploration, and general inquiry into the fundamental nature of matter and energy, with special emphasis upon the structure of the atom," the Nucleus was born. Consisting at first of a physics building, a cyclotron, and chemistry laboratory, hastily constructed, inadequately staffed, and miserably financed, under the leadership of a series of vigorous directors gradually every type of instrument was assembled that might contribute to our knowledge of the atom. The central collection of laboratories and machine shops came to be known as the Nucleus, after the old Bohr atom; and the ring of dwellings surrounding it, the Shell. The 300-inch telescope, with its mirror cast from a single block of obsidian from Iceland, was a comparatively recent addition. Many of the scientists had lived within the Nucleus during their entire professional career. Even after

five years residence, I still felt like a stranger in my bachelor headquarters at the edge of the Shell, where the inhabitants are regarded as loosely attached, or valence, electrons.

I doubt if atomic theory can ever hope again to reach the state of perfection that it attained back in the early years of the feverish '50s. The wave theory of Schrodinger and the quantum mechanics of Heisenberg reigned supreme. As far as one could see in 4 pi directions nothing met the eye but a gleaming expanse of beautifully explained observations.

Then in 1957 Sondelius discovered the planetron, the nuclear particle that in a sense put the second dimension into atomic physics. Previously our concept of the fine structure of matter had been essentially linear or one dimensional, like a straight line. In the middle was the neutron without charge. To the right were the proton and positron with unit positive charge; on the left, the electron with unit negative charge. You could think of them as beads strung upon a wire. By combining them in the proper way the whole periodic table of the elements could be built up.

Trouble with the planetron is that it stubbornly refuses to fit into this neat little scheme of things. For it is neither positive, nor negative, nor yet is it neutral. A particle of mass 1111 e, unquestionably it is endowed with a charge of *some* kind, of that we are very sure. But just as we cannot comprehend a fourth dimension in space, no more can we comprehend a charge that departs from the straight line of plus and minus quantities. What is the planetron? That is the question science has been straining to answer for the last thirty years.

Following the collapse of the wave theory, there ensued a chaotic period of about five years when physicists had no atom whatever to guide them. Gradually there arose the idea of what has been termed the "psychological atom," an intangible mass endowed with virtually human powers of instinct and perception. It is as hopeless to try to describe or make a model of this atom as it is to draw a diagram of the character of a man. Yet we all have a fairly clear idea of what is meant by character, and from experience can predict with assurance how an individual would behave in a certain situation. In somewhat the same way, from a knowledge of the facts of observations concerning the different atoms, we can predict rather accurately how they will react under various temperatures, pressures, electrical excitation, et cetera.

Are you surprised to find that scientists, after shaking the world with the atomic bomb in 1945, chose to seclude themselves within the sanctuary of the Nucleus, instead of taking an active part in political affairs? Brother, you don't know scientists. They scurried back to their former jobs like the introvert rabbits they are, content to nibble again upon the meager rations which an indifferent population grudgingly allowed them.

But then according to Murdock,

our cynical young astrophysicist and chief ticket-taker on visitors' night at the observatory, men generally get precisely what they deserve in this life. Perhaps he is right at that. Come to think of it, Murdock generally is right. Which reminds me that I owe him two dollars since that big sunspot last week failed to create a magnetic storm—something that looked like a cinch bet at the time if I ever saw one.

So much for the scientific life on Julian Date 2447045 or September 5, 1987, in ordinary terms.

Dreaming of the manifold projects going on night and day within the Nucleus, I had nearly dozed off when Blakeslee yanked me out of my reverie.

"Ever think of the heavenly bodies as living things, Latham?"

Now this is not the type of question that the director of an observatory is likely to hurl at his assistants early on every morning. Consequently, I had to ponder for some time before hazarding a reply.

"Why, yes, subconsciously I believe I have. The Sun with its family of planets and Jupiter with his thirteen satellites naturally remind one of masterful dominating parents. The Moon is a cold white goddess." I paused to think some more. "Uranus and Neptune are great beasts prowling in semi-darkness. Sirius is a sparkling lady with a glass of champagne." I laughed nervously to cover my embarrassment at thus waxing poetic. "I guess that's as far as I can go along that line."

To my surprise, Blakeslee's deep-set eyes showed no amusement. Instead his face was deadly serious.

"I've often wondered how this world would appear to Halley's comet, if that flimsy conglomeration of gas and stone were endowed with super-radionic vision. What would such a creature, forced to pass this way every seventy-seven years, think of this little planet of ours?"

As if to answer his own question, he strolled over to the reference books by the fireplace and without even stretching his lanky frame, easily removed the worn copy of Sherwood's "Guide to World History" from the topmost shelf.

"This afternoon I jotted down the dates of all the returns of Halley's comet. Let's look up a few at random. I'm curious to know what it would have seen as it came this way."

Blakeslee turned the pages near the front of the volume. "Now here's the return of 66 A.D. What was the headline news around that time? 'Burning of Rome in 64 A.D. and first persecution of Christians begins by Nero.' Doesn't sound like a very auspicious start, does it?"

He turned some more leaves. "Suppose we try 374 A.D. 'The Huns advance into central Europe. The Visigoths, expelled by the Huns, are allowed by Valerius to settle in Thrace.' Very considerate

of him. Wonder what his motive was?

"Let's go on to the next return. Here we are in 452 A.D. 'Attila ravages Italy. Rome is saved by its bishop, Leo the Great.'"

Blakeslee was talking more to himself than to me. "Now comes the most famous return of them all—1066 A.D.: 'Harold II elected king; killed at the Battle of Hastings. 1146: Thebes and Corinth plundered by the Sicilians. 1455: Outbreak of the War of the Roses. 1608: Henry IV plans downfall of Hapsburgs. 1683: France invades the Spanish Netherlands. Siege of Rome by the Turks.'

"Now we're getting down to modern times. The pace quickens. What have we here? 'Invasion of Canada in 1759. Death of Wolfe. Quebec taken. Russians and Austrians defeat Frederick the Great. 1836: Massacre of the Alamo and defeat of the Mexicans at San Jacinto.'"

He paused and drew a deep breath. "And finally the last return in 1910. The world must have looked pretty good for a change. Everything pretty peaceful. Only a hint here and there of the holocaust to come."

"Anything about 1987?" I inquired.

Blakeslee closed the book grimly and replaced it upon the shelf.

"Remember the end of World War III in 1968? How the delegates from each country solemnly vowed that never again would such destruction be set free. In less than twelve hours they had seen one of the most powerful nations on earth destroyed, wiped out, utterly and completely obliterated as if it had never existed. Those honorable men were never more serious than when they pledged their sacred word to keep the peace."

He laughed bitterly. "And today it's merely a matter of weeks or days till World War IV."

Suddenly he turned on me as if I had dared to challenge his statement. "Right after a war a nation is like a man coming out of a long drunk. How awful he feels! How can a man live and feel so awful? It's never, never going to happen again. And he means it—*then!*

"But wait till he's sobered up and back on his feet. The old urge returns, the old restlessness, the old lust for exhibitionism and power, that will not down or be put aside.

"Do you know what I would do if I were Halley's comet?" he blazed. "I would destroy this world and myself along with it in one grand and glorious smashup. So that never again would I be condemned to return century after century to witness such suffering and stupidity."

The mood left him as suddenly as it had come and he was Blakeslee once more, cold, aloof, objective. He glanced at his watch.

"Our plate should be dry by this time. I'm anxious to see how closely the comet is following our predicted path. That close brush with Saturn could have had seri-

ous consequences. It wouldn't have taken much to make a big difference in the eccentricity and the longitude of the node." He looked at me quizzically.

I got it without being told. "Murdock said he'd be glad to help with the measurements. I've had the astrographic zone and the comparison stars selected for a week. With good luck we should have the position by morning."

"Excellent," said Blakeslee. "In that case, I'll leave it entirely in your hands. Don't hesitate to wake me when you've got the answer."

"If you say so," I told him, getting up and stretching.

I was mildly surprised to find Murdock in the measuring room seated before one of the computing machines. From the pile of cigarette stubs in the ash tray I judged he was at grips with the praseodymium atom again.

"How's the spectrum analysis coming?" I greeted.

"Not so good," he muttered, his dark face flushed. "Trying to find combination differences in praseodymium VII is like trying to work a crossword puzzle in three dimensions blindfolded."

"Well, suppose you exert your talents on this plate for a while," I said, extracting our precious photograph from its envelope.

Murdock regarded it without enthusiasm. "One of those rush jobs, I'll bet."

"Just the discovery plate of Halley's comet is all."

He whistled. "Don't tell me the rest. Blakeslee is champing at the bit wondering if it fits his ephemeris or not. O. K. Let's get going."

He switched on the light behind the big Reuchlin measuring machine, swept some papers in the wastebasket, and began adjusting the eyepiece. "I feel wide awake now. Suppose I measure and you record."

"Suits me," I agreed, handing him the plate. He held it up to the light inspecting the star images critically. There was very little evidence of coma thanks to the zero power correcting lens we use at the Newtonian focus of the 300-inch. I had already drawn ink lines around the stars I wish to use for comparison.

Murdock opened the astrographic catalogue to the page I had marked. Fortunately we were working in a zone assigned to the reliable Observatoire de Bordeaux, so that I had every confidence in their results.

"First star to be measured will be number 56 on cliché 1003," he announced. "Zone plus fifteen degrees and six hours twenty-eight minutes." He bent over to read the fine print at the bottom of the page. "Measured by Mesdemoiselles E. Chatenay and G. Vèdrome."

"All I want is the astronomical part," I retorted. "You can leave out the sex."

Chuckling, he moved his head from side to side testing the optical system for parallax. After a

few more minor adjustments he turned the horizontal dial slowly from left to right.

"I'll give you the setting in X first." He brought the crosshairs up until they bisected the image of the star. "It is ten point one two seven four."

"Ten point one two seven four," I repeated, writing it down.

He reversed the dial, approached the setting from left to right again. "Ten point one two six eight."

"Point one two six eight."

With the approach of dawn the Nucleus had grown very still. But for us the long grind had only begun.

Blakeslee opened his door so promptly that I suspect he was sitting up waiting for me. Taking the measures, he opened a loose-leaf notebook with "H. C." stamped on the cover in large letters, and turned to the last page where the ephemeris was typed. After a few minutes work he jotted down the predicted right ascension and declination interpolated for our position that night. We stared at them in awe.

"Why they're almost identical!" I exclaimed.

Blakeslee frowned. "This is the true mean place of Halley's comet referred to the equator and equinox of 1987.0, isn't it?" he asked, indicating my figures.

"That's right," I responded.

"Hm-m-m!" he sighed, still frowning.

Again I realized I was confronted by one of the curious quirks of the scientific mind. Nothing worries some scientists so much as having their predictions agree precisely with their observations. It recalled the first job assigned to me of making some thermocouple measures on the Moon. The astronomer for whom I was working didn't give me the least hint of the results I was to get. He simply told me how to operate the apparatus and turned me loose. When I showed him my galvanometer deflections he was dumfounded. They gave temperatures for the Moon's sub-solar point that agreed exactly with his computations! So immediately he got busy trying to find out what was the matter with them!

Now Blakeslee looked as glum as a navigator who had plotted his wind in backward. Finally after much figuring he shoved the paper reluctantly back at me.

"Well, you might as well get this off to Harvard. Need the code? That I. A. U. handbook should be around here some place."

"No, I think I can do it from memory. It's very simple."

While I was toiling over the message in the measuring room Murdock came in for his praseodymium notes.

"Well, do tell," he said, "is Halley's comet following that high-powered path you fellows laid down for it, or does it have ideas of its own?"

"The agreement is almost exact," I said rather complacently.

"How's Blakeslee taking it?"

"Pretty hard." We both grinned.

First I wrote out the telegram in everyday language.

COMET HALLEY HAS BEEN OBSERVED ON SEPTEMBER 4, 1987, BY BLAKESLEE AND LATHAM AT 10 HOURS 50.1 MINUTES UNIVERSAL TIME AT RIGHT ASCENSION (1987.0) 6 HOURS 28 MINUTES 31.3 SECONDS. DECLINATION (1987.0) PLUS 17 DEGREES 11 MINUTES 30 SECONDS. MAGNITUDE 15. DIFFUSE WITH CENTRAL NUCLEUS.

After scanning this with the utmost care word for word I proceeded to condense it into the official code adopted by the International Astronomical Union.

1987 September 5
The Nucleus, Arizona
COMET HALLEY 04157 SEPTEMBER 10501 06283 21711 81330 23982 BLAKESLEE.LATHAM

When I had this on the wire, Murdock deigned to read it over.

"By the way, how close is Halley's comet coming this trip?"

"It will be slightly under a million and a quarter miles on May 1, 1988," I said. "This is closer than any comet has ever come before. The previous record holder was Lexell's comet way back in 1770 that came within a million and a half miles."

Murdock looked a trifle less bored if possible. "So we may expect some excitement along about May Day, eh? Lots of little people running around getting panicky, and all that." He yawned. "Wake me up when it happens."

I was dead tired myself, and lost no time in getting to bed in my room at the observatory. Although I had not slept for twenty-four hours, yet my mind was racing so that I tossed restlessly for half an hour. At last I got up, took half a grain of phyllonal, and climbed back under the covers. Faintly from down the hall I could hear Murdock's radio giving the seven o'clock news report, something about war tension rises in Turkestan and Persia. Five minutes later I was sound asleep.

The days that followed found me on the go every moment, photographing Halley's comet after midnight and measuring and reducing plates in the afternoon. Also, I tried to keep our regular program going in the fore part of the night of high dispersion spectrograms on emission type B stars. Since Congress had failed to come through with an appropriation for an extra night assistant, I got it in the neck, as usual. There were times when I had to drive myself plenty hard. The comet returned to follow Blakeslee's calculated path with uncanny precision, like a high-frequency controlled rocket.

About the middle of February Halley's comet became visible to the unaided eye if you knew exactly where to look. People began calling up by the dozen wanting to know when it would be nearest the Earth, if there was likely to be a collision, would we all be suffocated by poison gas, et cetera, et cetera? In fact, people grew so agitated

about the comet that sometimes it actually edged the war news off the front page. Murdock wrote down the answers to questions people asked most frequently, so that when called to the phone he could reel off long numbers without a second's hesitation, thus acquiring a wholly unmerited reputation as a cometary expert.

Waiting in the early morning for Halley's comet to rise over the dark pines in the northeast, watching its soft filmy structure come up in the developer, following it against the glittering background of stars, night after night for weeks, gradually a strange feeling took possession of me such as I had never felt toward an inanimate object before. I can best express it as a conviction that Halley's comet and I existed for each other alone. One must remember the strained unnatural conditions under which we all were working. I was absorbed in Halley's comet. I lived with it. There was not a waking moment when it was entirely out of my mind.

Speeding sunward the comet behaved like a living thing, changing erratically in form and brightness, as unpredictable as a woman. Now it would die down in luminosity, then flare up again as brilliant jets streamed from the nucleus in gracefully rounded envelopes. On nights when Murdock or Blakeslee had the exclusive use of the telescope I felt acutely jealous. Wasn't it Balzac who wrote a story about a fellow who fell in love with a tiger?* Well, I won't go so far as to say I fell in love with Halley's comet, but I must confess that I came to regard it—very secretly—with a deep sense of personal possession and attachment.

By April, Halley's comet was within one hundred twenty million miles of the Earth and fifty-four million miles of the Sun. Have you ever had a nightmare in which a huge ghostly figure towers menacingly above you, threatening you with some horrible fate, so awful as to be beyond the power of words to express or the mind to contemplate? That was the feeling Halley's comet inspired as it rose in the morning sky. People stood facing the dawn huddled close together, as if afraid to view the intruder from outer space alone. At first they watched in hushed silence, speaking to one another only in whispers. But as the pale specter loomed larger and larger in the heavens, a sort of uneasy restlessness would occasionally run through the assemblage, marked by excited mutterings and outcries. Women were frequently overcome, partly by persons jostling roughly against them, but more often purely from dread engendered by contemplation of the comet itself. Many cases of trance, somnambulism, and paralysis were reported which psychiatrists claimed were entirely hysterical in origin.

Naturally all sorts of rumors and predictions spread about the comet, and the wilder they were the more ready people were to believe them. Despite repeated

* Yes. "A Passion in the Desert." Ed.

assurances from the highest authorities that no possible evil could be associated with the approach of Halley's comet, nevertheless there developed in the public mind the firm conviction that it foretold the final destruction of mankind, the "death, and mourning, and famine," prophesied in the Book of Revelations. Those of us in the Nucleus never ceased to marvel at the hold superstition has upon the human race. Here we had flattered ourselves that we lived in a rational scientific age when objects such as comets were thoroughly understood. Yet I doubt if the darkest hours of the Middle Ages ever beheld scenes such as we witnessed in Anno Domini 1988.

Gradually a form of mania for destruction and revelry seized people which even presumably sane and well-educated individuals were unable to resist. So-called "comet orgies" occurred all over the globe in which hundreds were killed and property damage ran into the millions. In Lisbon a mob ranged unchecked for three days before troops were able to restore some semblance of order.

Then, just as people were becoming partially reassured that Halley's comet was indeed merely a "harmless bag of nothing," as Professor Challis of the University of Illinois characterized it, the very worst thing imaginable happened. The old premier of China, Ts'ai Lun, certainly one of the most influential men in the world, was delivering an address in which he implored his people to come to their senses and quit pointing to Halley's comet as an evil omen in the sky. Just as he was ridiculing the notion that the comet could possibly harm anyone, he was stricken by coronary thrombosis and died on the platform before help could reach him. Riots immediately flared anew with increased violence and now no appeal to reason made the slightest impression.

Scientists — especially astronomers—came in for plenty of abuse. People associated us with the comet and in some obscure way felt that we should get busy and do something about it. Twice on Saturday evenings when the telescope is thrown open to visitors members of the staff were attacked by cranks; and one night a rock came hurtling through the opening in the dome, narrowly missing the big mirror and laying Murdock out cold for a couple of minutes. Eventually the situation grew so serious that the authorities were forced to erect a high barb-wire fence around the entire Shell. Sentries were posted at all the gates and everyone rigorously excluded except the scientific personnel.

Despite the unsettled times we managed to keep our observing program going pretty much according to plan. Probably never again would astronomers have an opportunity to study a large comet at such close range, and we were determined that posterity should not find us wanting.

Apart from its sensational as-

pect, the most interesting feature about Halley's comet as it neared perihelion was the extraordinary development of the carbon spectrum. Murdock and I got a complete series of overlapping spectra from 12,000 angstroms in the infrared down to the beginning of the ozone absorption at 2900 in the ultraviolet. The cyanogen band heads at wave lengths 3596, 3883, and 4216 were always conspicuous, while the Swan band system of carbon grew in strength until it dominated the whole spectrum in the blue, green, and yellow. The region around the (1,0) 4737 band was particularly interesting. We had no trouble in detecting the faint isotope band at 4744.5 due to the carbon molecule C13C12. In addition, Murdock was highly elated over what he believes to be a new band system of CO for which he has been able to make a tentative vibrational analysis.

One evening near the summer solstice I had strolled out on the railing that surrounds the 300-inch dome to watch the sunset. The weather had been oppressively warm during the past week, and now a hot dry wind had risen, rendering the air electric with tension, and sending up clouds of brown dust and leaves. If we had been in Haiti instead of Arizona, I would have said there would be voodoo going on before the night was over.

Whether it was because of the dust or whether it was my overwrought imagination, the whole landscape seemed lit up by an unnatural bluish-red tint, as if seen through a lens poorly corrected for chromatic aberration. The curious part was that when I looked at a distant bright object by averted vision it appeared vividly colored, but upon regarding it directly the effect vanished. I was experimenting to see if the light might possibly be polarized in some way when Blakeslee joined me. He was sucking on his briar pipe, as calm and unruffled as if the whole scene were created for his special benefit.

For probably fifteen minutes we stood there watching the changing shape of the sun as it neared the horizon. Lights were beginning to come on in windows, people were scurrying for home, while others were already returning to desk or laboratory. Over in the Horological Laboratory the entire third floor was illuminated, where according to the local grapevine some high-powered experiment was in progress.

As the last trace of the oblate crimson sun disappeared behind the ventilators on Ballantyne Hall, I could not refrain from asking Blakeslee:

"Say, have you noticed anything peculiar about the appearance of the landscape lately?"

"A kind of prismatic effect?"

"You might describe it that way."

He nodded. "Yes, I've been aware of it for the last two weeks."

This was news to me. "Never noticed it until tonight. A peculiar

meteorological condition, I suppose?"

Very deliberately he knocked the ashes from his pipe against the iron railing. "Let's take a look in the library. It's my experience you can find practically anything in the library."

The book-lined walls were a welcome relief from the dust and wind on the balcony. Blakeslee went to the shelves where the "Astrophysical Journal" is kept and took out a faded volume. Without hesitation he handed the book to me open at page 373.

"I rather think you'll find the answer to your question here," he said.

I glanced at the cover. It was volume XXXIX for the year 1914. The article to which Blakeslee had referred me was entitled, "Possible Effects of Halley's Comet on the Earth's Atmosphere," written by Edward Emerson Bernard, a name I recognized as belonging to one of the most careful and astute observers of the early part of the century. After the phenomena I had witnessed that evening, his words might have been addressed directly to me across three-quarters of a century.

". . . consisted of a peculiar iridescence and unnatural appearance of the clouds near the Sun and of a bar of prismatic light on the clouds in the south. This, combined with the general effect of the sky and clouds—for the entire sky had a most unnatural and wild look—would have attracted attention at any time than when one was looking for something out of the ordinary.

"The most suggestive phenomenon, however, was apparent later on, in June and for at least a year afterward. It was first noticed here on the night of June 7, 1910, and consisted of slowly moving stripes and masses of self-luminous haze which were not confined to any one part of the sky. It is true that these peculiarities might in some way have been of auroral origin, but this I do not think probable, for they do not seem to resemble in any way, either in position or in appearance, any auroral phenomenon with which I am familiar."

I read the brief article through several times before laying it aside. "So it's Halley's comet that's responsible," I said.

"Don't think there can be much doubt about it," Blakeslee replied. "We are probably immersed in that portion of the tail near the head, if indeed we are not in the coma itself. For the past month I have had two junior astronomers making naked-eye observations, as well as taking exposures on the night sky with a one-prism spectrograph."

Blakeslee worked faster sometimes than one would expect from his indolent attitude. "By the way," I remarked, "how is Halley's comet following your predicted path? I've been too busy recently to keep track of it."

Blakeslee hauled out his pipe from the patch pocket of his threadbare observing jacket, crammed the

bowl with rough-cut, and took several reflective puffs before answering.

"I don't see any reason why you shouldn't know," he said at length. "However, I'd advise you to keep it quiet for awhile. As a matter of fact, the nucleus of the comet upon which I have based my orbit, is now nearly two degrees in declination from my computed position."

"Two degrees!" I exclaimed. "Why that's four times the diameter of the full moon! What on earth has gone wrong?"

Blakeslee studied the glowing bowl of his pipe with a critical eye. "I'm sure I haven't the ghost of an idea what on earth has gone wrong," he said.

It was at precisely 0212 Mountain Time that I heard a commotion outside the dome that night as if something unusual had happened. I recall the time distinctly because I had just started an hour exposure on H. D. 218393 and was entering it in the record book. Living in a place constantly you become extraordinarily sensitive to deviations from the norm. Pretty soon Blakeslee came in looking very grim.

"Something up?" I inquired.

He snapped on the television set we keep in a cabinet over by the plane grating Cassegrain spectrograph. "They say Pittsburgh and Seattle are being destroyed—if they aren't destroyed already."

He fiddled with the dials on our old Vane-Hanlon set. "What's the matter with this thing anyhow?"

"We had the same trouble with it last night. There—it's coming in now."

But the image kept fading in and out and the static was so bad that after a few minutes Blakeslee gave it up.

"I don't see how they could get through so easily," I puzzled. "What about our highly vaunted hydromagnetic wave defense? Thought it was supposed to form a kind of canopy over the country. Detonate anything that got within a thousand miles of us."

"That's what they're trying to figure out now," said Blakeslee. "Apparently it worked perfectly on two rockets that exploded in the

North Atlantic near Greenland. But half a dozen others seem to have come through according to schedule."

I went back to the telescope and took a look at the bloated image of H. D. 218393 hopping about on the slit. The seeing was terrible.

"What shall we do?" I asked.

Blakeslee rose wearily and started for the stairs. "Keep going," he replied. "Keep going as usual. We don't know how soon they'll hit us, but until they do let no one say we faltered in our task."

At the head of the stairway he paused. "Besides—what else can we do?"

After Blakeslee left the seeing became so much worse I had to lengthen the exposure time by thirty minutes to compensate. Incredible as it sounds, I was not nearly so concerned over the fact that another war had started as I was over my photograph. This was the first chance I had had to try out my new all-mirror concave grating spectrograph that is particularly fast in the ultraviolet of the second order. We had all been anticipating the war for so long that when it finally came we were resigned in a dull apathetic way. The human animal is peculiar in that it will persist in its routine activities up till the very end, when the ground is crumbling beneath its feet.

Waiting for the plate to develop down in the darkroom, I noticed that my eyes burned as if I had not slept for days, and the skin over my cheeks felt tight and dry. The interval timer aroused me with a jerk.

"This had better be good," I muttered to myself. "I don't think I can last out another exposure."

The plate was good all right. At least, there was plenty of spectrum there. But I had trouble in recognizing it at first. Then slowly I began to identify the old familiar landmarks: H beta with a bright hydrogen core, H gamma with a distinctly bright edge on the red, 4471 of helium, and the ionized silicon lines at 4128 and 4131. The puzzling feature was the long irregular extension of lines and bands far into the ultraviolet, ending with a big black blob at the edge of the plate.

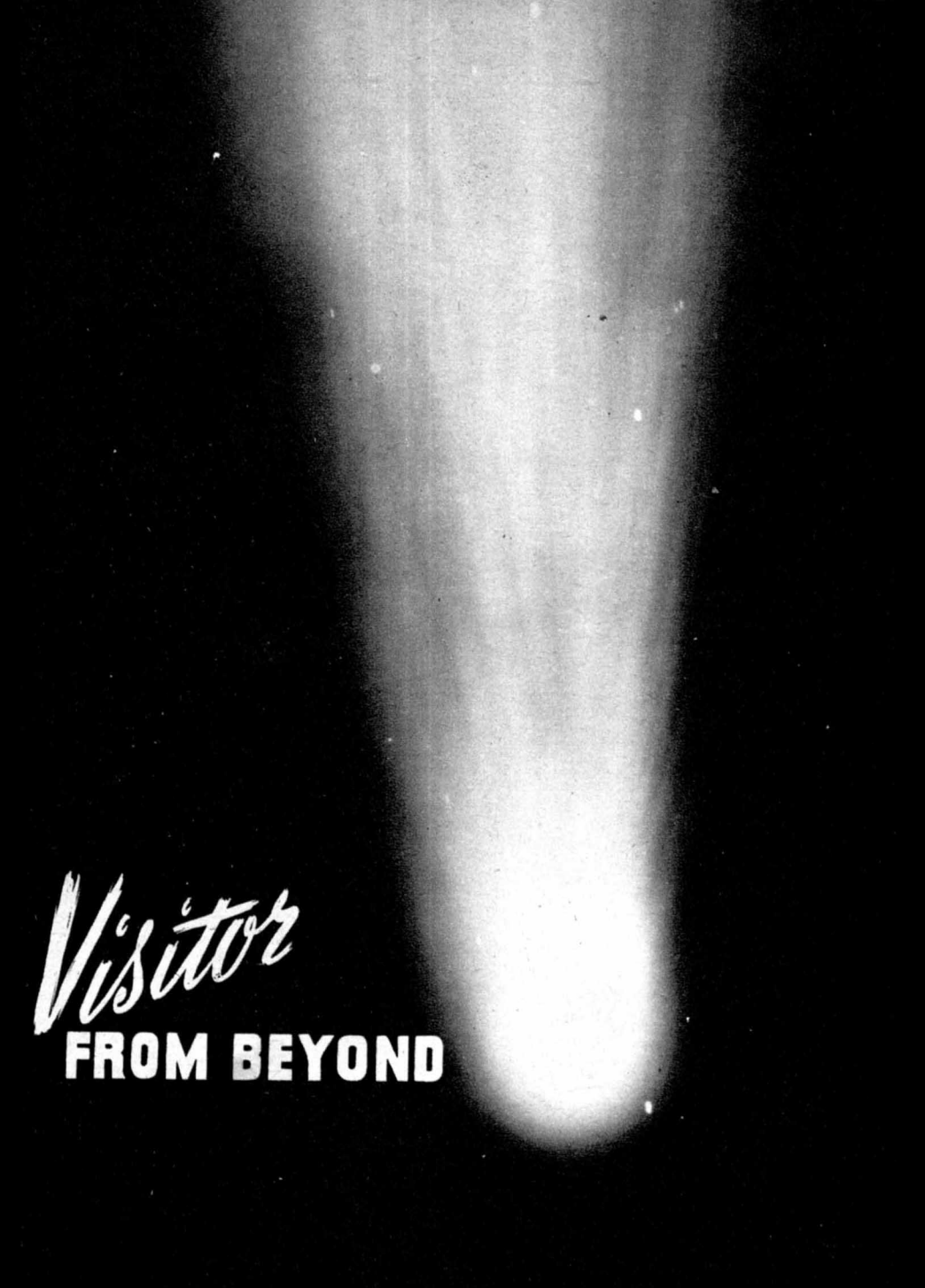
Studying the spectrum further, a tingling sensation began creeping up my spine, a wild excitement, that snapped me out of my lethargy like a shot of benzedrine. If this was what I thought it was, it was the biggest thing in astrophysics since Janssen observed helium in the sun without an eclipse. No use getting excited until I had confirmation first, though.

Dashing upstairs, I found Murdock in the dome tinkering with the television set.

"You're a spectroscopic expert," I told him. "Come down to the darkroom and tell me what I've got on the plate I just took."

Murdock looked as puzzled as myself when he examined the strip of spectrum with his ocular.

(Continued on page 123)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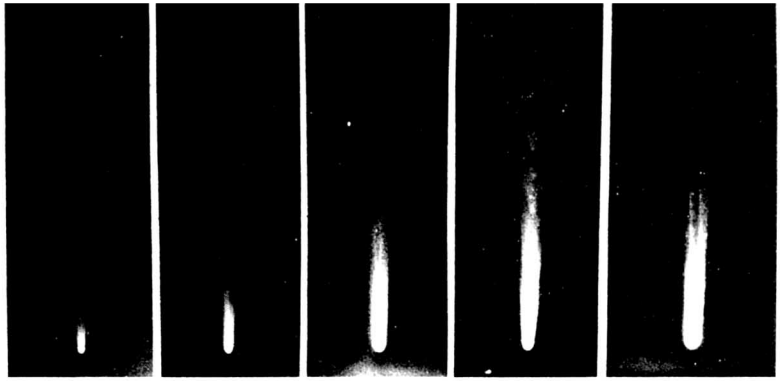

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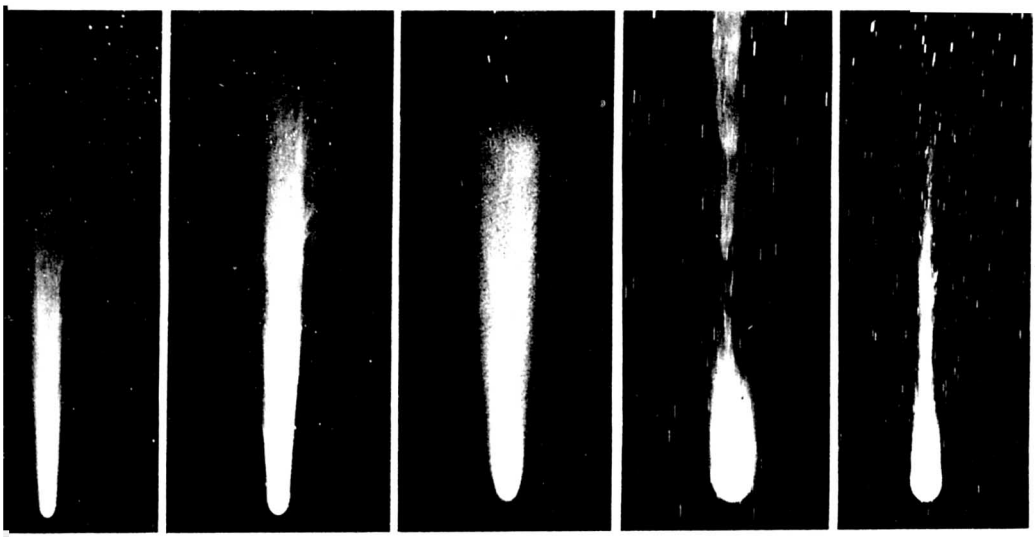

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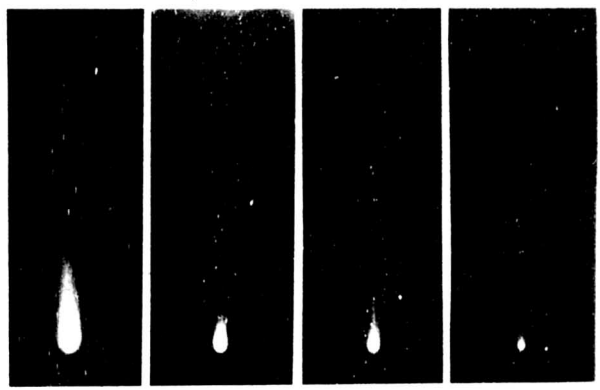
Halley's Comet in 1910



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Portrait Of A Voice

by J. J. COUPLING

***Reducing** the human voice to a pattern of light and shade that will make sense to human eyes is more of a trick than one might think—because the analytical method of the human ear is a purely arbitrary thing. It's easy to fool the ear. The ear can accept a rattling cardboard cone in a loudspeaker as a whole symphony orchestra. Making a mechanism as naive was harder to accomplish than making a really precise device!*

Photographs from Bell Laboratories

From the title, this might seem a disquisition on oratory, a singer, or even Frank Sinatra. Actually, it is something much nearer home, for it has to do with your voice or mine, good voices and bad, and, in this century of the common man, just his run-of-the-mine voice. It is the art of portraying the voice that we will consider, not how good the voice is or even what it has to say.

In this matter-of-fact attitude, men have been trying for centuries in their bungling way to make pictures of the voice. Of course, the first attempts were at writing pictured objects, not words. The Egyptian hieroglyphics show birds, men, boats, feathers, sun and stars. It wasn't long, however, before man's thoughts and his desire to record them went beyond all ability to draw pictures of concrete objects. As a first step, a sort of punning could be resorted to, as if we were to make a picture of a piece of kitchen plumbing stand for the verb, to sink. Ingenious minds outran this expedient, and when a Babylonian renter of four millennia ago wrote, "Akhibite has taken the house of Mashqu, the owner, on a lease for one year," he used signs which were not pictures at all, but stood for syllables and words. Greek and Roman writers, of course, used alphabets much

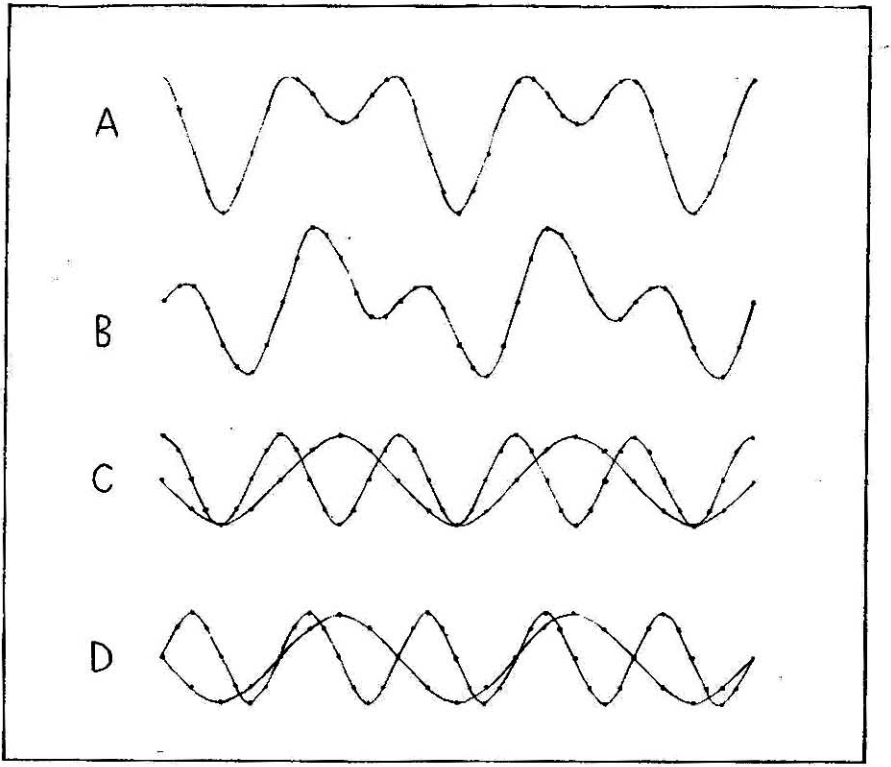


Fig. 2. The oscillograph analysis of sound does not correspond to human sensory analysis. The curves A and B differ markedly in shape, yet both are compounded of the same two pure tones; the ear hears both combinations as identical complex sound waves.

like our own, and, ever since, people when writing have drawn symbols representing the actual words a speaker would have used.

Writers haven't drawn a picture of the speaker's voice. In fact, the symbols used don't form a very valid representation of the words uttered. Writing has stuck at this point for some four thousand years. What kind of art is it, anyway, that we use to represent the words we speak? Certainly, it is highly artificial at the best. The confusion of c, k and s is almost as if an artist drew a nose and ears the same way because both have holes. Those who object to the artificiality of modern art might well vent some of their rage on the traditional way of representing the spoken word. Not only is all the human emotion of the voice absent from such representations — "in a shaking voice" and "she sobbed out" are written confessions of this inadequacy of writing—but even such obvious matters as accent and pronunciation can be

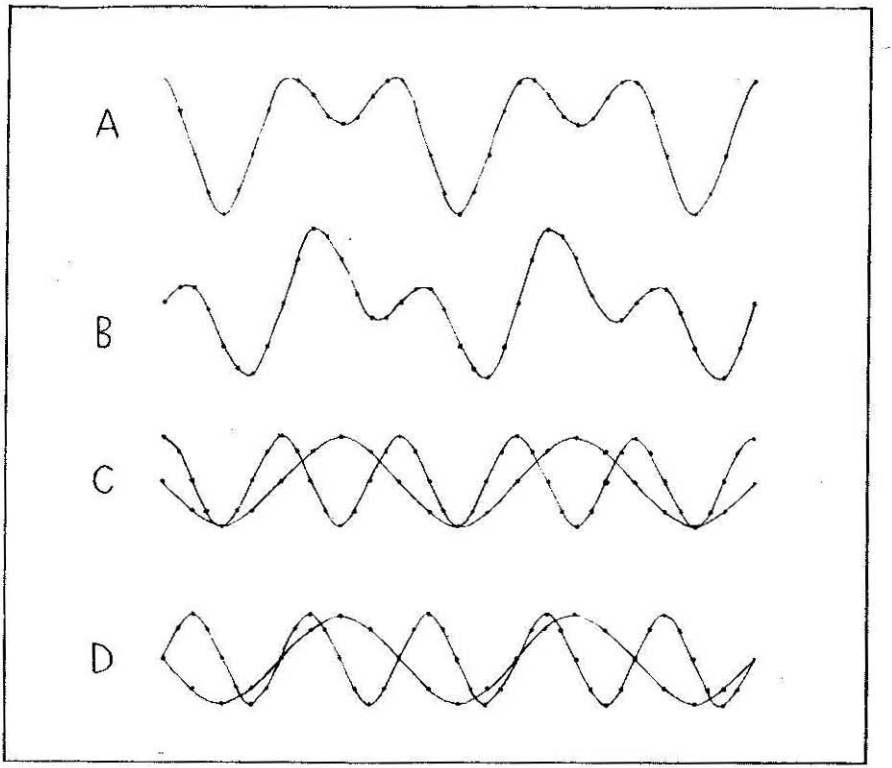
indicated only by a clumsy misspelling. The devices for supplementing the failure of writing are more artificial than the confusing symbols of the most mannered modern painter. Picasso's portraits give as clear a picture of a pretty woman as the poet's best and most lucid writings give of her pretty voice.

But, disregarding the subtler shades of accent and emotion, perhaps the simplest and worst defect of all in this mechanical age is that there is so little correlation between the written symbol and the spoken word that we are frustrated in our attempts to make voice operated devices. We have all dreamed, if we have not read, of voice operated typewriters which take down dictation without fatiguing or distracting, yet our preoccupation with written words which bear little relation to speech has prevented our realizing even this. The voice operated lock, the voice-operated furnace—a whole host of voice-operated mechanical servants have likewise languished in the land of the unborn, and this may be primarily because of a silly and antiquated way of looking at and visualizing words.

Whether we view speech as artists or engineers, sometimes we rebel at such restrictions. We ask not for more skill but for a good technological solution. We feel like the painter, Sir John Lavery, who said he would give all the portraits of Jesus in the world for one photograph of him. We want science to provide some sort of camera which will accurately portray the voice.

But has not science succeeded in this? Strictly, perhaps, yes; success and miracles we have indeed, but not just of the sort we had in mind. The phonograph has preserved the voice—embalmed it like a fly in resin—but, peculiarly, in an unsatisfactory manner. We have learned so to rely on the written word that we want to *see* the voice. Then, too, there are totally deaf people, who not only want to see the voice, but *must* see it if they are to understand.

We may advise the person who wants to see the voice to look at the groove in the phonograph record with a microscope. The voice is all there; it must be, or it wouldn't come out of the loudspeaker. And, in a more elegant fashion, just this has been tried. The spoken word when it travels through the air as a sound wave is merely a succeeding series of high and low air pressures. The rapidly fluctuating pressure at a point is an accurate representation of the sound, and if we make a graph, plotting air pressure versus time, just as we might plot the barometer reading versus time, we do have an accurate representation of the sound of the voice. The wavy groove of the phonograph record is just such a plot; if the groove swings toward the center of the record and that means the air pressure at the microphone was higher than average, then when the groove swings toward the rim, it indicates a lower than average pressure, and when the loudspeaker diaphragm fluctuates in accordance with the swinging of the needle in the groove,



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it accurately—we hope—reproduces the fluctuations of pressure of the voice which originally put the wiggles in the groove.

Machines are available which trace out not tiny grooves in wax but full scale representations on paper of pressure fluctuation versus time, large enough to see with the naked eye. Such records are called "oscillograms," and Figure 1 shows an oscillogram of the name "John."

Here at last we feel we have a portrait of the voice! All the information is there. If we made a phonograph needle trace out rapidly the fluctuations shown in the oscillogram, we would hear the actual sound of the word. We are, of course, disappointed. This picture of the name "John" seems so much more complicated than the word itself. The word, which was spoken rapidly and took only a fraction of a second to say, is stretched out over several inches of space and yet seems to be very fine grained and complicated. Still, perhaps we expected too much. At least, we have an accurate picture of the word. Or have we?

Here we come to one of the great disappointments of the physicists, engineers, and experts in phonetics who have studied such oscillographic records of the human voice. It is true that the information is *there;* the oscillogram *does* describe a particular word spoken by a particular voice into a particular re-

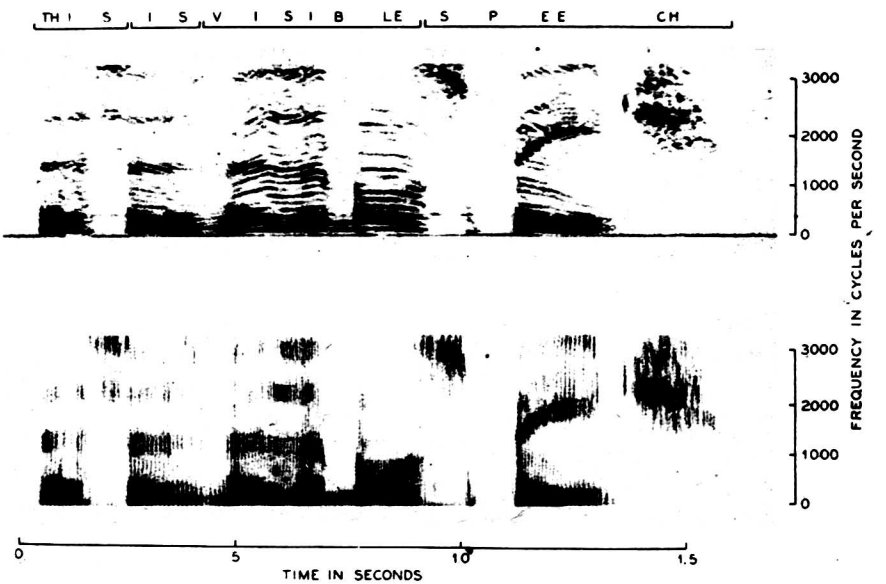


Fig. 3. The analysis of the words "This is visible speech" as performed by the new Bell Laboratories system. The two analyses differ only in that the upper was done with a "low resolution" system, the lower with the "high resolution" system using more filter channels.

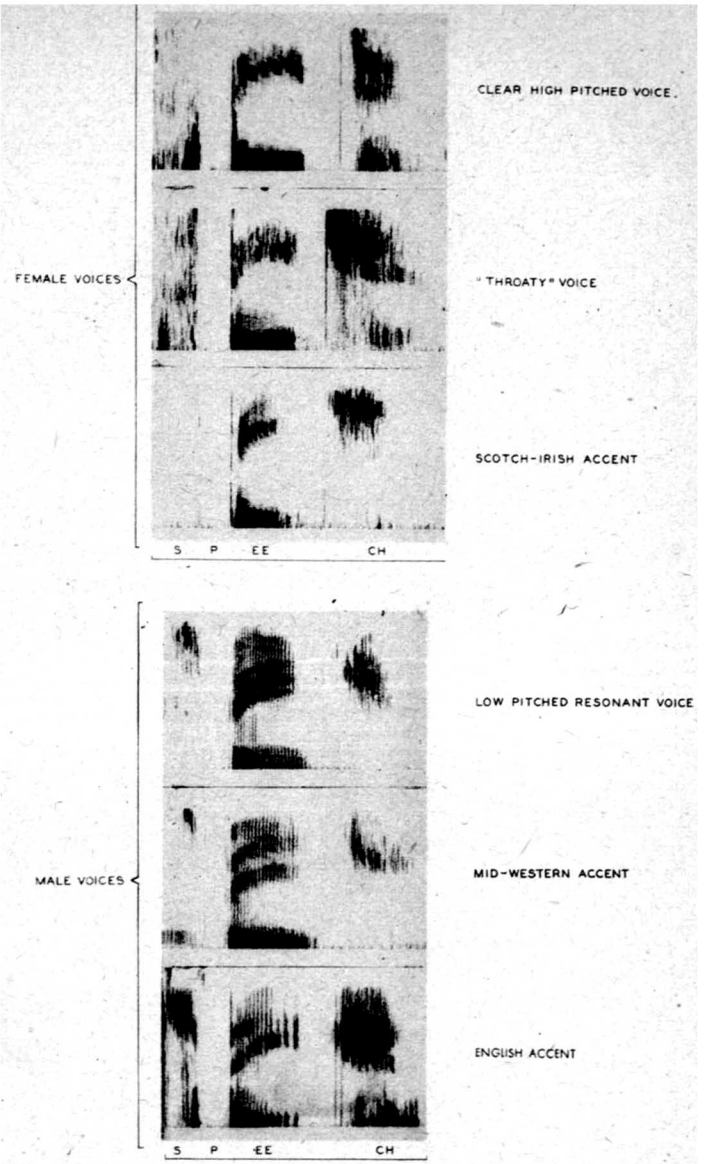
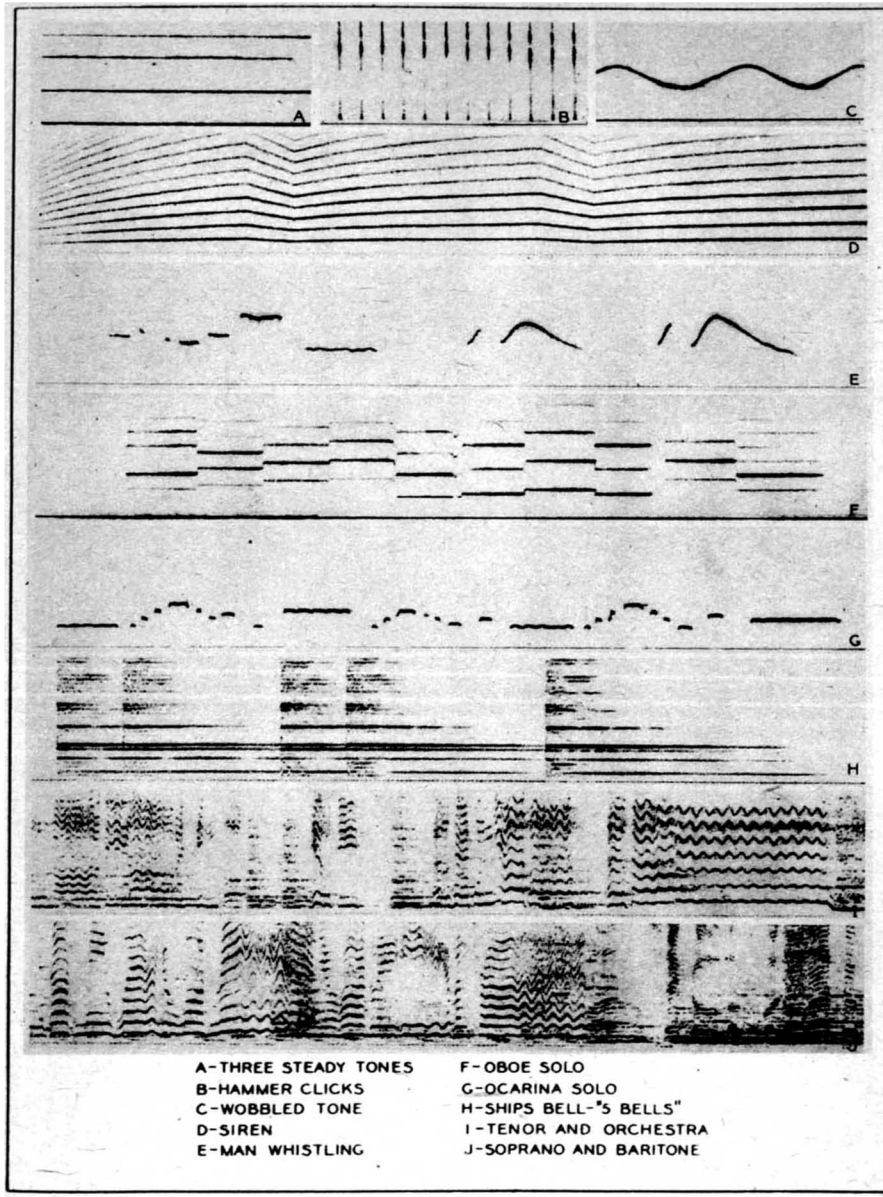
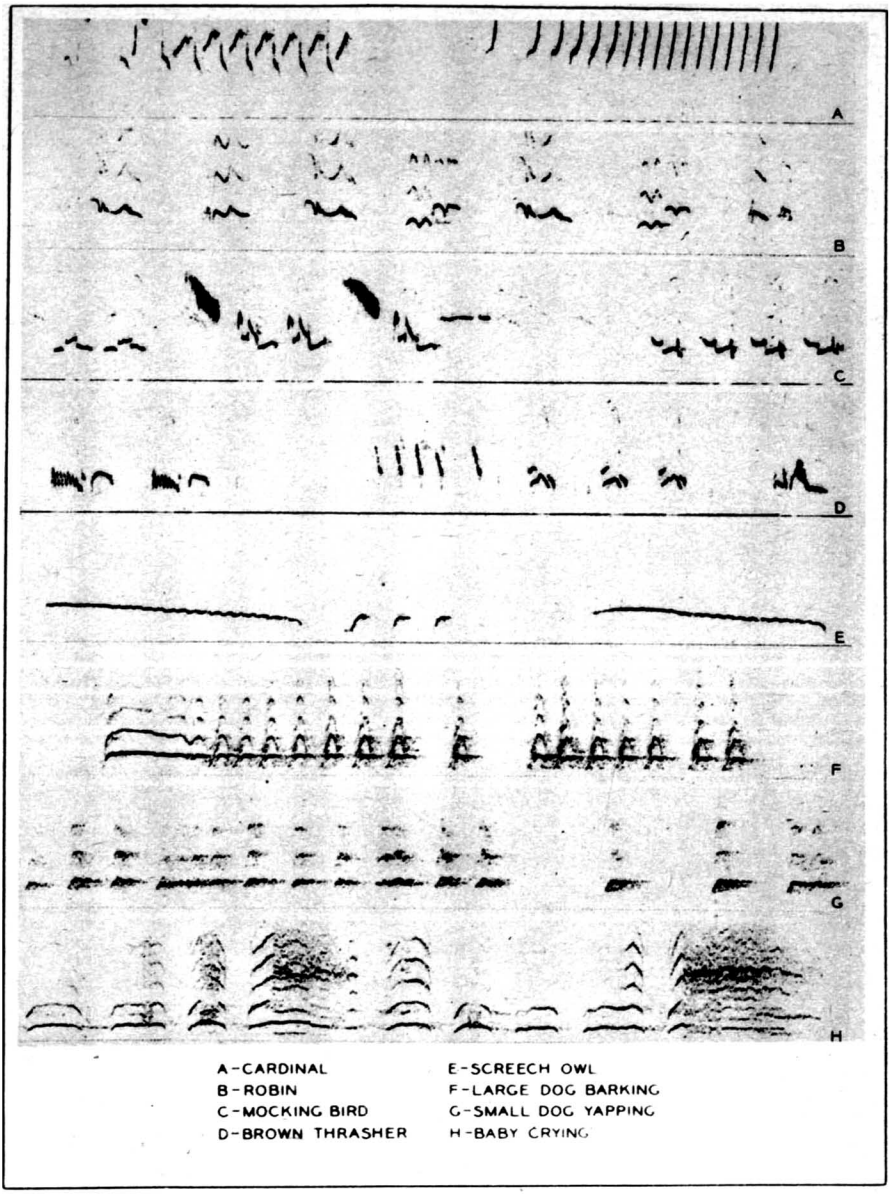


Fig. 3. The visible speech analyzer detects not only the meaning of the word used—"speech" in this case—but can detect differences of voice-quality and accent. It is this feature that is of immense importance to the deaf-mute. It is the inverse of the Voder.



Figs. 4. and 5. Various sounds analyzed by the visible speech system help to show how it—and the human ear—evaluates different sounds.



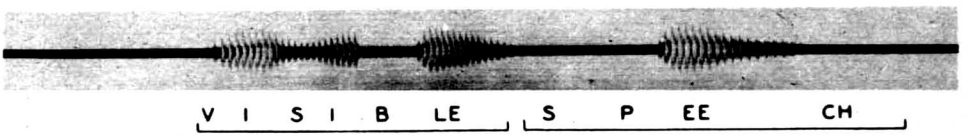
A, B, and C on page 108 show the system most clearly. Can you make out what the "Man Whistling" was whistling?

cording device. The information is accurate, but tantalizingly ill-assorted. The oscillographic trace gives both too much and not enough information to enable us to recognize words visually, at least with any practical degree of certainty and ease.

To see why this is so, we must investigate a little the nature of hearing. Perhaps the oscillographic record of speech strikes us as foreign to our feelings about sound. If so, we are on safe ground, for it doesn't at all correspond to the way the ear functions.

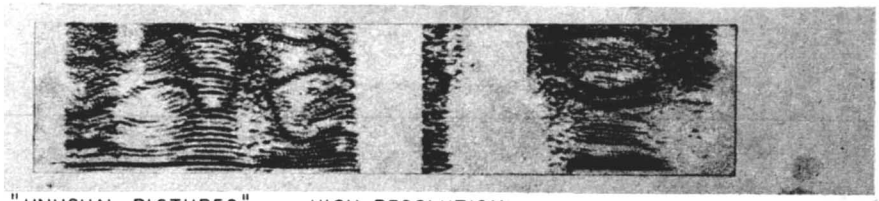
The things we all know about sounds are loudness and pitch. The loudness of a sound is so obvious a quality as to need little explanation, but the pitch perhaps requires study to make it clear. We know that a stretched string vibrates when plucked, giving forth a musical sound or tone. If the string is stretched more tightly, or is made shorter, the vibration becomes more rapid; the *frequency* of the vibration, that is, the number of times the string swings back and forth in a second, is greater, and the pitch is higher. The more experimental minded of us know that a string which is *tuned* to vibrate at such a rate as to produce a given note, say, middle C, will be induced to vibrate if we hum or whistle middle C near it. If we connected to the string some sort of electrical amplifying device capable of recording its motion, we would find that the string acted as what electrical engineers call a *filter;* that is, it would respond to sound only when a particular note was present in the sound. If, for instance, we sound the note E near a string tuned to C, there will be little or no response. And even in the presence of complicated music, a string will be made to vibrate only when the note to which it is tuned is among those played. Such a tuned string can be called a filter because it filters from the many tones present to the one to which it is tuned.

We easily suspect that there must be some similar action in the ear which enables us to distinguish tones with a certain degree of accuracy. When two tones are sounded at once we can recognize that there are two tones and not just a more complicated sound, although we may add that we like or dislike the way

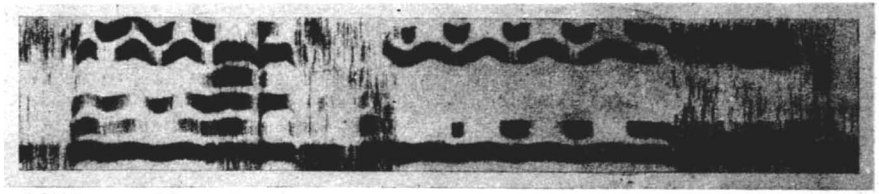


Figs. 6. and 7. The oscillograph analysis of "visible speech" above should be compared with the analysis of the same words on page 106, and the clear and readable, but inordinately long oscillogram of "John" on pages 102 and 103. The "B", "SP" and "CH" sounds above are completely indecipherable; at the right, above, the "P" and "S" sounds in "Pictures" are clearly distinguishable.

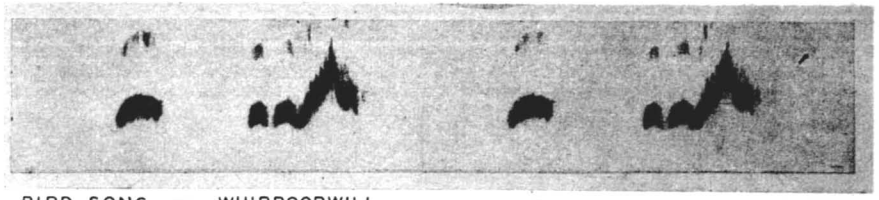
"UNUSUAL PICTURES" — LOW RESOLUTION



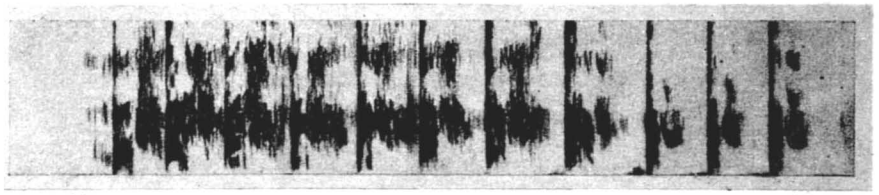
"UNUSUAL PICTURES" — HIGH RESOLUTION



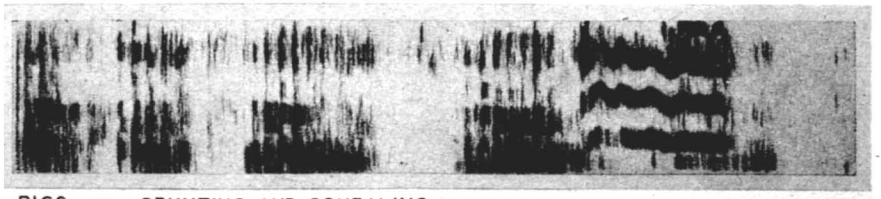
SONG — TRAINED SOPRANO VOICE



BIRD SONG — WHIPPOORWILL



LAUGH



PIGS — GRUNTING AND SQUEALING

the two particular tones go together. If we investigate a little further, prying into the anatomical structure of the ear, we find it only natural that we should recognize tones in this fashion. In the inner ear, in a long spiral liquid filled canal called the cochlea, are many tiny filaments, tuned to vibrate at frequencies in the range of sound. When a particular tone is sounded, it sets certain of these tuned filaments into vibration and these excite nerves attached to them. The nerves in turn transmit a message to the brain that a particular tone has been sounded.

But the eye is not equipped to sort out tones in this fashion. When we gaze at an oscillogram in puzzlement, we have no way of telling what tones are present or in what intensity. To use a rather inexact comparison, the information in the oscillogram is somewhat like the information presented in a totem pole or in a surrealist picture; the eyes, joints and limbs are there, but the organization is missing, and we are at a loss to make sense of the oscillographic representation of the voice.

Worse than this, the oscillogram can be downright misleading. It makes distinctions that aren't there. Oh, yes, they may literally be there in the sound wave, but the ear doesn't appreciate them as differences. Sometimes it seems that the oscillograph almost concentrates on small unimportant differences and slurs over those which convey real meaning. As an example, let us examine the made up oscillograms shown in Figure 2. That in 2a is not very similar to that in 2b. To the ear, however, the two represent identical sounds. Both 2a and 2b are combinations of two tones, one having twice the frequency of the other. Figure 2c shows both of the tones, I and II, which, when added, give 2a. But in 2d the same two

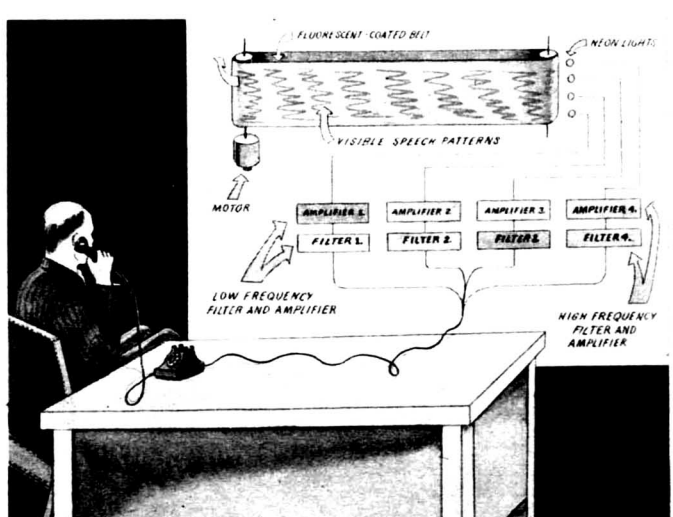
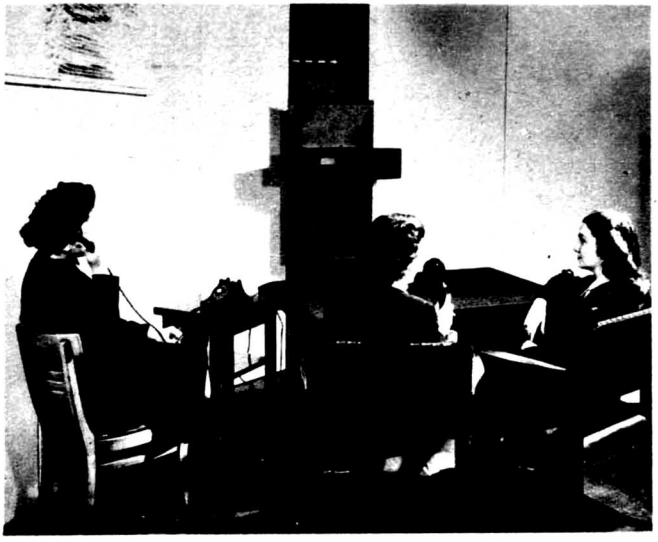


Fig. 8. Schematic drawing of the method used in the speech analyzer so that the totally deaf can "hear."



Corresponding set-up of actual apparatus, with the mechanical features out of sight.

tones are shown, II displaced a little to the left. The ear takes no account of such a displacement, yet when the two tones of 2d are added they give 2b, so different appearing from 2a.

Such displacements occur because of chance reflections and distortions and because of defects in telephones, radios and electrical recording equipment. They profoundly alter the appearance of oscillograms, but have little or no effect on the sound as interpreted by the ear. The oscillogram as a picture of the spoken voice is worse than complicated; it is misleading as a hair-splittting lawyer who makes fine distinctions, distinctions which according to the final tribunal, the ear, just aren't valid.

If the oscillogram is not a very useful picture of speech, how are we to picture it. Perhaps, given time enough, you could guess. It will be easiest if we pass on to the real gist of this discussion, and describe a true portrait of the voice, as presented for the first time in an article in the November 9th issue of *Science* by R. K. Potter of the Bell Telephone Laboratories, who tells us how the portraiture of the voice has been reduced both to a science and a fine art.

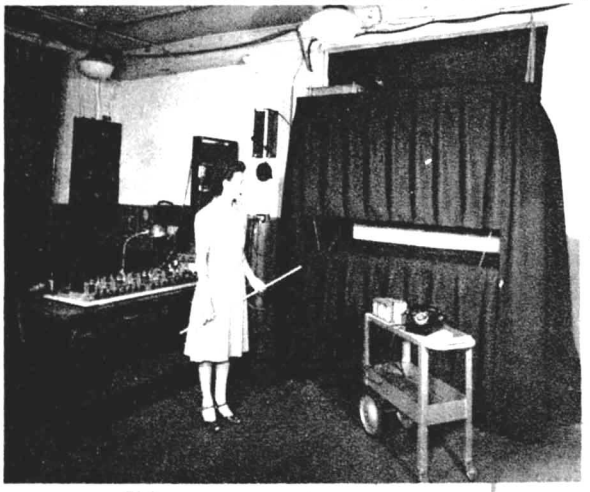
Suppose we look at Figure 3, which shows an actual picture of the spoken words, "This is visible speech." Without explanation, the pattern means nothing. Perhaps the reader needs some assurance as to what is really there. This is not an obscure cryptogram to be worked out by a laborious process. Trained persons can read such records accurately, and as fast as the words are uttered. In fact, such patterns, imprinted continuously on the phosphorescent coating of a moving endless belt, can be read by an observer in the moments between the time

they are uttered and recorded and the time they pass from view. These patterns are, then, true, readable pictures of what has been said, and they represent the first readable record of speech made by mechanical means.

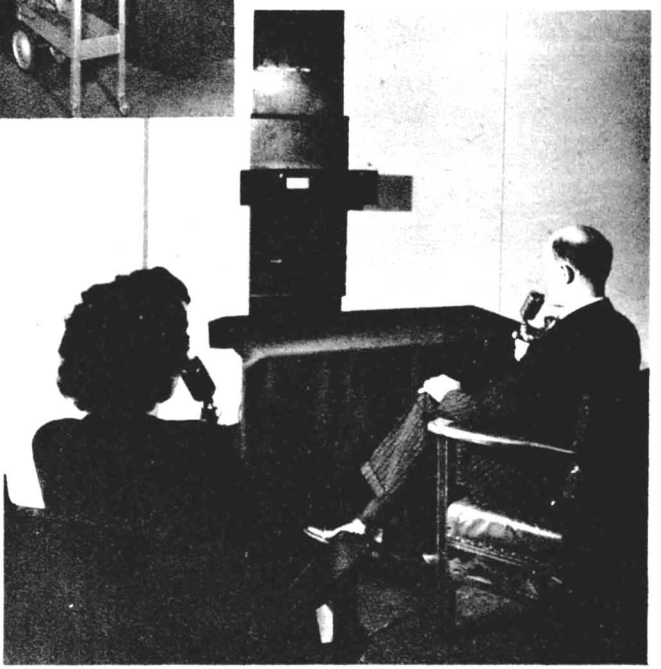
But we want to know just what the patterns mean, and how they are made. What is the secret of rendering speech visible and readable.

Horizontally, of course, we have time. The words uttered first are recorded to the left and those uttered later to the right. Thus, the record is read left to right, just like printing.

Amplitude or loudness is represented by degree of blackness. Thus, silence gives a blank, white



On the table at left is the system of filters and amplifiers; the long-persistence fluorescent belt is visible between curtains.



The man at right, totally deaf since birth, had never heard human speech, hence was unable to learn to speak properly. With the aid of speech analyzer, he has been able to compare his voice with those of others, and so improved.

record, visible between the words and syllables in Figure 3. An overpowering din, such as a steam calliope going full blast with all the keys pressed down, would record dead black all over.

Vertically, frequency is recorded. Thus, if a single pure tone were played loudly, we would see recorded a single, horizontal black line. If several notes or tones were sounded simultaneously, as in a chord, several horizontal lines would be recorded, and, indeed, just such a recording of three steady tones* is shown in A of Figure 4.

Now, suppose we have a single pure tone, such as is made by whistling, but that it changes in pitch, as in whistling a tune. In Figure 4E we have a record of a man whistling, and if one knew what height corresponded to what pitch or frequency, he could tell just what notes the man had whistled. High notes high, low notes low, the figure is an accurate representation of the tone; it tells the pitch, the length of each note, and the loudness—blackness—as well. Thus, such diagrams give a little more information than a musical score. Figure 4G shows a tune played on an ocarina, which gives a pure tone much like that of whistling.

* Technically-minded readers will want to know how this and other permanent visible speech records were made. The sound was first recorded on a magnetic tape. Then it was played back many times through an electrical filter and the variation of filter output vs. time was recorded as a horizontal line of varying intensity. For each successive playback the electrical filter was tuned to a slightly higher frequency, and each line was recorded a little above that before, giving the records shown in Figures 4-7. A different device, described later, is used in producing continuous records of visible speech.

Now look at Figure 4F. This is an oboe solo. Yes, it is a solo, despite the several traces corresponding to each note. Why are there several traces? The upper traces represent the *overtones* or *harmonics* of the note sounded. We remember that a stretched string will vibrate when the note to which it is tuned is sounded; it will filter out this tone from complicated sounds. Now, suppose we sounded a note on an oboe near a series of stretched strings, one tuned to the frequency of the note played by the oboe, another tuned to twice that frequency, a third to three times that frequency, and so on. We would find that all of the strings would vibrate. If we whistled a pure tone near the strings, only one would vibrate. Thus, the note of an oboe is not a pure tone, like a whistle. When we sound treble A—concert pitch—on an oboe, we get not only a tone of 450 cycles or vibrations per second, but one of 900 cycles, one of 1,350 cycles, one of 1,800 cycles, and several more as well. All of these overtones, and their relative intensities as well, are faithfully revealed by the position and blackness of the lines recorded in Figure 4F. Here we have a record not only of the tune and loudness of the oboe solo, but of the nature or quality of the instrument's tone as well, for it is the number and relative intensity of the overtones or harmonics that give the distinctive quality which enables us to distinguish one instrument from another by the sound of a single note.

Figure 4 shows that aside from

whistling, the ocarina, and some bird songs—shown in Figure 5—most sounds are not pure tones, but are rich in harmonics. Suppose we examine Figure 6. This is a record of the same words, "This is visible speech," which were shown in Figure 3. There is a difference, which I will explain in a moment.

We find the pattern in Figure 6 to be very rich in harmonics. It is these many harmonics which give the human voice its wide range of quality. We see that some of the traces representing harmonics are blacker than others; that is, these harmonics are stronger than others. We notice, however, that the loudness or intensity of the harmonics changes slowly in going from one harmonic to those above or below it in frequency, so that adjacent harmonics tend to have nearly the same strength. Thus, over a region including several harmonics the intensity may be very low—white—or very high—black. We see that human speech is characterized not so much by the relative strengths of the individual harmonics, but by the relative strengths of whole groups of high pitched, medium pitches, or low pitched harmonics.

This is not just an idle conjecture. Examine the record of "This is visible speech" shown in Figure 3. To one skilled in reading speech patterns, this is just as intelligible as the record shown in Figure 6, yet in Figure 3 we see no harmonics at all! Why is this? The reason lies in the equipment used in making Figure 3.

We know some people who have a good musical ear; they can distinguish small differences in pitch. Others of our acquaintance can barely tell one note from another. They can tell a low note from a high one, but may not be able to tell which of two adjacent notes on a piano is higher. The apparatus used in making Figure 6 had a "good musical ear"; it could distinguish and record individual harmonics and their intensities. The apparatus used in making Figure 3 had a very poor musical ear. It could tell that there was a large group of low, medium or high pitched harmonics and that such a group was weak or strong, but it could not distinguish the location or intensity of individual harmonics. Still, it could record the sense of the speech, which resides in the distribution of intensity in rather broad frequency ranges, and not in the distribution among individual harmonics.

How true this is may be seen by examining records of the same word spoken by different voices, as shown in Figure 7. In the clear high pitched voice and the low resonant voice the intensity of sound at a given frequency is almost the same. Had these voices been recorded in a fine grained manner, as in Figure 6, we would have seen in the dark regions of the low pitched voice many lines representing closely spaced harmonics, while in the dark regions of the high pitched voice there would have been fewer lines, representing more widely spaced harmonics. This comes about because the frequencies of the harmonics are al-

ways multiples of the frequency of the fundamental tone or pitch of the voice.

To make the matter clear, consider the cases of a voice pitched at 100 cycles per second, and another pitched an octave higher, at 200 cycles. The lower harmonics which could be present in each voice are identified below:

	Low	Octave up	
fundamental	100	—	
2nd harmonic	200	200	fundamental
3rd "	300	—	
4th "	400	400	2nd harmonic
5th "	500	—	
6th "	600	600	3rd "
7th "	700	—	
8th "	800	800	4th "
9th "	900	—	
10th "	1,000	1,000	5th "
11th "	1,100	—	
12th "	1,200	1,200	6th "
13th "	1,300	—	
14th "	1,400	1,400	7th "
15th "	1,500	—	
16th "	1,600	1,600	8th "
17th "	1,700	—	
18th "	1,800	1,800	9th "
19th "	1,900	—	
20th "	2,000	2,000	10th "

You may wonder why such a long list has been given. The range in the column to the right, from 200 cycles to 2,000 cycles, includes about the frequency range needed to transmit speech with good intelligibility. Good telephone circuits transmit a greater frequency range, about 200 cycles to about 3,500 cycles, and fine FM radios from perhaps 30 cycles to over 10,000 cycles, but speech is almost perfectly intelligible if we eliminate all frequencies outside of the range from 200 to 2,000 cycles, and the records shown in Figures 3 and 7 include about that range.

Examining the table of harmonics, we recall that in Figure 7, voices of different pitch have about the same intensity at a given frequency. That is, in speaking the vowel o, for instance, the high voice would have about as much intensity around the fifth harmonic as the low voice had around the tenth harmonic, which is of the same frequency as the fifth harmonic of the high voice. This is a fundamental quality of intelligible sounds; the intensity pattern for a given sound tends to remain the same regardless of the pitch in which we utter it.

The comparatively blurred patterns of Figures 3 and 7, which could not distinguish nearby notes at all*, are, as experiment proves, quite intelligible. Just what does this mean? It means that, given training, people can read them off at least as fast as words are spoken. That is not only interesting and desirable; it is absolutely vital if this mechanically produced portrait of a voice, or visible speech, is to fulfill one of its most interesting and vital functions. That vital function is to provide totally deaf persons with a means of understanding human speech transmitted by telephone or radio.

With a clear idea of what we wish to accomplish, it doesn't take much gadgeteering to provide a device which will produce visible speech patterns continuously. Such a device is illustrated in Figure 8. To

* These patterns distinguish about twelve frequency ranges. Thus, two notes would have to be separated by more than 1/12 of the frequency range represented to give separate traces.

the wires ordinarily attached to the telephone receiver, a number of electrical filters are connected—only four are shown in Figure 8—actually there are twelve. Now, each of these filters will respond, that is, give electrical output, only if the input has frequencies lying in a given range. In the present devices, each filter has a "pass band" or width of frequency response of about 300 cycles per second. The first will respond to tones whose frequencies lie roughly between 150 and 450 cycles per second, the second to tones with frequencies from about 450 to 750 cycles, et cetera, up to around 3,600 cycles. To the output of each filter is connected a vacuum tube amplifier which steps the filter output voltage up sufficiently so that it can light a neon bulb. The brightness of the bulb increases as a tone in its filter's frequency range is made stronger. The bulbs themselves are shielded from the observer. A continuous belt coated with fluorescent material passes the bulbs and a fluorescent glow is produced if the bulb is lighted. This persists as the moving belt passes before the eyes of the observer, enabling him to recognize the frequency patterns produced by the bulbs. The apparatus obviously gives just the visible speech patterns we want, and in this simple manner a device has been provided which makes possible something entirely new—for a completely deaf person to understand a conversation by telephone.

One may object that the deaf person can learn lip reading, anyway, and he might then hear by television. The obvious answer is that we don't have two-way television in the average home, but we do have a telephone. What is more, the engineers at the Bell Laboratories have devised an experimental visible speech viewer similar to that illustrated in Figure 8 which is only about as large as a portable typewriter, and can be easily attached to a telephone.

Visible speech is better than lip reading in other ways, however; for one thing, it helps a deaf person to learn to speak. People who are born deaf may learn to speak, but their voices will sound expressionless, harsh, and peculiar, for they have no means for comparing the words they utter with those spoken by normal people. Even persons who become totally deaf lose the art of speaking normally; their speech degenerates toward unintelligibility when no longer corrected by daily comparison with that of others. Now, with a visible speech device a person can watch his own voice as he speaks, much as an actress might study her gestures in a mirror. And this is not a mere pious hope of what can be done, for in experiments deaf people have actually improved their speech by use of visible speech devices, and those experts in speech training who have followed the experiments and observed the results are, to put it mildly, wildly enthusiastic. Visible speech promises not only to make the deaf "hear" face-to-face and telephone conversation, but to enable them to speak intelligibly and agreeably as well.

In this connection, one failing of patterns such as those shown in Figures 3 and 7 has become apparent. We have said that all trace of the pitch of the voice has vanished from them. Yet pitch is an important part of normal speaking; we all know how much a rising or a falling inflection can help in conveying shades of meaning or feeling. To provide the sense of pitch, a separate trace may be provided on the visible speech pattern, which may rise or fall, or perhaps darken or lighten as the pitch of the voice becomes higher or lower. So aided, a deaf person has the means for training himself to mimic all the qualities of the normal human voice.

We have mentioned two superiorities of visible speech over lip reading. There is another; intelligibility. It takes about the same time to learn to interpret visible speech patterns as it does to learn to interpret lip motions, but the interpretation is much surer. No ventriloquist talking with still lips is silent to the deafened person with a visible speech device, and no silent mouthing can resemble speech to him. Visible speech distinguishes just what the ear does, and that includes many differences in sound which do not show up in lip motions.

Just how "intelligible" is visible speech? That is, how certainly and easily can we identify from a pattern such as that of Figure 3 or Figure 7 what was actually said? Obviously, there are many factors affecting this. We have seen that it is not necessary to provide a vertical frequency pattern so clear cut that the individual harmonics can be identified, but certainly if we smeared the pattern sufficiently, either vertically, confusing the frequencies, or horizontally, confusing the time of utterance, the pattern could no longer be read. Where is the boundary between unnecessary detail and loss of meaning? Then, too, it is a well known fact that the human ear is less sensitive to differences in frequency or pitch at high frequencies than at low frequencies. Thus, the ear can distinguish successively sounded notes of 100 cycles and 102 cycles, but cannot distinguish successively sounded notes of 5,000 and 5,002 cycles. In fact, the ear tends to distinguish equally well fractional changes in pitch rather than differences in frequency. Does this mean that on our visible speech patterns we should allot equal

vertical distances to the frequency range between 1,000 and 2,000 cycles and to that between 200 and 400 cycles, despite the fact that the frequency differences in the two ranges are 1,000 and 200 cycles? And what about loudness? Suppose that on a luminous pattern the normal human voice gives five-foot candles illumination. Should a voice of twice the energy give ten-foot candles and a voice of twice that energy give twenty-foot candles? Or, if the normal voice gives five-foot candles, should a voice of twice that energy give, say, eight-foot candles, and a voice of twice that energy give eleven-foot candles, et cetera, with a constant difference in brightness for each doubling of the voice energy? Oddly enough, that is more the way the ear works.

How are we to settle these points and tell how intelligible a visible speech pattern is? The natural reaction is, I suppose, to ask a person who is thoroughly familiar with such patterns and is able to read them. Just that was done at the Bell Laboratories. New and supposedly better patterns were shown to a group of girls who had been trained to read the patterns produced by earlier devices. What was the result? We might have expected it—they liked the sort of patterns they were already familiar with! It isn't the eternal feminine; if one becomes accustomed to a certain automobile, or food, or radio, or accent, he naturally understands it better and appreciates it more than a somewhat different automobile, or food, or radio, even though that which is different may be a little better.

What was to be done? The solution arrived at is ingenious and simple. Patterns were made of words spoken in groups of three, two alike and one a word likely to be confused with the other, as, cat, rat, rat or get, get, bet. Then untrained persons were asked to tell whether the center word was like that to the right or that to the left. If the distinction was made correctly half of the time, this would indicate pure guessing, and a complete inability to distinguish the two words in the visible speech pattern. But, if the difference could be distinguished correctly almost always, then, presumably a person could be trained to make the distinction quickly, and to read the word when it occurred in visible speech rapidly and correctly. By this test it is possible to evaluate changes, and to see whether they really mean increased intelligibility, or only unimportant differences in the appearance of the patterns.

A long series of such tests has been made. What improvements they will work in visible speech we do not as yet know, and we will have to wait for further announcements to tell us. The tests have shown that nearly all of visible speech is intelligible, and that reading it is not merely a matter of getting hints and guessing, as people do in understanding half overheard conversations or in lip reading.

Where, then, has the art of visible speech taken us? Potter's article tells us that the patterns can be produced continuously from a device as

small as a portable typewriter, a device which can be attached to a telephone or radio. He tells us that with training the patterns on such a device can be read accurately by normal or deaf people. He says that deaf people have been trained to speak more naturally by watching the patterns of their own voices. He mentions and hints at other possibilities, some of them almost more intriguing.

He recalls that the ear does not need to store up several words on a tape; it retains a memory of what has been said, and pieces the words together thus. There is a literal meaning to the idea of words "ringing in one's ears"; one sound is not lost to consciousness before another is presented to the mind. The analogue in visible speech would be to have a single vertical line instead of a stretched out pattern, and to have the light intensity up and down it indicate the instantaneous intensity at different frequencies — vertical positions—relying on the memory to store up and put together what had gone before. Such an effect would be achieved with the device of Figure 8 by looking at the passing belt through a narrow slit, so as to get just a glimpse of each part of a word as it went by. Some preliminary experiments have indicated that this makes it harder to understand visible speech. Though the ear is used to catching words on the fly, piece by piece, the eye still wants to see a whole line at a time.

Potter mentions the use of color instead of black and white. Imagine Dorothy Lamour's voice in gorgeous Technicolor. He mentions voice operated devices. If the human eye can distinguish words in the visible speech patterns and easily and correctly identify the same word spoken by a man or by a woman, in an English or a Mid-Western accent, why can't a machine? Electronic sorting devices have been used for similar purposes. Will a machine, then, locate a name or a subject in a file at the sound of a word? And how will the material in the file be expressed? In conventional letters, or in visible speech? Will a machine turn visible speech into the ABC's, and take down dictation on a typewriter? Or, why should it? Perhaps we will all learn to read visible speech as easily as we read the words printed on this page. In that case, no further mechanism is necessary, for a machine could easily be made to record the spoken word in small visible speech patterns neatly arranged in lines on a page, and these could be unerringly read by anyone with training.

And what is in such a record? The pitch of the voice is missing in a rough record such as that of Figure 3 or Figure 7. The pitch can, however, be supplied on a separate trace. Can the sound be reproduced from the record itself? Potter hints that this may be possible. If so, we would have books that could be read either by eye, or aloud by a machine. Could the deaf and the not-deaf then enjoy the rhythm and tune of music recorded in the same book, without ever hearing it? What possibilities

this opens for a synthesis of the arts!

Certainly, visible speech contains much more information than the ordinary printed word. If we examine Figure 7 we see distinct differences in the records of various accents, although the words spoken in various accents are obviously similar enough to be recognized as the same. Will we have Milt Gross' characters and Artie Greengroin reproduced in the exact intonation and accent the writers intended, accurately, unerringly apparent to the reader's eye? Will the sweet tones of the heroine strike straight through our eyes to our hearts; will we see the terror in her voice as she repulses the villain; will melting loveliness fairly ooze down the page? Will the broken sounds that she utters show a real discontinuity?

And, finally, will some artist with his brush create a portrait of a feminine voice so lush or dulcet and beautiful that the idealist will hunt the world over for a human counterpart, and finally sink in disillusionment to repairing or reselling or writing about yet to be produced devices for visible speech?

THE END.

THE ANALYTICAL LABORATORY

The Lab this month has a little elbow room for once, and you may be interested to consider something more general than simply the April Astounding Science Fiction. To wit, the reception earned by stories of different lengths.

Generally, the longer a story is, the more chance the author has to work out his background ideas, characters, and plotting. Serials usually take first place, primarily because the author can do a better job. Unlike here-and-now-stories, science-fiction must describe even the common things of life—life in the story environment. More space gives more chance for that. The result is that there are very few long-remembered, "classic" short stories, a few novelettes, but many much-mentioned serials. The ratings this time for instance:

April Astounding Science-Fiction

Place	Story	Author	Points
1.	Pattern for Conquest	George O. Smith	2.07
2.	Memorial	Theodore Sturgeon	2.80
3.	Swamper	Jerry Shelton	3.13
4.	Black Market	Raymond F. Jones	3.29
5.	Loophole	Arthur C. Clarke	3.71

"Memorial" was unusual in beating out novelettes; its timely appeal helped a lot, no doubt. But otherwise the pattern is about as it usually runs—which is one reason why you've found Astounding Science-Fiction running heavily toward novelettes recently.

THE EDITOR.

The Blindness

(*Continued from page 98*)

"It's a ninety minute exposure on H. D. 218393," I explained, "taken with my new ultraviolet spectrograph. The star's a peculiar B-type variable with hydrogen emission lines. What I don't understand is all this spectrum south of 2900."

Murdock was studying each line in turn. "What's your dispersion?" he asked.

"Fourteen angstroms to the millimeter."

He took out a little millimeter scale and made some measurements on the various lines. Next he did some figuring on the back of an envelope, checking each result by repeating his measures on the plate.

"Well, there's only one answer that I can see," he said finally, tapping the scale against his fingertips. "Apparently the ozone layer in the Earth's upper atmosphere has ceased to function. Looks as if the oxygen bands are laying down on the job, too. At any rate, the thin layer of molecules that we depend upon to shield us from the Sun's ultraviolet light has gone on a strike.

"As a result, my dear Latham, you have obtained the first stellar spectrogram of that distinguished head of the hydrogen family, Lyman alpha at 1216." He indicated the black blob at the end of the plate. "Congratulations."

"Let's go tell Blakeslee," I said.

We routed Blakeslee out of the library where he was going over some tables in an old copy of the "Astronomische Gesellschaft." He inspected the plate closely and listened silently to Murdock's interpretation of the spectrum.

"This may explain a lot of things," he said slowly. "We can tell definitely when the sun comes up tomorrow morning."

"Yeah, providing we're still here to see it," Murdock added.

I didn't wake up till nearly noon next day. The first thought that popped into my head was that spectrogram of H. D. 218393. The plate should be dry by now so that I could put it on the measuring machine and really find out what I had.

When I reached the darkroom to my chagrin the busy sign was hanging outside.

"Open up," I called, pounding on the door. "It's Latham."

"Hello, Latham," Murdock called back cheerily, "How are you this morning?"

"I'm all right. I want to get that plate."

"What plate is that?"

"You know what plate I mean. Come on—open up."

Murdock looked like a wild man when he unlocked the door. He was unshaven, his black hair was standing straight up, and there was an excited gleam in his eye. He thrust a dripping plate into my hands.

"The solar spectrum down to 600 angstroms!" he cried.

From the looks of the place he must have been up for hours. There were a dozen plates in the drying rack and a dozen more in the hypo.

"Six hundred angstroms!" I gasped. "Man, you're crazy. There ain't no sunlight left at six hundred angstroms."

"And still going strong!" he enthused. "Why, there's apparently no limit to the Sun's ultraviolet spectrum. If anything, it's picking up instead of petering out."

One glance at the plate was enough to confirm his assertion.

"Way back in 1937," Murdock said, lighting a cigarette, "astrophysicists began to suspicion that the Sun didn't radiate like a black body at six thousand absolute. Half a dozen different lines of evidence all agreed in indicating that the ultraviolet spectrum of the Sun corresponded to that of a black body at around twenty thousand absolute. Of course, they couldn't be sure. Then when the coronal lines were identified with atoms of iron and nickle ionized a dozen times, they realized there must be energy loose equivalent to a temperature of hundred thousand, maybe a million, degrees."

He was so excited he kept walking around the darkroom, taking plates out of the wash, examining them with his eyepiece, putting them back in the wash again.

"Trouble was, nobody could figure out how you could get such high-frequency radiation from a yellow dwarf like the Sun. Saha suggested some process akin to uranium fission might be the answer. It sounded kind of far-fetched at the time. Now it looks as if we had been too conservative, as usual."

He crushed out his half-smoked cigarette and reached for another.

"Reports come in from anywhere else on this?"

Murdock shook his head. "Elec-

tronic communication all over the globe's tied up in a hard knot. Ionosphere's been knocked to hell and gone. Have to rely on carrier pigeon and pony express from now on."

"How's the war coming?"

He shrugged. "Search me. We're still here, aren't we?"

All the rest of the afternoon we banged away at the coudé focus of the 300-inch, taking plates as fast as we could, so that by sunset we had a complete record of the solar spectrum down to 100 A with calibrations, enough to keep a corps of assistants busy measuring till 2000 A. D. When the last plate was photometered and developed we heaved a sigh of relief and for the first time began to think of food. Murdock had a can of coffee and some cheese and crackers in his room, and I contributed a couple of chocolate bars. While the coffee was boiling we had our first chance to talk things over.

"Murdock, what's happened, anyhow?"

He reached for a sheet of paper and pencil. "Well, here's the way I dope it," he said. "You can fill in the details later, but essentially the story must be something like this.

"There's no doubt but that the molecular equilibrium of the upper atmosphere has been completely upset. Now the fundamental process of ozone formation is the photolysis of the oxygen molecule, like so."

And he wrote down the equation $O_2 + hw = O + O$, in his bold irregular handwriting.

"That is, each photon absorbed by an oxygen molecule produces two oxygen atoms. At moderate altitudes where there are still plenty of other molecules handy, we get three-body collisions of the type, $O_2 + O + M = O_3 + M$, where M can be any old collision partner, say another nitrogen molecule, for instance.

"Ozone is a highly unstable molecule, so that we also have the reverse processes going on continually, of ozone back to oxygen again. Therefore, the concentration of ozone at any instant will depend upon the relative rates at which these various reactions proceed."

He paused long enough to examine the concentration of coffee in the coffee pot before returning to the ozone problem.

"But now Halley's comet comes along and so what happens? We know from observations of its spectrum that it's loaded to the guards with carbon. Carbon and oxygen have a powerful affection for each other, so that whenever possible they immediately proceed to unite with great exultation. Result is that the oxygen of the upper atmosphere, instead of forming ozone and other compounds, is busy forming stable carbon compounds. This opens the door for your far ultraviolet light for the first time, which comes blasting through a layer that previously had stopped it like a stonewall."

He poured out the coffee in

beakers we use for mixing developer.

"Wait a minute," I objected. "Sounds to me as if there's a fatal flaw in your theory. Carbon monoxide and carbon dioxide also absorb strongly in the ultraviolet if I remember correctly."

"Right," Murdock agreed. "But not so effectively as ozone and oxygen. As a matter of fact, your objection furnishes me with a conclusive proof of the theory."

He selected a plate from the drying rack and passed it across the table to me. "Take a look at that exposure over on your left there. Notice that heavily absorbed region between 1150 and 690 angstroms. Know what that is? It's the strongest band of the carbon dioxide molecule. See how they've been stuffing themselves on the ultraviolet of our sunlight."

In the days that followed we learned what life is like on the surface of a planet such as Mercury or the Moon that is exposed to the shortwave end of the solar spectrum. Never before had I the faintest conception of how delicate is the balance between contending forces that makes our existence possible. For ages man has strutted about utterly oblivious of the death that forever threatens him from above, his sole protection a shifting unstable mass of molecules. Talk about the Sword of Damocles! It was no laughing matter when it fell, believe me.

Within the Nucleus, scientists grasped the seriousness of the situation at once, and by taking suitable precautions were able to manage without difficulty. Not so with those outside. Although people were warned of the danger and informed how to guard against it, yet just as in the case of Halley's comet, through perversity or plain stupidity they refused to make the necessary adjustments. This was due in part to the fact that superficially everything *seemed* about the same as before. The sunlight looked somewhat bluer but the effect was not particularly striking. The trouble is, you can't see or smell or taste an Xray.

As Murdock said, communication was tied up in a hard knot, but after sunset fragmentary reports occasionally filtered through of the havoc outside the Nucleus. People were going blind by the thousands. Even with glasses enough diffuse radiation could enter the eye to produce severe injury. Almost overnight men were reduced from clearly seeing upright individuals to helpless groping creatures. The pandemic of opthalmic conjunctivitis came to be known simply as The Blindness, a term which aptly described it from several points of view.

The injury to the eye had, of course, been anticipated and to some extent discounted in advance. What was wholly unforeseen was the startling increase in certain other maladies which developed at a rate beyond any possible control. Among the most serious was the appalling outbreak of skin cancer —lupus erythematodes discoides—

among infants and the aged. Apparently this variety of cancer is latent in all of us, waiting only suitable stimulation to flare into being. Radiologists determined that a narrow band of radiation from 2670 to 3200 is the activating cause of skin cancer. Ordinarily, only the rays between 2900 and 3200 can get through, so that skin cancer develops chiefly in those who undergo prolonged exposure to the sky, such as sailors and farmers.

As if the uncontrolled growth in cancer were not bad enough, gradually through the heavily censored news reports there spread terrifying rumors of other diseases, rendered all the more fearful because of what was left untold and only suggested. Of the effects of ultraviolet light upon the central nervous system due to overradiation and heating of the skull, producing shock, convulsions, and in extreme cases, insanity and suicide.

As for the war, it was stopped almost before it was well under way. Electronically controlled rockets went careening wildly, often destroying the very ones who had launched them. Technicians working far underground sat helpless before elaborate instrument panels, impotent when their sense of sight was dead. And so peace was forced upon a reluctant world, that accepted it only when stricken by a plague worse than one of its own devising.

Slowly the return to normal began. Recovery was by lysis rather than crisis. But each day as Halley's comet receded from the Earth we watched our photographs shrink in the ultraviolet, until they terminated at 2900 as before.

It was on an evening in August about a week after peace was proclaimed, that Blakeslee, Murdock, and I were engaged in our favorite occupation of watching the sunset from the balcony of the 300-inch. As the light faded, we were able to discern Halley's comet in the western sky in the constellation of Sextans, where it was moving slowly south into Hydra. Now more than three hundred million miles from the Earth it retained little of its former splendor, a thin ghost dissolving into the sunset.

I thought of the long journey that lay ahead of it, out into the region of perpetual twilight between the orbits of Uranus and Neptune, before turning sunward again. And what kind of a world would it find at the next return? That I would never know.

I said to Blakeslee, "Did you ever find out what caused Halley's comet to deviate from your calculated course?"

He was gazing off at the comet probably with much the same thoughts as my own. "No, I never did," he said. "I checked my integration series over every step from the last perihelion passage on April 19, 1910, to that night last August when we secured our first photograph, without finding a single error large enough to affect my positions appreciably. The

whole thing seems incomprehensible by the law of gravitation."

He paused to reload his pipe. "This anomalous behavior of Halley's comet is not without precedent, however. At the previous return, Cowell and Crommelin at Greenwich did a magnificent piece of work on the motions of Halley's comet from perihelion in 1759 to 1910. When the Gold Medal of the Royal Society was presented to Cowell, the statement was made that he had rigorously taken into account distances along the comet's path of less than five feet. Yet Halley's comet passed perihelion in 1910 three whole days before the predicted time. That discrepancy of three days has never been explained."

Murdock shifted his position against the railing. "There's one conceivable explanation that occurs to me. It sounds fantastic, I'll admit. Still it's not incompatible with current atomic theory.

"There is evidence that inorganic matter possesses a certain degree of sentience; that is, the atom may have consciousness and will, and therefore in a limited sense the power to control its own destiny. We got our first intimation of this power more than half a century ago when the famous physicist, Pauli, announced his so-called exclusion principle. The exclusion principle says that inside the atom one and the same quantum state can be occupied only by one electron. It is forbidden for any two electrons in an atom to have the same values for all four of the quantum numbers necessary to specify a particular electronic state.

"The catch comes in trying to figure out how in heck the electrons can be aware of the quantum positions that are to be occupied, so that they never transgress Pauli's exclusion principle? It was never adequately explained by the old wave mechanics, and today it is still one of the most mysterious and fundamental properties of the atom.

"Whether atomic sentience can be invoked to explain the misbehavior of a comet I don't know. Maybe Halley's comet likes to stray by the wayside once in awhile like the rest of us. Maybe it gets tired at having to look at us every seventy-five years, or whatever it is." He paused.

"Maybe we'll find the answer next time when Halley's comet comes back about 2065," I suggested.

Murdock laughed. "Well, there's no predicting what Halley's comet may find then. Have you heard the big military secret that everybody in the Nucleus is talking about? Dillon over in the Horological Laboratory has cracked the time problem. Went forward in time last Friday night after five years of experimentation."

"How far?" I asked.

"About three-thousandths of a second. But I got it straight from MacIntire, who is Dillon's chief assistant, and he claims that with their technique they can easily measure a millionth of that amount. So it looks like the goods, all right.

The Army's been swarming all over the place."

"So Halley's comet may find us fighting a Time War next trip?"

"It could be," Murdock said.

Blakeslee had been gazing moodily off toward Halley's comet apparently indifferent to Murdock's remarks. "There isn't going to be a next trip," he said quietly.

Murdock and I both turned in astonishment. "Why, what do you mean?" we demanded.

"I mean that this is the last visit Halley's comet will ever pay Earth," he replied. "During the past month the eccentricity of its orbit has definitely turned from an elongated ellipse to a hyperbola.

"Take a good look now, for this is the last time anyone will ever see Halley's comet again."

A hyperbola! A curve that begins and ends at infinity. And Halley's comet was heading for infinity. Surely, it couldn't be! I tried to protest but somehow my throat was all choked up so that the words refused to come. As if from a great distance I heard Murdock speaking.

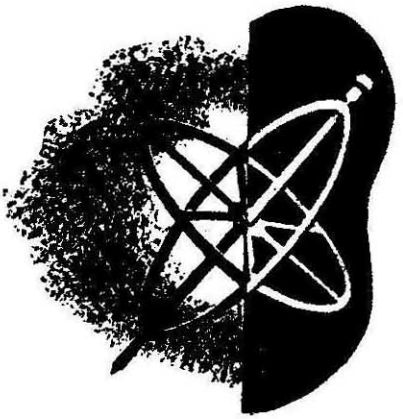
"Funny how people always think of comets as evil omens," he mused. "It seems to me that Halley's comet has been a faithful companion and a mighty good friend of ours during all these years. It certainly stopped World War IV in a hurry. If it hadn't been for The Blindness we might not even be here tonight."

"Yes," said Blakeslee. "If it hadn't been for The Blindness."

THE END.

Stability

by A. BERTRAM CHANDLER



***Balance** is important in modern planes—but a serious misbalance in something trying to balance on a jet of flaming gas could be more than merely annoying!*

The port captain snatched the gold-crusted cap from his head, dashed it to the gleamingly spotless deck of the control tower. With the crest of white hair standing stiffly erect above the scarlet face, the plump body in the glittering uniform, he looked like an angry cockatoo. And his voice, when at last he found words, heightened his resemblance to that unmelodious bird. "Why don't they come in?" he demanded shrilly of the world at large. "Why *don't* they come in?" Then, to the girl at the R/T— "Why don't they answer?"

"Search me," replied the blonde wearily. "Sir," she added as an afterthought. The wisps of straw-colored hair hanging over her face made her look as tired as she sounded. "Perhaps—" she lay back in her chair and looked lazily up at the big screen upon which, against the blue-black background of the upper stratosphere, an object compounded of gleaming metal and dazzling fire cavorted wildly. "Perhaps they don't *wanna* come in—Perhaps they're all nuts up there—" After she had been told to look after her job and mind her own business she added, *sotto voce*, "Not so nutty—"

Then the wall speaker that had so long resisted her wiles and bland-

ishments burst into tinny life. "*Canis Majoris* to control," it said. "*Canis Majoris* to control. Can you hear me, control? Over."

The blonde noted the reading of her dials and meters, edged a little closer to the microphone. "Control to *Canis Majoris*," she said slowly and distinctly. "Control to *Canis Majoris*. You are coming in loud and—" She gasped indignantly as the port captain elbowed her aside. "This is Captain Hoppinson!" she heard him yelp. "Captain Hoppin-

son speaking. What are you doing up there? Don't you know that I have to get the Lunar Ferry off? She's half an hour late already! Come in at once!"

"We can't."

"Come in at once!"

"You'll be sorry if we do. She won't handle."

"Come—" began Hoppinson again. Then— "What's wrong?"

"Cargo shifted. We shall abandon attempts to land and throw ourselves into a closed orbit around Earth until we can rectify matters. Out!"

"Roger. Out!" repeated the port captain automatically. Then— "Cargo shifted? How could it? Surely any possible shift must be *away* from the direction of acceleration? And that would lower your center of gravity. How has it shifted? HOW HAS IT SHIFTED?"

But no answer came from the wall speaker. *Canis Majoris'* crew had too much on their plate to concern themselves with idle conversation.

There was really no reason why the cargo of Gannymedan protoplasm should not have been carried by one of the "Thunder" class—the Jovian regular traders. But they were passenger ships—and *Canis Majoris,* in spite of her imposing name, just a tramp freighter. This Gannymedan protoplasm was dead—and in very cold storage. In Gannymedan laboratories it had been thawed, heated, literally cooked —and nothing had happened. It had been exposed to all kinds of radiations, hard and soft, but none had supplied the missing spark of life. If it *had* come alive it would have been no more than a blob of nonsentient, helpless, harmless jelly. But—the "Thunder" ships were passenger carriers. And passengers pay for safety—they aren't paid to take risks, even nonexistent risks.

All this, and more, Captain Winstanley was told shortly after he touched down at Port Lasalle. He was seated at ease in his room, sharing a bottle of whiskey with the port captain. The formalities of clearing the ship inwards had been completed and both men were enjoying a break in their routine duties. To the master it was relaxation after the strain of bringing his ship to a strange little port on a strange little world—normally the regular traders handled all the traffic to and from the moons of Jupiter. To the port captain it was somebody fresh to talk to.

"Don't know why Jenkins is not down yet?" he said. "He's your agent. But I doubt if he'll be able to tell you more than I have."

"But what *is* the stuff?" asked Winstanley again.

"Protoplasm. Just that, nothing more. But it's dead. It's never been alive, they reckon. Once this world must have been warm, with a gaseous atmosphere and even a sea. A thick, soupy sea. Somehow, as happened on the inhabited worlds, the stuff of life was formed from inorganic chemicals. But it never came alive. And then the Sun cooled or Jupiter cooled or

something—I'm no astronomer—and these great hunks of life stuff were frozen up, kept in cold storage until a party of prospectors stumbled on them about a year ago. And you're to take the first big consignment back to Earth."

The captain was not impressed.

"As long as I can keep my center of gravity down it's all one to me what I carry," he said. He rose to his feet, a short, stocky figure, his face heavy rather than intelligent, the face of a worrier. "The last cargo I carried," he continued, "they put uranium on top of light case goods. They say that Manton . . . d'ye know him? He's port captain at Port Reval—nearly had a fit the way I wobbled coming down. *I* nearly did," he finished gloomily. A little bell rang. He picked up a telephone. "Who? Mr. Jenkins? Show him up, will you?" He looked at the bottle on his table, worried a little about the size of his expense account if he should have to start a fresh one for the agent.

Canis Majoris' stay in Port Lasalle was far from unpleasant. Like the port captain, most of the population of the little town were pathetically eager to make the most of the new company that had descended upon them from the sky. There were dances in the great social hall that occupied the geometric center of the domed city, there was a continual round of parties in priviate dwellings. And there were, for those interested in alien worlds themselves rather than the human settlements thereon, trips over the frozen surface of the little satellite.

It was on one of these excursions that Captain Winstanley and Canfield, his navigator, saw the protoplasm being quarried—that is perhaps the best word for the process—ready for shipment. It looked curiously dark in the blaze of the arc lamps, contrasted against the white crystalline purity of the frozen water and atmosphere among which it lay. Like a peculiarly veined jelly it was—but as the digging machines dug their sharp blades into it it did not behave like jelly. It splintered and crumbled like ice—but a rather tough kind of ice.

Winstanley and Canfield, a little illogically, drew back as they were spattered by the flying fragments. Inside their spacesuits they were immune from contamination—if contamination there could be. And this was manifestly impossible. But somehow in both minds some obscure train of thought led to the absurd conclusion that this was a scene of butchery. They more than half expected to see blood flow from the mangled flesh—the flesh that had never known life, that had never, even, existed in cellular form, that was but the raw material of life.

"Sickening, somehow," said the captain as they withdrew from the scene. Canfield agreed, his voice sounding subdued in the helmet phones.

Both men drew a deep breath. It was peaceful here, behind the white

hill that cut the human and mechanical activity, the glare of the artificial lights, from their view. Jupiter rode the black sky—huge, pale and awesome. More awesome than when seen from the viewports of an inward bound ship—here the horizon of low, jagged hills served to accentuate its great bulk.

"And this world," continued Winstanley, "it gives me the creeps. I know Mars—with its good, clean deserts. I know Venus. There's life there—unpleasant life. But it's life you can fight. You know where you are with it. But this stuff— It's not a case of what it was—if it ever was anything. It's not a case of what it is. But—what it *could* be. And I just hate the idea of its being in my ship!"

"But it's never been anything yet, sir," comforted Canfield. "They've tried everything to supply the missing spark. And *Thundercloud* has taken two small consignments in her mail room already."

"I know, I know. But why have they had such a rigorous survey of the hull insulation? Why have they fitted all those extra grids in the refrigeration system?"

"Nothing like making sure, sir, that nothing *does* happen!"

"I know, I know. And I still don't want it to happen to me!"

The protoplasm was finally loaded into *Canis Majoris'* hold. That compartment was now doubly insulated—against the irruption of heat from the engine room or Outside— Space is *not* cold when the full radiance of the sun is beating against the hull of your ship—and against cosmic radiation. A circulation of brine from the side of the ship in shadow throughout the cargo spaces insured that a temperature well below zero Centigrade would be maintained. During the ship's descent through Earth's atmosphere the brine would be switched to a compact little refrigeration unit. All had been foreseen. All, that is, but the unforeseeable.

In *Canis Majoris'* control room Captain Winstanley, Canfield and Wallis, the chief pilot, were strapped into their deeply padded chairs.

"It's not a bad little world," Canfield was saying. "The people certainly put themselves out to please us."

"I should say they did," growled the pilot. "What was the name, now, of that little blonde?"

"Never you mind, Wally. You weren't doing too badly yourself—" He looked at his chronometer. "Just two minutes to go. Two minutes to go, sir," he repeated to Captain Winstanley.

"Watch your chronometer, Mr. Canfield."

"Ay, ay, sir! Yes, Wally, I prefer blondes — they get dirty quicker."

"Watch your chronometer, Mr. Canfield!"

One minute . . . thirty seconds . . . twenty . . . ten . . . five . . .

Canfield's finger pressed the button actuating the warning bells. Their shrill clamor resounded throughout the ship. At the exact split second he released the pres-

sure. The abrupt stoppage of the sound was Wallis' executive signal. Balanced on her shaft of flame *Canis Majoris* climbed into the Jovian night. Somewhere aft a little tube flattened under the acceleration, flattened and fractured.

The run from Gannymede to Earth was as uneventful as such trips invariably are. Perhaps even more so—for it was experienced under conditions of free fall. This would not normally have been the case—but *Canis Majoris'* main converter had been giving trouble. The surveyor in Port Lasalle had passed it for the homeward voyage on condition that it was used for blasting off and landing only. The local representative of the Imperial Research Foundation had at first demurred—the terms of the charter party called for a passage made at an acceleration approximating one Gannymedan gravity. But no other outside ships were available, and if the shipment were made by one of the regular liners it would be made at the standard one gravity, Earth, of the passenger services.

If the trip had been made under constant acceleration the little defect—and its consequences—could hardly have escaped notice. Had Spurling, the junior officer acting as engineer, paid more attention to his duties it would have been noticed. He could hardly help discovering that the brine circulation system of the refrigerated hold was losing quantities of liquid daily. It wasn't much—each grid was independent of the rest. But it was a continual drain. But Spurling just mixed a few odd pounds of calcium chloride with water and poured the solution into the reservoir as necessary. It was his first trip with a refrigerated cargo, and perhaps he thought that this was normal procedure.

The faulty grid was on the after bulkhead of the hold. This bulkhead was insulated against the ingress of heat—but with the failure of the grid it became warmed, little by little, by the relatively high temperature of the engine room. True, the main drive was not working—but all the auxiliaries were. It was insulated against hard radiations from either the main drive or those same auxiliaries. But *insulwool*, invaluable though it is, has one grave disadvantage when compared with a thickness of lead of the same opacity. It doesn't like water. The moisture from the leaking pipe caused it to shrink upon itself so that, instead of a tightly packed mass of interlacing fibers, there was something that resembled nothing so much as a collection of large holes loosely tied together with sodden string.

So there it was.

Just the right degree of heat. Just the right hard radiations from the auxiliaries. Just the correct magnetic field from the same source. And—perhaps the most important—the brine.

The run from Gannymede to Earth was as uneventful as such trips invariably are. The officers played bridge and poker. growled

about the food, smoked too much and slept too much. The surgeon had a quarrel with the captain lasting almost the entire voyage. He wanted to be allowed to take just one infinitesimal, unmissed spoonful from the cargo for his own private experiments. With some masters the request would have been granted. But not Captain Winstanley. It was all one to him whether his cargo was radium or refuse—his duty was to deliver it to the consignees correct to the last fraction of an ounce. It would have saved him much worry if he had unbent this once. He would have found that his cargo, lacking other nutriment and occupation, was making a hearty meal of the plywood insulation casing in the hold. But it was loath to stray far from the gentle heat, the comforting radiations, that streamed from the after bulkhead.

At last the moment came to commence deceleration. The ship hummed and quivered to the song of the gyroscopes, the stars marched in orderly procession past the forward viewports. Spurling, spacesuited in his engine room, stood by the main converter. As far as lay within his rather limited capacity he was rather anxious. Crawling in from Gannymede as he had done, Canfield was not putting on the brakes until *Canis Majoris* was almost in the outer, tenuous fringes of Earth's atmosphere. And if the surveyor had been over optimistic, if the converter should fail to function, the ship and all her crew were due for a very long drop without much opportunity to do anything about it.

The warning bells shrilled and the red light flashed on over the main switchboard. The engineer made some hasty, last minute adjustments and hoped for the best. He took a tight grip on the guide rail. It seemed that there was no interval of silence between the ringing bells and the thunder of the jets. But Wallis was a master pilot and Spurling was eased to the deck almost gently. He inspected his meters and started a shrill, tuneless, self-satisfied whistle. He hoped that they wouldn't keep him too long aft. He wanted a smoke. He pressed the stud that would indicate to control that all was functioning as it should.

A little white light flashed impatiently on the switchboard. He uncoiled a length of flex from his belt, plugged it in to the socket just below the signal. "Engines," he said.

"Control," came Winstanley's voice. "Have you remembered to switch over your brine system to the refrigerating machinery?"

"Yes, sir," lied Spurling, resentful at being caught out. He started the little motor on its endless, rhythmic compression and expansion cycle, watched the thermometer dials for an indication that the time had come to turn the necessary cocks.

"A lot of trouble for a dirty great hunk of dead jellyfish—" he growled forgetting that his telephone was still plugged in. Captain Winstanley reminded him in no uncertain terms that it was. "And now, I

suppose," complained the engineer whilst recoiling the flex on his belt, "the old basket will keep me here all the way to Port Curtis without a break."

He was dozing, sunk deep into the padding of his chair, when *Canis Majoris* gave her first lurch. He was awake in a second and peering intently at his meters. All tubes of the main drive were firing evenly and sweetly. Still—that didn't mean that faulty firing had not taken place.

The little light on the switchboard flashed again.

"What are you doing, Spurling?" came an indignant voice.

"Nothing. She's firing perfectly."

"She may be now—but she just made a dirty dive to starboard. Much more of this and we shall have to cut out the stabilizer and come in on manual."

Spurling, with his telephone unplugged, told those in control what they could do with the stabilizer. He went back to the tube breeches. Again came the lurch, sending him sprawling against the converter. Even through his insulated suit he could feel the fierce heat, the sting of short radiations. Yet he could swear that the needle of none of his dials had so much as flickered. When he had recovered he reported this to a skeptical control.

But he was not surprised when faintly, through his padded helmet, he heard the clatter of feet on the metal ladder from forward. The insulated door above his head was flung open and a spacesuited figure entered. He didn't see who it was till the other touched helmets with his preparatory to talking. It was Kemp, the second pilot.

"Sorry," he said briefly, "but Pop sent me. I checked up in the gyroscope room on the way down—but the stabilizer seems in perfect order. I left young Mason there just in case. What's the trouble?"

"There's no trouble," began Spurling indignantly, then a third heavy lurch sent them both rolling on the deck. Kemp was first to his feet. For a moment it seemed that he would kick the engineer with his metal-shod foot. "No trouble?" he demanded, forgetting that the other couldn't hear him. "*No* trouble?" He staggered to the tube breeches, sat down, straddling his legs wide so that he would not be overset by any further sidewise motion. And his study of the meters throughout all that followed convinced him that the engineer, for once in his life, was right. There was no faintest hint of irregularity. And at irregular intervals the auxiliary jets brought *Canis Majoris* back to the vertical with bone-shaking jerks.

In the gyroscope room Mason was equally puzzled. The stabilizer hung in its gymbals as it always did, humming gently to itself, a mere toy compared with the big flywheel used to swing the ship's head in any desired direction when falling free. Power of its own it had very little, yet through its circuits and relays it ruled the steering jets, could and did keep the vessel vertical relative to the surface

of any world upon which a landing was being made. Mason watched the clinometer, and saw that *Canis Majoris* was not making the usual leisurely topple common to all ships on these occasions—to all ships, that is, whose center of gravity was kept decently low. Instead it seemed that she was doing her best to turn through one hundred and eighty degrees, that she had a vicious determination to descend to Earth in unseemly, screaming haste.

The cadet remarked on this to Captain Winstanley when he came down to inspect conditions for himself. "I know," replied the master, "there's a perfectly good clinometer in control!" Then, regretting having hurt the lad's feelings, "But what can be the cause of it?"

"Shifting cargo, sir."

Mason had a passion for sea stories. But even he should have known that the cargo of a spaceship can shift only away from the direction of flight. *Down.*

Winstanley closed the face plate of his helmet and went on down to the engine room. Mason watched his form, bulky in its armor, vanish down the tube running through the cargo space, along the axis of the ship, to the power units. His face still burned to his reaction to the scorn with which the captain had received his suggestion. Through his mind flashed incidents from books, from films. In his imagination he saw seamen, stripped to the waist, shoveling with desperate urgency the bulk grain that, by its shifting, had put their ship on her beam ends in a Western Ocean hurricane. The light of the hurricane lamps was dim and fitful—but the face of one of those sailors was surely that of Cadet Mason. With a sigh he put his dream from him. His young face stiffened with resolution. He went to the telephone and called control, fearful lest the captain, aft, was already on the party line.

On top Canfield, left in charge, was feeling far from happy. He had never known the ship—any ship—to behave like this before. In his periscope mirror he could see the distant greens and browns of Earth, the harsh yellow of the desert landing field. From the speaker on the bulkhead came a woman's voice: "Port Curtis control calling *Canis Majoris.* Control calling *Canis Majoris.* Can you hear me? Over." But the captain had told him not to answer any signals, to say nothing until there was something that could be said. He knew that *Canis Majoris'* unspacemanlike antics could not possibly have passed unnoticed, and he wanted to be able to salve some shreds of his dignity by having a convincing explanation for the port captain ready to hand when he broke radio silence.

Canfield was feeling far from happy. He knew Mabel well, wanted to be able to be—as by Captain Winstanley's tolerance he always was—the first to greet her. He wanted to make a date for tonight. But—

Canfield was feeling far from happy. The motion was not what

he was accustomed to. A fleeting thought crossed his head that this was what the heroes of young Mason's favorite stories had to put up with. He managed a sickly grin, was half tempted to ring the cadet in the gyroscope room and ask him how he liked a life on the ocean wave. But the Old Man would be on party line at any moment. He wished that the Old Man would give the order to put her on manual. Being able to *do* something would take his mind off his physical misery.

He became aware that Tarleton, the junior cadet, was thrusting the telephone into his face. With a limp, nerveless hand he took the instrument.

"Mr. Canfield, sir, this is Mason. Would you mind if I took off the inspection hatch in the gyroscope room? I think the cargo's shifted!"

"I think you'd better ask the captain," Canfield intended to say. He got as far as "I." Just then *Canis Majoris* excelled all previous efforts. Over she went, and over. Those in control just clutched the arms of their chairs and prayed. Over she went with an accelerating, sickening swing. They could see the rim of Earth through their viewports now—a rapidly widening segment.

Canfield was too good a spaceman to attempt to interfere with the efforts of the stabilizer. That would turn probable into certain disaster. But there was one thing he *could* do. He reached across Wallis and cut the main drive. On the bulkhead the wall speaker fell suddenly silent in mid-sentence. The navigator felt comfort in the assumption that Mabel had seen what was happening in the control tower screen, had broken off her efforts to raise the ship in an agony of horror and apprehension.

Slowly, too slowly, the auxiliary jets took hold. Viciously, too viciously, they drove the stern round in an arc of violent acceleration. The bows reached the apex of their swing and started to plunge down the other side of the slope that led to certain destruction. The opposing jets took hold and every structural member complained loudly and bitterly as the turning moment was suddenly and violently checked.

Tarleton, at the telephone, struggled for breath and gasped— "Put her on manual, sir. The captain says to put her on manual before she breaks herself up!"

The monosyllable "I" could be confused with "ay." Especially when the speaker is struggling with a desire to vomit, and when the listener desires an affirmative answer to his request. But it was not until *Canis Majoris* had done her best to nose dive to Port Curtis that Mason was able to do anything about it. Then the stabilizer was cut—and any doubts he may have had as to his superior's meaning were dispelled by this fact. He had been told to watch the stabilizer. It was no longer working. It was, therefore, obvious that he was supposed to be doing something else.

With human hands at her controls *Canis Majoris'* motion was

much easier. She plunged as wildly as before, and the corrections were not applied with the same speed—but she was nursed back to the vertical instead of being slammed back regardless of the feelings of herself or her crew. Even so it was no easy job that the cadet had to raise the heavy, hinged, insulated plug. Staggering with every lurch he toiled manfully. And then, when he had it open the merest crack, he let it drop as though he had caught a glimpse of the hell fire of the ancients in the dark cavern beneath his feet.

Cut off by the falling slab a slimy film of grayish life stuff contracted itself into a ball, then stretched out a questing pseudopod that licked across his boot Under its touch the leather seemed to rot, to melt even. Mason kicked wildly and retreated to the furthest corner of the gyroscope room. The alien life contracted upon itself once more, then began to crawl aimlessly around with motions reminiscent of those of an amoeba.

A helmeted head emerged from the tunnel hatchway, followed by an armored body. It was Captain Winstanley. For a few seconds he watched the cadet, who had taken a spanner from its rack and was crawling around on the deck, beating wildly at something that seemed always to elude his blows.

"Mason! Mason! What *are* you doing, boy?"

"It's the cargo, sir! It's shifted! Like I said!"

"Impossible!" snorted the captain.

"But it *has,* sir! It's *alive!*"

"Alive?" Winstanley was shocked out of his attitude of superior scorn. All the misgivings he had felt whilst loading this shipment of potential life rushed back in one frightening flood. "Alive?" he demanded again. He looked down at his feet. Over them had flowed a long streamer of gray slime. It rippled slowly along its length. And it came from the inspection hatch, oozing up through the cracks along its edge.

Here, at last, was the explanation of his ship's impossible behavior. The cargo had been stowed so as to occupy the lower third of the compartment. It now, for some reason, occupied the upper third. The center of gravity had been raised far above its safe limits. But this was no time for theorizing.

"Get that hatch dogged down as tight as you can!" he barked to the cadet. "Then run down to the engine room and get a blowtorch! Hurry!"

Himself, he clambered up the ladder to control with a speed that, in armor, he would have deemed impossible. He went straight to the R/T. The others heard Mabel reply, then heard Hoppinson break in. When he heard the port captain's "come in at once." he laughed shortly and bitterly. At the words that he was going to throw the ship into a closed orbit around Earth Canfield got busy on the necessary calculations. With the controls on manual Wallis was still fighting the plunging ship. At a brief order from the master the chief pilot

heaved a great sigh of relief and poured all the power at his disposal into the main drive. The acceleration pushed them deep into their padded chairs, made their very bones creak, but the discomfort and actual pain were as nothing to the knowledge that they were headed out and away to where they could fight the danger at leisure, well clear of Mother Earth's perilous embrace.

It was only natural that the surgeon should be one of the conference that, a few hours later, met in the captain's room to consider ways and means. He was the only officer with a knowledge of the mighty forces, the delicate machinery, which, to those who sent the great rockets roaring across the void, were still almost forbidden mysteries.

He had a long memory, had this Dr. Sheridan—almost as long as his lean, equine face.

"This wouldn't have happened," he reminded the captain, "if you'd let me have the stuff for study. But suppose you let me know what you've found out."

"You couldn't have—" began the Old Man, then thought better of it. He got his voice, his dislike of his medical officer, under control. Then— "First of all, it's alive," he said. "I don't know how or why. Secondly, it's motile. Thirdly, it likes radiations of various kinds, including heat, but not too much of them."

"And its food?"

"Anything organic, so far as we can see. And, perhaps, metal."

The boot of the spacesuit the captain had been wearing in the gyroscope room was passed around for inspection. The tough, rubberized metal fiber was corroded and pitted, almost eaten right through. Unconsciously they all looked at the deck at their feet. Somebody remarked that it didn't *really* like metal—it was only after the flesh that was inside it.

"And so," continued Winstanley, "I have young Kemp standing by with the blowtorch in the gyroscope room. Spurling has the other one in the engine room in case it—they?—break through the after bulkhead."

"Then it's quite simple," said Sheridan. "We just burn the stuff up. All living matter—as we know it—likes heat. But not too much of it. And all living matter can be destroyed by fire."

"Fine!" replied the captain, but without enthusiasm. "But please remember that—even though the safety of my ship does come first—I'm also supposed to deliver the cargo. Oh yes, I know that even if we should have to destroy it it will all come under General Average—but first of all I must do my best to make port without resorting to what would be the equivalent of jettison."

"There's one way," put in Canfield. "But we might have to kill it. But it wouldn't be damaged."

"And that is?"

"Evacuate all the air from the ship, sir. I thought at first that we could evacuate from the hold only—but there are no air cocks there.

Still, we have our reserve cylinders. Not that it really matters—we could make the short run home in suits if necessary."

"Before we try that," suggested somebody, "couldn't we drive it and keep it aft with the blow torches?"

"No. We've tried that. It's too big and the torches are too small. It just curls away—and round. Even if we did succeed it would be liable to break through the after bulkhead into the engine room. Then there'd be a mess!"

"Spacesuits it is, gentlemen," said Winstanley. "Pass the word down to the engine room and gyroscope room. And you, Mr. Wallis, stand by to open the cocks as soon as all is in readiness."

Winstanley and Canfield were in the gyroscope room when the air was exhausted from the ship. Kemp was there too, his youthful slightness hidden by the bulky armor he wore. He held his torch like a weapon—as indeed it was against any specialized, organized form of life. Against the amorphous mass of growing proliferating cells it was like a needle against an elephant.

No machinery was now working, so there was no static to interfere with the built in helmet sets. It was not necessary to plug in the telephone leads. Faint and metallic came Wallis' voice— "All cocks open!" In every compartment but one *Canis Majoris'* crew watched the dials of pressure meters. This last compartment also contained life, but no meters. They were not necessary. The thing inside was sensitive to changes in its environment. And this change came slowly at first, tardily enough to give time for readjustment as the air hissed out through the not quite tight joints of the inspection hatch. When Kemp sprang forward and knocked back the dogs the heavy plug did not, as he had anticipated, explode open under the sudden pressure of atmosphere rushing into a vacuum. It lifted a little, there was a tiny puff of ice crystals, then it fell back.

"Must have all leaked out through the hatch," said the captain. "Let's see what's happened down there."

Kemp caught hold of the ring bolt of the door and pulled. It was awkward work, the ship was falling free and he had no purchase. Canfield went to assist him—and between the two they threw the plug back on its hinges.

It took many minutes' work—or fighting—with the blowtorch to get their cargo back into the hold. The thing had encysted itself—but it had shrunk very little and was still active. Its mass was now encased in a leathery integument—and the worst of it was that this skin seemed insensitive to heat. True—it was only a matter of split seconds before the biting flame pierced it, but there was not the instantaneous shrinking away from the heat that there had been before.

But they got it down. Once Canfield was almost enveloped in the flowing folds so that Kemp had literally to burn him out. And once a pseudopod succeeded in snatching the handle of the blow-

torch from the cadet's clumsy grasp. It was indeed fortunate that their enemy was not intelligent.

But they got it down and slammed the hatch tight shut. Then they were able to inspect the damage.

Nobody was hurt. But Canfield was in a sorry state. The thing may have developed a skin—but the corrosive juices it secreted were in nowise hindered. The navigator's suit was scarred and pitted. In places the metal must have been paper thin. And as they ran curious, gloved fingers over the armor the weakened air tank blew out with a soundless, yet violent, explosion. Canfield needed no bidding to hurry back to control for a spare tank. And after he got it shipped he found that his suit was leaking.

"And that's that," said Captain Winstanley glumly a little later. Canfield, lugging there a cylinder of oxygen, had been able to change into the one spare suit in the air lock. Then Kemp had discovered a serious leakage in his own protective clothing. It could have been repaired—but it had been discovered that anything in the nature of a hand to hand combat with the monster in the hold was dangerous, especially with a hard vacuum in lieu of atmosphere. So the cocks had been shut and the reserve cylinders of oxygen and helium opened.

"What now?" asked Captain Winstanley of nobody in particular. "Lunar Radio hasn't been very helpful."

"They know less than we do," said Wallis. "We're Johnny on the spot. We've bought it."

"Of course," continued the captain, "we could do as they want. Stay here in this orbit until they send out a shipload of scientific johnnies to board us and take over. Three days, they said. But the beast has holed the shell in a dozen places—and Kemp and Mason have their hands full clapping patches on the deck of the gyroscope room. At this rate we shall soon have to take to our suits again—and two of those are leaky."

"Abandon ship?" suggested Sheridan.

"We have to go through the hold to the lifeboat. Besides—" He didn't finish—but they all knew that—even in the interests of science—this expedient would never be considered by the captain. Not while he had a ship under his feet with an ounce of power in the converters.

That is the way that Canfield put it to himself. As the word "converter" formed itself in his mind he had his brainwave. He spoke swiftly, convincingly. "And so," he concluded, "the radiations will drive it back aft, push our center of gravity back where it belongs. We shall be able to land."

"Where?" demanded the surgeon abruptly.

"Port Curtis, of course. Where else?"

"Not while I'm medical officer of this ship. It's quarantine for us, I'm afraid. I'm sorry, captain," he went on, "but if you'll look through the Regulations you'll find that I'm right. This thing in our hold can

be classed as an unknown, alien life form. So you'd better tell Lunar Radio to expect us at Port Copernicus."

Canfield's plan was simplicity itself. The main converter was to be dismantled and brought up, through the tunnel, to the gyroscope room. Its output was to be fed through four venturis for which the skin was to be pierced at four equidistant places. It would not be efficient—the jets would be pointing at too much of an angle from the fore and aft line of the ship for that. But it would dispose, once and for all, of the high center of gravity and the free surface effect which had defeated their first attempts to land. Just as the mass of protoplasm had surged forward, to put as much distance as possible between itself and the main converter, so it would now retreat aft.

There was need for haste. As the bulky converter was hauled and manhandled through the tunnel it was noticed that the smooth bore showed signs of pitting at many points along its length. And it was soon more than mere pitting—pseudopods, pencil thin, poked through the holes and reached aimlessly around. And there was something hopeful about their blind questing that chilled the beholders. Kemp and Mason scuttled down the tube with their rubber patches, but the air was already very thin. Winstanley lost no time in giving the order to don spacesuits.

The command would not have been long delayed in any case. Willing hands had torn away the plywood sheathing, the spongy *insulwool,* from all around the base of the gyroscope room. An electric welder flared and sputtered as an improvised tripod on which the converter would stand was secured to the deck. Thin as it was, weakened by the corrosive fluids secreted by the monster below, it would never stand the pull of the power unit. So more metal struts were placed so as to distribute the thrust over the deck above.

From the base of the converter, ragged where it had been hastily cut, protruded the main drive. Luckily its lining, although impervious to the searing heat of the blast, was soft and yielded without a struggle to a pair of shears.

Four spare auxiliary tubes were hoisted up from the engine room. They were already lined, as was the improvised cap that had been hastily made to fit over the ragged end of the big driver. The last air puffed out into space as the holes, through which the venturis would project, were cut in the skin of the ship. The welding arc flared ghastly blue as they were secured. From a tube running down the bulkhead protruded strings and festoons of wiring, for all the world like the intestines of a sorely wounded beast. Even though they were not intestines the anatomical simile was fairly apt. They were nerves—the nerves of *Canis Majoris.* And with swift precision they were connected up to the displaced power unit. And the organs of balance, the gyroscopes, torn from their

places to make room for this intruder, hung sullen and silent in the corner to which they had been flung, secured by a few hastily welded clamps to prevent them from drifting free and impeding the workers.

Canis Majoris, driven from her orbit by the blast of her improvised drivers, swung down towards the Moon. Unsure of himself Captain Winstanley, at the controls, twisted and turned, at last got her stern down and bows up. There was no real power—that was the trouble. But she handled.

After much backing and filling Winstanley got the ship over Port Copernicus. Sitting idle, a mere passenger, Wallis was bitter. He could have done it so much better, he knew. Especially since Canfield was so obviously right. It was evident that with the first surge of power through the converter the thing in the hold had retreated aft, away from the unpleasant heat and radiation.

He said as much, *sotto voce,* to Canfield. "I wonder—" replied the navigator. "Doesn't matter much anyhow."

Wallis thought this over. He wasn't feeling too bright—when the order had been given to don suits he had been left with one of the leaky ones. But now the high crater walls, the squat port administration buildings, of Copernicus were plainly visible in the perilens. It would not be long until he could relax and breath deeply in the Earth-normal atmosphere of the Quarantine Station.

"Of course it does," he said at last. But the navigator was busy with the radio telephone. Some female voice was answering—and Canfield was trying hard to get some warmth into the coldly official words. The girl at the other end seemed to know him—and managed it quite well. Wallis was faintly envious. After a rough trip it was good to have a woman to come home to.

Tired of being a fifth wheel to the coach he asked the captain if he could have a look at the cargo. Winstanley, intent on his pilotage, grunted a syllable that could have meant either yes or no. Wallis took it to be an affirmative. He got to his feet and walked across the amazingly steady deck to the hatch.

In what had been the gyroscope room he found Spurling, watching the converter like a mouse watching a cat. As a spectacle it was—interesting. But it was far from reassuring. In the midst of its web of stays and girders it shook like an infuriated spider. Wallis put his helmet to that of the engineer. "It will see us down!" he shouted. "I hope."

Ducking under and through the maze of struts and rods he came to the inspection hatch. Kemp, his junior was there, and Mason, the latter still clutching his blowtorch. They helped him to lift the plug. He almost screamed his amazement. Where there should have been a clear drop of thirty feet was a quivering, faintly gleaming, gray

mass. It was alive still, surged half heartedly up into the opening. A pseudopod extended itself — and died as it stretched out from the parent body. Wallis tried to kick it back into the hold. And then the three of them were on their hands and knees plucking at the dead protoplasm with clumsy, gloved fingers. It stretched. It pulled out into long, elastic strings. But it refused to come loose from the deck.

It was then that Wallis went almost frantic. His frenzy communicated itself to the others. They jumped up and down on the mass of almost dead tissue in the square of the hatch, they attacked it with the blowtorch, with the electric welder. Somehow Canfield's plan had miscarried. It seemed that the ship had achieved a purely fortuitous equilibrium, a lucky balance that might at any moment be destroyed. A crash on the Moon, with its feeble gravity, would be less serious than one on the Earth —yet might well be sufficiently serious to cost the lives of every man of *Canis Majoris*' crew.

Yet the ship was still coming down steadily—so steadily that Wallis felt that it was, it must be, too good to last. At any moment would come the inevitable tilt. And Winstanley, lulled into a sense of false security, would not react sufficiently fast to deal with the emergency.

The chief pilot left the others still struggling to force the tough, resilient mass down into the hold. He had to warn control. He made his way to the nearest telephone socket, uncoiled the lead from his belt and plugged in. But he could get no answer. The violent vibrations had broken the wire somewhere along its length.

Hastily, his lungs pumping in their efforts to make the most of the thin air supply in his suit, he clambered up the ladders to control. Winstanley gave him a glance as he burst into the compartment—then gave his undivided attention to the task of piloting his ship in to a safe landing. Wallis considered reporting to him personally—then decided that if he did so the captain would be sure, in the excitement of the moment, to do something wrong. He went instead to Canfield, bent until his helmet touched that of the navigator. He shouted, all in one breath: "But it's still up. The center of gravity is still far too high!"

Canfield said nothing. Through the transparent plastic of his helmet Wallis could see his bored, superior smile. He took a pencil from the rack before him, placed it upright with the point on his gloved finger. He removed his restraining hand. The pencil, in spite of the futile attempts made to balance it, fell.

Canfield took another pencil, and a pair of dividers. One point of the instrument he forced into the plastic just above the point of the pencil. This leg made an acute angle with the little rod, the other end was bent inwards. Again Canfield put the pencil point on his finger. It balanced. He pushed up. Still the pencil did not fall.

"For'ard drive," he condescended to explain. "She's stable. Of course the hull will be badly burned and pitted by the back blast from the jets—but as far as this landing is concerned she's safe—safer than she has ever been. Thrust *above* the weight—" He smiled, a smug, self-satisfied smile. "So there's nothing to worry about, Wally. Nothing at—"

It was lucky that *Canis Majoris* had only twenty feet to fall, and that twenty under Lunar gravity. It was lucky that converters are designed so as to automatically cut out in the event of the control circuit being broken. And most fortunate of all were Spurling and Kemp and Mason. In the confusion of crumpling bulkheads and flailing stays they needed far more than their fair share of luck to stay in one piece.

Still maintaining her hard won equilibrium she dropped. The big vanes gouged deep furrows in the pumice dust of the landing field. She sagged amidships; her nose, with the control room in its very tip, broke away from the rest of the structure, hung briefly by a single, twisted girder, then snapped loose. It rolled for a hundred yards or so before bringing up against the port captain's office. This was not without convenience—the rescue crew did not have far to come.

"Safer than she's ever been," said Wallis bitterly. He, not being strapped into a chair, had suffered the most severe shaking up of all when the control room broke adrift. He sat in his bed in the little hospital, glaring at Canfield who had come to visit him. *"Safer than she's ever been."*

Canfield had the grace to look slightly embarrassed. "Oh, well," he admitted, "she wasn't. But it was the builder's fault really."

He fumbled in his pockets, drew a blank. He opened the door of the locker at the head of Wallis' bed, found what he was looking for—a pack of cigarettes.

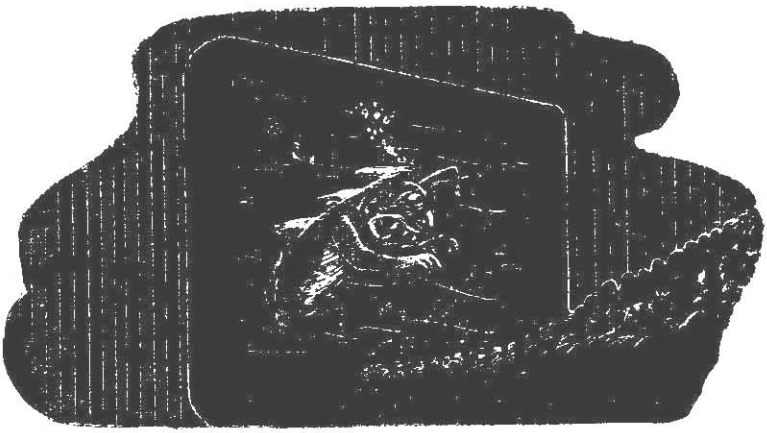
"Hey!" said the pilot in alarm, "there's only one left. And you know very well that there's a shortage here!"

"Oh, that's all right. I'm not going to smoke it." The navigator put the little cylinder on the top of the locker. He placed the forefinger of his right hand at one end, his thumb at the other. "Inertia," he said, "and thrust. All along the longitudinal axis." He pressed gently at first, then with increasing force. Nothing happened. "Now," he went on, "we substituted a diagonal thrust for a fore and aft one. Imagine the parallelogram of forces. Thrust along the longitudinal axis is still there—but so is a component at right angles to it." He held the cigarette, still between forefinger and thumb, up for the other's inspection. Then, with the index finger of his left hand, he pushed the little tube hard in the middle. The inevitable happened.

Wallis was not impressed.

Knowing all the answers would not get him a smoke.

THE END.



Film Library

by A. E. VAN VOGT

***Their** novelty films were remarkable —but no novelties. Not, that is, at the time they were filmed—*

The hundred delegates to the electronic manufacturers convention, who had attended the showing, were drifting towards the doors. Several wives had been present, and their voices mingled with the deeper tones of the men. The sounds faded swiftly into the distance of the hotel, but Senor Pedro del Corteya, looking up suddenly from what he was doing, saw that he was still not alone.

He continued rewinding the reel, then he put it back into its can, and began to pack away the projector. Out of the corner of his eyes he watched the other with the curious, speculative intentness of the Latin. At last, his job completed, he turned.

"Is it me you wish to speak to, senor?"

The big man hesitated, then he came forward. He was a tall, chunky, fortyish individual with brown eyes and skimpy hair.

"Odd picture you showed us there tonight."

Corteya smiled his personal acceptance of the compliment. "You were amused, senor?"

Again that hesitation, then, "Where did you get it?"

Corteya shrugged. These direct

Americans. Did the man expect him to hand over his trade secrets? He said as much.

"Do you think I am a fool, senor? Perhaps you are planning to start up in opposition to my business. You have plenty of money, maybe, and I go broke when you undercut my prices."

The stranger laughed. But he drew out a card, and handed it over. Corteya read:

Walter Dorman

President
Electronic Company of America

Corteya looked at it, then handed it back. He saw that Dorman was staring at him hard. The man said finally with a tiny note of incredulity in his voice.

"You still don't believe I'm not after your hide."

Corteya shrugged. "What is it you wish to know, senor?"

"That film?"

Corteya raised his hands in a gesture of deprecation. "A ten minute novelty."

"Very smoothly done, if you ask me."

"All the world, senor, knows that Hollywood is wonderful."

"Hollywood never made a picture as good as that."

Corteya smiled his if-you-say-so-it-must-be-so smile. For the first time, then, he let his mind go back over the picture he had shown. He couldn't remember it very clearly. It was his custom to watch the audience not the film. Nevertheless, he recollected that it had been about an automatic electric stove that merely had to be supplied with the appropriate ingredients, and it would mix them, and serve up the finished meal piping hot at any desired time. He had shown the same film two weeks earlier at a local dieticians meeting, and the audience had laughed heartily at the nonexistent device.

Corteya said, "Senor, I obtain my films from several film libraries. Where they secure them, I do not know. They compete for my business. All I do is look over their catalogues, and order films when I need them."

He lifted his shoulders. "It is so simple as that."

"Have you had any other novelties like the one tonight?"

"A few. I cannot remember."

"Do they all come from the same film library?"

Dorman's persistence was beginning to wear. "I really cannot remember, senor. To me it is all ordinary business."

"Have you any similar films on hand right now?"

"You mean here? No!"

"I mean at your office."

Corteya looked unhappy. He was a simple, honest man, who could lie as well as the next man, but only if he had started with a lie, and had to carry on. Having started with the truth, he could not stop.

"At the Areo Club dinner tomorrow," he said gloomily, "I am showing a film about a trip to

one of the planets. The catalogue says it is very amusing."

Dorman said, "I know this is a lot to ask, but will you drive over to your office, and show me that picture now?"

"Senor, my wife, she is waiting for me at home."

Dorman said nothing. He took out his pocketbook, and peeled off a twenty dollar bill. As he expected, the other's slim hand reached forth delicately but without diffidence, and accepted the money.

It took only eight minutes to get to Corteya's place of business, and a few minutes after that the young man's projector was set up and purring.

A seascape broke the shadows of a cloudy but brilliantly bright horizon. The sea was flat, a tideless expanse of water. Suddenly, in those murky depths, there was a stirring. A creature charged into view. It burst the surface, and leaped up, twenty, fifty, a hundred feet. Its enormous, bulbous head and vast, yawning mouth seemed almost to touch the camera. And then it began to fall, still struggling, still furiously determined to grasp the prey at which it had leaped.

It failed. It fell. It hit the water with a splash so gigantic that Dorman was startled. He had been admiring the illusion of stark reality that had been produced with what must be an artificial monster being mechanically activated in some indoor imitation sea. But those splashes looked—*real*. A moment later, the narrator said:

"That was a Venusian squid. These creatures, which frequent the depths of the warm seas of Venus, come to the surface only after food. Our camera artist acted as bait, and so enticed the squid to attack him. He was not however in danger. Electronic devices protected him at all times."

Dorman was smiling twistedly. First an electric stove that prepared its own meals, now a trip to Venus. Both slick jobs of photography, and, in this case, it was especially clever to suggest there had been no danger. So many of these travelogues about places that actually existed faked suspense and excitement to the point of nausea.

He climbed to his feet, his interest close to the vanishing point. He felt very tolerant of himself. Just for a minute, while watching the stove go through its motions, he had had the wild thought that the picture was an advertising stunt for a competitor. The Venusian film put the whole affair into its proper perspective.

He saw that Corteya had stopped the machine. The overhead light clicked on.

"You have learned what you desire?"

"Practically."

The younger man continued to unwind the reel. While he waited, Dorman glanced around the small room. It had a counter at the front. The projector rested on it

near the wall. Behind the counter was a single chair and a small set of shelves. That was all the furniture. The white calcimined walls of the office were decorated with still pictures from one-reel and two-reel films. Printed on each of the pictures was a caption giving the subject and the cost of showing.

It was obviously a selling business. No one would come into a place like this without having been previously canvassed or told about it in some way.

"What else, senor?"

Dorman turned. The film was in its can, the projector in its case.

"I'd like you to check to see if the two films came from the same film library."

"They did, senor." Corteya had not moved. He was smiling in his deprecating fashion. "I looked in the can," he explained, "when I came in."

Dorman made no move to leave. There was nothing else, really, but he hated to leave unfinished anything he had started. Check on everything, then recheck. That was his method, and he had no intention of changing now. He took out his pocketbook, and removed a ten dollar bill.

"The catalogue of this particular library. I'd like to have a look at it."

Corteya accepted the bill, and reached under the counter. He came up with several folders.

"They send one of these to me every month. These are for the last four months."

Only the final two contained lists of the novelty films. Dorman ran his gaze down the column, the smile on his lips broadening. There were several travelogues. Venus, a spaceship voyage to the Moon, a journey through a Martian desert, an aerial trip over mountainous Europa, one of the moons of Jupiter, a camera examination of the rings of Saturn, a boat trip down a river of liquid oxygen on the far planet Pluto, and, finally, the size of the Sun as seen from each one of its ten planets.

Dorman glanced swiftly at the remaining score or so films given under the novelty heading. He found the one he wanted instantly. The caption was, "Amusing account of an automatic stove that does EVERYTHING."

He closed the folder, and paused to look at the address. Arlay Film Library, Sunset Boulevard, Hollywood, California.

"Thanks," said Dorman.

He went out into the street, and climbed into his car. It was getting cooler out, so he turned up the window, and sat for a minute lighting a cigarette. He drove unhurriedly back to the hotel. In the lobby, a man hailed him:

"Hey, Wally, come into the bar and have a drink. The boys have been looking for you. Where you been?"

As he settled into a booth a minute later, Dorman said, "I've been wild goose chasing." He ex-

plained briefly. One of the other men looked at him.

"Wally," he said, "you're a smart man." He gulped down a drink. "I mean that more than you think. One of the reasons I attended this convention was to find a man who could be the new chairman of the board for our firm. You'd have to buy about a thousand shares, but you'll see what a deal it is when I show you the statements tomorrow. What we're mainly interested in is a good man who doesn't miss any bets. Your action tonight is pure genius, so far as I'm concerned, and you're in."

"Waiter," said Dorman, "more drinks."

The ever happy music swelled around them. The voices rose and fell in gyrations of sound. The night dragged on.

Ten weeks before, Mr. Lester Arlay, of the Arlay Film Library, had read the first complaint with a faint frown creasing his already lined forehead. The letter had been shoved inside the can of film, and it began:

"Dear Mr. Arley—"

Mr. Arlay started to scowl right there. He did not approve of his name being misspelled. He read on grimly:

Dear Mr. Arley:

The sound film, "Food Magic," which you sent me, is entirely different from what I expected. Neither the audience nor I could make head or tail of it. Certainly, it has nothing to do with food. My program for the retailers convention here was ruined.

The letter was signed by one of his best customers; and Mr. Arlay, who remembered the two reeler, "Food Magic," perfectly, was stunned. It was an educational feature turned out by one of the big food distributors; and it was really a dandy job, one of those films which small film libraries could borrow for nothing, and then rent out at a small but profitable rate.

It was a film definitely suitable for a grocery retailers convention.

Frowning, Mr. Arlay shoved the letter back into the can of film, and put the can on the "To Be Examined" shelf. He began to open the ten other cans of film that had been returned that morning.

Of the ten, four borrowers complained that "This is not the film we asked for." "I cannot understand your sending a film so different from what we ordered." "This is visual gibberish." "Your joke ruined our show."

For several moments, Mr. Arlay stared palely at the letters, and then, with a sudden burst of activity, he examined one of the criticized films.

Presently, he slid the reel onto the projector, made the necessary adjustments, switched off the light —and stared with a blank expectancy at the screen.

There was a faraway rustle of music. The music drew closer, but the nearer it came the more uncertainty there was in it. Singing violins played a sweet melody,

but swiftly a harsher theme intruded, a trill of doubt. The doubt grew and grew until finally the happy strains were completely dominated.

Darkly, almost discordantly the music played—and retreated into distance.

The screen itself came to life. Color flared over it, an intricate weaving movement of color, that never quite formed a recognizable pattern. And the rich, vivid colors grew darker and darker until finally the screen was almost black.

Out of the darkness walked a young woman. She came from the shadows into the light with a casual grace, an agreeable ease, that marked her immediately as one of those marvelous photogenic types. Mr. Arlay had never seen her before, but she quirked her lips into a smile, made a movement with her fingers; and she was a personality.

The trouble was, she had barely appeared when, abruptly, she vanished in a gyrating puff of dark colors.

She came on again, and this time she walked along an intense blue hallway into a living room, where a young man sat reading beside a vast window. Mr. Arlay had a flashing glimpse of a city beyond that window; and then the camera angle shifted to the girl.

She was standing behind the man, hesitant. As she stood, the human details of her flesh merged into the dark thematic colors; and it was these colors in human form that moved forward, and very obviously kissed the young man on the lips. It was a long kiss, and at the end of it, the young man too was a color pattern.

The mingled colors began to twist and spin. The screen was a chromatic splendor of gyrating light. It was just beginning to stir with returning music, as Mr. Arlay emerged from his puzzlement, and held the letter he had received about this particular film in the blazing beam of the projector.

He read: "This is visual gibberish!"

So that was the one! He laid the letter down, and held up the can cover with the title on it: "How To Operate A Chicken Farm."

On the screen, the young woman was walking uncertainly along a street, looking back at the man who was coming along a little behind her.

Mr. Arlay clicked it off, rewound the reel, then took another film out of its can. It was the one about which the complainant had said:

"Your joke ruined our show."

He threaded the reel into place, and presently a picture of a machine came onto the screen. It was a very bright, clear picture, without any nonsense about it, but the machine was not one that Mr. Lester Arlay remembered having seen before.

The fact did not disturb him immediately. The world was full of machines that he had never seen:

and, what was more, that he never wanted to see.

He waited; and a quiet baritone said:

"No spaceman should have any difficulty repairing this new space drive."

Mr. Arlay sighed, and lifted the can cover up into the light. The title on it was: "How to Operate the American Cogshill Diesel Engine."

What had happened was clear enough, it seemed to Mr. Arlay. Somebody had returned a whole series of wrong films to him; and he had sent them out in their original cans. The fantastically bad luck angle of the affair was that no less than five wrong films had gone out all at once.

On the screen, the baritone voice was saying:

"Now, raise the drive case itself. Since the standard weight of the case is eight tons, care must be taken when near a planetary body, to balance the antigravity needles at a similitude of ninety-nine gravitons. Unwringing them becomes a matter of one good shove—"

Mr. Arlay shut the film off, and he was packing it into a can when the thought came: What did he say? *What* did he say?"

He stood owlishly blinking his realization that something was very wrong indeed.

There was an interruption. The outer door opened, and a young woman came in. She wore a mink coat, and heavily jeweled rings flashed on her fingers.

"'Lo, honey," she said in a husky voice.

Mr. Arlay, all extraneous thoughts flying from his mind, came around the counter. His wife skillfully evaded the kiss he attempted to plant on her lips.

"Have you any money?" she asked. "I'm going shopping."

Mr. Arlay said, "Careful, Tania. We're almost at rock bottom."

He said it affectionately. He tried to kiss her again, and this time managed to brush her cheeks. His words made her shake her slim body impatiently.

"That's all I ever hear from you," she said darkly. "Why don't you make money like some of the people in this town?"

Almost, Mr. Arlay pointed out that he did. He refrained. He had no illusions about his hold on this young woman. His business netted him between three and five hundred dollars a week. It was not a terrific amount of money, but it rivaled the salaries of featured movie players. They might make a little more per week, but few of them made it fifty-two weeks a year.

It was that income which had enabled him three years before to marry a small-part player, who was a far more attractive person physically than he could have hoped to marry without money. Mentally —that was another matter. She was a survival type in the strictest Darwinian sense. Regardless of the variation in his income, she

managed to spend it all, month in, month out. Her adaptability sometimes amazed even that defeatist Mr. Arlay.

What he did not realize, and certainly she neither knew nor would she have cared if she had known, was the profound influence she had had on him. All the imaginative qualities that had built his business had been replaced by a complete dependence on experience. He regarded himself as a practical man, and he had no inkling that his habit of thinking himself as "Mr." was but one compensation for the psychic disaster he had suffered when she entered his life.

Not that he would necessarily have suspected anyway that he had come into possession of films that had been made more than fifty years in the future.

Now that she had come into the office, he strove to keep her there.

"Got something here that might interest you," he said eagerly. "Somebody sent me a film of some other library by mistake, and it's quite an odd affair, a sort of a visual freak."

"Now, darling, I'm in a hurry, and—"

Her narrowed eyes saw that this was no moment to refuse him. He needed an occasional crumb, and he was so *completely* unsuspicious. After all, she'd be a nut to let this soft touch walk out on her.

"All right, honey," she crooned. "If you want me to."

He showed her the film with the man and the girl and the swirling colors—and realized the moment the girl appeared on the screen that he had made a mistake. His wife stiffened as that superb actress came into view.

"Hm-m-m," she said bitingly, "what kind of ham are you serving up now?"

Mr. Arlay let the film run its course without another comment. He had momentarily forgotten that his wife did not admire other actresses, particularly stars.

Watching the film, he noticed absently that the reason for the dark tones of music and color seemed to be that the girl was unhappily married, and the twisting colors were designed to show her changing emotions, the doubts that came, and the thoughts that welled up into her mind.

"Interesting," he thought. "I wonder who made it."

As the reel ended, Tania jumped to her feet. "Well, got to be running. I'll cash a check for five hundred dollars. O. K.?"

"Three!" said Mr. Arlay.

"Four," his wife said in a tone of friendly give and take.

Four hundred it was. When she had gone, Mr. Arlay began a check-up to see who had sent him the unusual films. The card index for the film, "How to Operate a Chicken Farm," gave a list of men and schools and institutions that had rented the item. The second last renter would obviously be the

one. His gaze flashed down to it.

"Tichenor Collegiate," he read.

Mr. Arlay frowned at the name, and mentally changed the wording in the letter he had intended to write. Tichenor Collegiate was easily one of his best customers. And what was more, the operator in charge, Peter Caxton, a science teacher, was a thoroughly experienced man. It seemed scarcely possible that Caxton could be guilty.

Quickly, Mr. Arlay examined the card for another of the eccentric films. The second last borrower was Tichenor Collegiate.

The same name came up for each of the three other returned films, which didn't belong to his library. Mr. Arlay sat down at his typewriter, and, bearing in mind that customers were seldom offended by the facts of the case, wrote:

Dear Mr. Caxton:

A number of films which you have returned to us were not the ones which we originally sent you. Altogether five films—

He paused there. Five? How did he know there were only five? Mr. Arlay made a beeline for the Tichenor Collegiate's personal file card. It was a thick one, additions having been glued to it from time to time.

He skipped down to the fifteenth name on the card. That would take it back just a little over two weeks. The title was "Pruning Fruit Trees." The film itself was a fantastic concoction in which a curious shaped ship seemed to leave the Earth's surface and go to the Moon. The illusions were very realistic, and the photography had a Hollywood slickness.

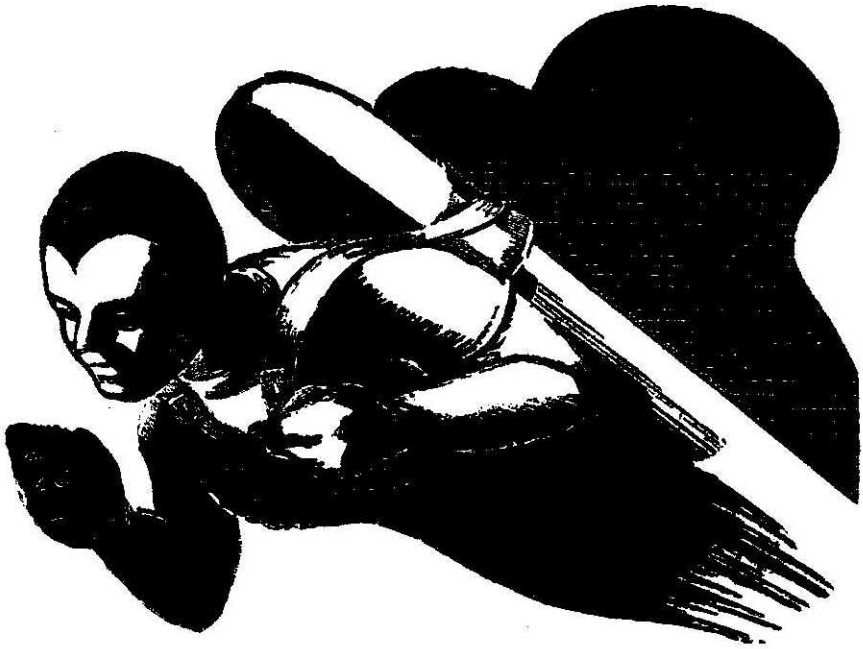
Mr. Arlay shut it off finally, thinking for the first time that whoever was making those pictures would be well worth representing.

Meanwhile, there was a job to do. One by one, he screened the last nineteen films that had been borrowed by Tichenor. That is, he screened the sixteen that were in. Three had been re-rented, and in due course no doubt he would hear from them.

Of the sixteen, seven were travelogues. Travelogues: Unique, incredible creations, filmed by a madman. But mad or not, he was a genius, and he had designed some of the most lifelike backgrounds ever conceived for fantasia.

Among the first few that Mr. Arlay screened was the one about Venus which, ten weeks later, Pedro del Corteya showed to electronics manufacturer Walter Dorman. Mr. Arlay watched it and the other reels about the Solar System with an appraising eye. There was, it seemed to him, much to be said for a skillful motion picture presentation of what science believed about the various planetary bodies.

Seven travelogues and eight how-to-operate or how-to-repair films—of the eight, one dealt with the operation of a meaningless engine. At least it seemed meaning-



less to Mr. Arlay. It had a single extrusion in a strong boxing. There were little chambers in the boxing, and when they were filled with a fine metallic powder, the extrusion could be made to turn with a velocity that was not slowed even fractionally when it was connected to a large machine of intricate construction.

Another machine dealt with the repair of what was called an atomic gun. Here, too, the fine metallic powder was tamped into tiny chambers, but there was a transformation tunnel, the purpose of which was not clear. When fired at the end, the gun, a hand weapon, blew a four hundred foot high hill into dust.

Mr. Arlay became impatient as the eight films unreeled onto the screen. This was going a little too far. The travelogues had a certain scientific value, but these operation and repair films, with their pretense to details, strained all credulity. An atomic engine and an atomic gun. How to repair a space drive. Care and operation of the Fly-O, an individual flyer—a combination of straps and a metallic tube that lifted the man in the film off the ground and transported him through the air like Buck Rogers. A radio that was simply a bracelet made of what was called "sensitive" metal. The crystalline structure of the sensitivity was shown, and also how the

radio waves were transformed into sound by ultra-thin bubbles in the metal.

There were three rather amusing films about household devices. There was a light that focused wherever desired out of thin air, rugs and furniture that couldn't get dirty, and finally the automatic electric stove that was later to rouse Walter Dorman's competitive instincts.

Long before the showing was finished it had struck Mr. Arlay that there was a type of audience that would be interested in such novelties. It would be important, however, to stress the novelty angle, so that the people would be prepared to laugh.

His best bet, of course, would be to locate their source, and stock a few himself. He phoned Tichenor Collegiate, and asked for Caxton. Caxton said:

"My dear Mr. Arlay, it cannot possibly be we who are at fault. To prevent confusion in bookkeeping, I have long adopted a policy of renting from only one library at a time. For the past two months we have secured our material from you, and returned it promptly. Perhaps you had better re-examine your files."

His tone was faintly patronizing, and there was just enough suggestion in it of an affronted customer to make Mr. Arlay back down permanently.

"Yes, yes, of course, I'll have a look at them myself. My helper must have . . . uh—"

Mr. Arlay hung up, saw that it was nearly one o'clock, and went out to lunch. He drove all the way up to Vine Street for a bowl of tomato soup. The fever in him died slowly, and he realized that it was not actually a difficult situation. He had lost nineteen films, but if he wrote careful letters to the firms that had supplied them to him they would probably send him new ones immediately.

And as a sort of compensation for the wear and tear on his nerves, he had sixteen, possibly nineteen, novelty films, which might go over rather well.

They did. At least once a week, the novelties went out into the mails, and returned again. And by the time they came back there were orders waiting for most of them for the following week. Mr. Arlay did not worry about what the real owner of the films would think when he discovered what was happening. No single library film was worth very much. The owner would probably demand the wholesaler's percentage, and this Mr. Arlay was prepared to pay.

And just in case audience reactions would be required, Mr. Arlay sent printed forms for comments. They came back properly filled out. The size of the audience: 100, 200, 75, 150. The nature of the audience: Retailers dinner, university astronomy class, the society of physicists, high school students. The reaction of the audience—comments most often made—"Amusing," "Interesting," "Good photography put it over."

One common criticism was, "It

seems to me the dialogue could be more humorous befitting the nature of the subject matter."

The situation did not remain static. At the end of the second month Mr. Arlay had thirty-one more novelty films, and every one of them had been sent him by Peter Caxton of Tichenor Collegiate.

After ten weeks, just about the time that Pedro del Corteya was due to show the stove picture to the Electronic Manufacturers Convention, two things happened approximately simultaneously. Mr. Arlay raised the rental rate of the novelties fifty percent, and Caxton sent him a letter, which read in part:

"I have noticed in your folders a reference to some novelty films. I would like one dealing with a planet for next Wednesday."

"Now," thought Mr. Arlay, "now, we shall see."

The can came back on Thursday. The film inside was also a novelty type. But it was not the same one as he had sent out.

On his way to Tichenor Collegiate for the afternoon classes, Peter Caxton stopped in the corner drugstore, and bought a pack of cigarettes. There was a full-length mirror just in front of the door. And, as he emerged, he paused briefly to survey himself in it.

The picture he saw pleased him. His tall form was well dressed, his face clean cut but not too youthful and his eyes were a smiling gray. The well-groomed effect was accentuated by a neat, gray hat. He walked on, content.

Caxton had no illusions about life. Life was what you made it. And so far as he could see, if he worked things right, he ought to be principal of Tichenor in another two years. The time limit was unavoidable. Old Varnish was not due for retirement until then, and Caxton could see no way by which the process could be speeded up.

Tichenor was no super-school, nor did it have the fancy money behind it that some neighboring communities raised every year for education. The smoking room for the men and women teachers was a joint affair. Caxton settled into one of the chairs, and puffed quickly at his cigarette. He was about half way through when Miss Gregg came in.

She smiled warmly. "'Lo, Peter," she said. Her gaze flashed significantly to the closed doors of the men's and women's dressing rooms, then back to him.

Caxton said, "Nobody in the men's."

She opened the door to the women's, glanced in, then came over in a gliding motion and planted a kiss on his lips.

"Careful," said Peter Caxton.

"Tonight," she said in a low tone, "at the end of the park."

Caxton could not suppress a faint look of irritation. "I'll try," he said, "but my wife—"

She whispered fondly, "I'll expect you."

The door closed softly behind her. Caxton sat frowning, dis-

turbed. At first it had been pleasant, his conquest of Miss Gregg's heart. But after six months of ever more frequent rendezvous, the affair was beginning to be a little wearing. She had reached the stage where she half anticipated that he would somehow manage to get a divorce, and that somehow it would not hurt his career, and that everything would come out all right. Caxton shared neither her anxiety for such a culmination, nor her vague conviction that there would be no repercussions.

Miss Gregg, he had realized too late, was an emotional fool. For a month he had known that he must break off with her, but so far only one method had occurred to him. She must be eased out of the school. How? The answer to that, too, had come easily. A whispering campaign against her and Dorrit. That way he could kill two birds with one stone. Ancil Dorrit was his only serious rival for the principalship, and what was worse he and Old Varnish got along very well.

It shouldn't be very hard. Everybody except Miss Gregg knew that Dorrit was nuts about her, and Dorrit didn't seem to suspect that his secret was known. The situation amused Caxton. He, a married man, had walked off with Dorrit's dream girl. There was no reason why he shouldn't also snatch the principalship from under Dorrit's nose, so to speak. He'd have to think a little more about the moves, and proceed with the utmost caution.

Caxton rubbed his cigarette into an ash tray with a speculative movement, then he headed for the auditorium. His first class was to have a film showing—a nuisance, those things. In the beginning, he had been quite interested, but there were too many poor films. Besides, the dopes never learned anything anyway. He had once questioned some of the brighter students about what they had learned from a film, and it was pitiful. Proponents, however, maintained that the effect was cumulative, the kids preferred it to other methods of teaching, and last week the school board had ordered that Grade Ten, as well as Grade Eleven, was to be shown each film.

That meant that once in the morning, once in the afternoon, he had to handle a swarm of fifteen to seventeen-year-olds in the darkness of an auditorium. At least, this was the last showing for today.

The film had been running for about a minute when Caxton took his first real look at the screen. He stared for a moment blankly, then shut off the projector, turned on the lights, and came down from the projection room.

"Who's responsible for this silly trick?" he said angrily.

No one answered. The girls looked a little scared, the boys stiffened, except for a few teachers' pets, who turned pale.

"Somebody," Caxton shouted,

"has switched films on me over the lunch hour."

He stopped. His own words jarred him. He had charged out of the projection booth without pausing to assess the implications of what had happened. Now, suddenly, he realized. For the first time in his four years at Tichenor he had been the victim of a student's prank, and he was taking it badly.

After a moment of further thought, he made an even greater mental adjustment, and the situation was saved.

Caxton swallowed hard. A wan smile lightened his tensed face. He looked around coolly. "Well," he said, "if this is what you want, you'll get it."

The second day his smile was grimmer, and it became a matter of discipline. "If this," he said, "happens again, I shall have to report to Old Varn—" He stopped. He had been about to say "Old Varnish." He finished instead, properly—"report to Mr. Varney."

It was a shaken and somewhat mystified Caxton who went into the principal's office the following day. "But where do they obtain the replacement films?" the old man asked helplessly. "After all they cost money."

The question was not his final word. On Thursday, the film again being different, he trotted dutifully to each of the two classes, and pointed out the unfairness of their action. He also indicated that, since the lost films would have to be paid for, the affair was beginning to take on a decidedly criminal aspect.

The fifth day was Friday, and it was evident that the students had talked things over. For the president of each of the two classes made a brief denial of the suspicions of the faculty.

"As you probably know," said one, "the students are usually aware of what is going on among themselves. But this class as a whole is unaware of the identity of the guilty party. Whoever is changing the films is playing a lone hand, and we herewith denounce him, and withdraw any support or sympathy we might normally give to a student who has gotten in wrong."

The words should have quietened Caxton's nerves. But they had the reverse effect. His first conviction, that he was being made game of by the students, had already partly yielded to a wilder thought, and the speeches merely enlivened the newer feeling. That afternoon at recess, without proper forethought, he made the mistake of voicing the suspicion to the principal.

"If the students are not to blame, then one of the teachers must be. And the only one I know who dislikes me intensely is Dorrit."

He added grimly, "If I were you, I would also investigate the relationship between Miss Gregg and Dorrit."

Varney showed a surprising amount of initiative. The truth

was, the old man was easily tired, and he was already worn out by the affair. He called both Miss Gregg and Dorrit and, to Caxton's dismay, repeated the accusations. Miss Gregg flashed one amazed look at the stunned Caxton, and then sat rigid throughout the rest of the meeting. Dorrit looked angry for a moment, then he laughed.

"This week," he said, "has been an eye opener for most of us here. We have seen Caxton wilt under the conviction that the student body didn't like him. I always thought he was a highly developed neurotic, and now in five days he has shown that he is worse than anything I imagined. Like all true neurotics of the more advanced kind, he failed to make even the most elementary investigations before launching his accusations. For instance, his first charge—I can prove that, for at least two days this week I could not possibly have been near the projection room."

He proceeded to do so. He had been sick at his boarding house on Tuesday and Wednesday.

"As for the second and more unforgivable accusation, I only wish it were true, though in a different sense than Caxton has implied. I am one of those shy individuals where women are concerned, but under the circumstances I can say that I have long been an admirer from a distance of Miss Gregg."

The young woman showed her first vague interest at that point. From the corner of her eyes, she glanced at Dorrit, as if she was seeing him in a new light. The glance lasted only a moment, then she returned to her tensed contemplation of the wall straight in front of her. Dorrit was continuing:

"It is difficult, of course, to disprove anything so vague as the charge Mr. Caxton has leveled, but—"

Old Varnish cut him off. "It is quite unnecessary to say anything further. I do not for one moment believe a word of it, and I cannot understand what Mr. Caxton's purpose could have been, to introduce such an ill-considered accusation into this wretched affair of the lost films. If the film situation does not rectify, I will report to the school board at their meeting next week, and we shall have an investigation. That is all. Good day, gentlemen. Good day, Miss Gregg."

Caxton spent a confused week end. He was pretty sure that the principal had derived satisfaction from the situation, but there was nothing to do about that except curse himself for having provided the man with an opportunity to get rid of an unwanted heir to his own position. The worst confusion, however, had nothing to do with Varney. Caxton had the sinking feeling that things were happening now behind his back. It was a feeling that turned out to be correct.

On Monday morning all the women teachers snubbed him, and most of the men were distinctly unfriendly. One of the men

walked over and said in a low tone:

"How did you happen to make such a charge against Gregg and Dorrit?"

"I was beside myself with worry," Caxton said miserably. "I was not in my right senses."

"You sure weren't," said the other. "Gregg's told all the women."

Caxton thought grayly, "A woman scorned."

The other man finished, "I'll try to do what I can but—"

It was too late. At lunch time, the women teachers entered the principal's office in a body, and announced that they would refuse to work in the same school with a male teacher capable of such an untrue story about one of themselves. Caxton, who had already permitted himself flashing thoughts on the possibility of resignation, was now confronted by the necessity of an actual decision. He resigned at intermission, the separation to take effect at the end of the month, the following week end.

His action cleared the air. The male teachers were friendlier, and his own mind slowly and painfully straightened out. By Tuesday he was thinking savagely but with clarity:

"Those films! If it hadn't been for that mix-up, I wouldn't have lost my head. If I could find out who was responsible—"

It seemed to him that the resulting satisfaction would almost compensate him for the loss of his job. He did not go home for lunch. He only pretended to start out. Swiftly, he doubled back to the rear entrance, and, hurrying to the projection room, concealed himself behind a substitute screen that stood there against one wall.

He waited during the entire lunch hour. Nothing happened. Nobody tampered with the locked doors of the auditorium. No one came near the door of the projection room. And then, after lunch, when he started the projector, the film was different.

In the morning it had been an ordinary film, concerned with dairy farming. The afternoon film was about the development and use of chemicals to thin or thicken the human blood, and so enable human beings to fit themselves overnight for extreme changes of temperature.

It was the first time that Caxton had closely examined one of the strange novelty films, of which he had ordered several starting about two weeks before. Examined with his mind as well as his eyes.

He thought, amazed, "Who is making those pictures? Why, they're wonderful, so full of ideas that—"

He returned to the projection room after school for another look. And received the shock of his life. It was a different film. Different from the one in the morning. Different from the one after lunch. It was a third film, its subject the inside of the Sun.

With trembling fingers, Caxton rewound the reel—and ran it through again. The perspiration

came out on his face as an entirely different, a fourth film unwound on the screen. The wild impulse came to rush down to the office to phone up Varney. That ended with the realization that the man would refuse. The principal had implied at least twice that the film tangle would probably rectify the moment Caxton left. The burden of weariness that he wore would make him cling to that conviction. "Tomorrow," he would say, "I'll have a look at the projector tomorrow."

It couldn't wait till tomorrow, so it seemed to Caxton. For the first time, he remembered the phone call he had received more than two months before from Mr. Arlay of the Arlay Film Library. The memory cooled him off. His second impulse within minutes—this time to call Arlay—faded before a recollection of what he had said to the owner of the film library. He had been rather snooty. He'd phone Arlay later.

Caxton began swiftly to dismantle the projector. What exactly he was looking for he didn't know, and he didn't find it. The machine was in first-class shape, everything as normal as it should be.

He reassembled it slowly, and, shoving it back into position, he once more re-ran the reel. This time there was no switch. It was the same film. He ran it over again, and again there was no change.

Caxton sank heavily into a chair. He had, he realized, made a mistake. Something fantastic had happened—just what his mind was not quite prepared to consider—but whatever it was, his action in dismantling the projector had nullified the process. Now he couldn't even mention what he had discovered.

He grew angry. Why should he worry about lost films when he was leaving the school shortly?

Still angry, he climbed to his feet, and strode out of the school, home.

The year was 2011 A.D., and though the automatic projector at Tichenor Collegiate was aware in an electronic sense that something was wrong, it continued its functions. The film distribution machine that operated from Los Angeles was aware that something was wrong, but the disturbance was not great enough to set alarm relays into action. Not at first. Not for about three months. And by then—but here is what happened from the very first moment.

An order came through from Tichenor by the usual electronic channels. The order was of human origin. First, the number of the film was punched, then the assigned number of the school. Usually, when the film was in its place in the library, no other human agency was required. However, if the film and all its duplicates were out on loan, a red light flashed in the projection room at Tichenor, and then it was up to the would-be-renter to order a substitute film.

On this occasion a copy of the

film was available. The electronic imprint of the number of the school was stamped onto the container's sensitives, and onto a series of bookkeeping plates. The bookkeeping plates moved through a machine, which took information from them, as the result of which money was collected from Tichenor in due time. The film flashed out of its shelf into a tube.

Its speed at the beginning was not great. Instant by instant other film containers clicked into the tube in front of it or behind it, and constant automatic readjustments of speed were necessary to prevent collisions. The number of *the* film's destination, Tichenor Collegiate, was 9-7-43-6-2—Zone 9, Main Tube 7, Suburban Tube 43, Distribution 6, School 2.

The cut-off at Zone 9 opened in its automatic fashion as the forces from the film container actuated the mechanism. A moment later, the film was in main mail channel number 7. It was the channel of small packages, and they were strung out in an endless train, each in its electronically controlled container. The train never stopped, but it slowed and speeded as new containers were precipitated into the tube, or old ones darted off into cut-offs to their separate destinations.

. . . 43—6—2. With a click, the film arrived in the receptor. Automatic devices slipped it into position on the projector, and at a set time—in this case about an hour later—the projector's seeing eye attachment opened and surveyed the auditorium. Several students were

still in the aisles. It clanged a warning alarm, waited half a minute, then locked the auditorium doors, and once more slid the cover from its "eye." This time a single student remained in one aisle.

The projector clanged its final alarm for the students. The next warning would be a light flash in the principal's office, together with a television picture of the auditorium, which would clearly show the recalcitrant student. This final action proved unnecessary. The youth ceased his capering, and tumbled into a seat. The showing began.

It was not within the capacity of the electronic devices of the projector to realize what happened then. The proper film showed on the screen, but the film that was subsequently put into the container and returned to the film library was an obsolete creation called "Food Magic," loaned to Tichenor by the Arlay Film Library in 1946.

The container likewise was not equipped to discover such errors. By pure chance, neither it nor any other container which subsequently acquired a 1946 film went out on call for nearly three months. When one finally clicked onto a projector in Santa Monica it was already too late. Caxton had dismantled the 1946 projector, and the sequential process of time connection had been broken.

Time is the great unvariant, but the unvariance is no simple relation. Time is here where you are. It is never the same elsewhere. A starbeam penetrates the atmosphere. It brings a picture from seven hundred thousand years in the past.

An electron makes a path of light across a photographic plate. It brings a picture from fifty, a hundred years in the future—or a hundred thousand years. The stars, the world of the infinitely large, are always in the past. The world of the infinitely small is always in the future.

This is a rigor of the universe, this is the secret of time. And for one second of eternity two motion picture projectors in two separate space-time periods lost some of their aspects of separateness, and there was a limited liaison.

It ended, and was never more.

Senor Pedro del Corteya packed away his projector. He was vaguely unhappy. Poor audience response always affected him that way. It was late when he got outside, but he stood for a moment beside his car looking thoughtfully up at the star-filled night. Blue was that sky above, alive with the mystery of the immense universe.

Corteya scarcely noticed. He was thinking:

"It is those novelty films that bored them. I have shown too many in this town. No more."

He began to feel better, as if a weight had lifted from his soul. He climbed into his car, and drove home.

THE END.

Brass Tacks

I think the gentleman better consult Joe Caldron's little friends.

Dear Mr. Campbell:

I would like an explanation of something which has been bothering me ever since I heard about it. This "thing" is the theory of the Space Warp. As I understand it, this space warp is a hole in space, a position in space where either both space and time or one of the two does not exist. At this point, if space—that is, distance—does not exist, it will take no time at all to travel from one place to another. If this is so, then the two places are super-imposed in time, and if this is so then a person or an object can be in two or more places at one time.

Now, in several stories printed in Astounding where this principle was used, the characters always came out of the space warp at the place they were wanting to go. This is impossible, for if this space warp will transport an object or person from one point to all others, then it will also transport all points to the one point where the space warp exists and if this is true, then this space warp exists at all points and, therefore, the original point does not exist as a point, but as all points. If one point exists as all points, all points exist as one point, and if all points exist as one point how can we determine the size of one point?

If you can clarify this for me I will greatly appreciate it, or if you can get anyone else to clarify it for me please have them contact me.—Jack Murrell, 1809 College Avenue, Indianapolis, Indiana.

I assume the aggressor wouldn't be a fool. If A. wanted to attack, she'd wait till we were having an argument with B. A. would then conclude a friendship treaty with us, speak harshly to B.—and blow our cities off the map.

Dear Sir:

I have just finished reading your

March editorial "Concerning the Atomic War" with a great deal of interest only to find myself "astounded" by one of your italicized statements: "And not knowing who committed the crime."

If we—and by we I do not necessarily mean you and I or the average man in the street but President Truman or President Bowles or President Bricker and the men around him, whoever they may be—do not know who the aggressor is we shall be guilty of such abysmal ignorance as to deserve the abyss into which defeat will plunge us.

To expect such ignorance is to ignore the basic characteristics of war which are based on social, political and economic tensions which exist prior to the declaration of war—whether announced or unannounced—and which lead directly to the war. A nation is not your palsy-walsy brother at one minute, all sweetness and light, and then plunging the knife into your back without any prior warning. As someone has said, war is merely the continuation of unsuccessful diplomacy, unresolved conflicts in the economic fields and the tensions have been building up for years so that the wise can see it.

After all Nazi Germany's path to war was *obvious* before the Nazis came to power and when they did come to power dozens of American correspondents wrote time and time again, as far back as 1933, warning that Germany meant war; Japan was broadcasting its intentions for the wise to read back in 1931. And the future aggressors' intention will be obvious for those who care to read it at least months before the actual blowoff comes. There are, at this moment, unresolved conflicts which might lead to war. If our path as a nation is to the political "left" our aggressors of the future may be found in Argentina, in Spain, in a possibly renascent Germany; if we swing to the "right" our unresolved conflicts may be with an expanding Russia; the point I am driving at is that we will know and while there may not be a lot of warning that war is coming there will be enough for an intelligent "U. S. Atomic Bomb Service" to have the "V-12's" with their atomic warheads pointed for those nations with whom the greatest political tensions had been building up—there may be "Pearl Harbors" in which we lose the race by seconds or minutes but that should be all—we will know the nation who has begun the war because the chip will have been on that nation's shoulders for the politically wise to see and take warning.

Basically I dislike editorials like yours not because I want to be "Pollyanna-ish" or with head in sand like the proverbial ostrich but because I think science fiction can, editorially and fictionally, play another and much more important role in this atomic age.

I believe, and I believe there are many others like me, that our only hope is world government, but I also believe that the world government we need cannot be formed

under *any* of the ideas that now hold sway. An unconventional outlook is needed to reconcile all the various political and economic conflicts that keep the nations apart —an unconventional plan is needed unlike anything we have now, a plan that will seize the imaginations and hopes of mankind to such an extent that they will forget all else in the drama of a world united.

Basically I think there is a need now for one of your "Fairy Chess Players"; a man who thinks unorthodoxically in the socio-politico fields; who can toss aside current thinking and take a new tack. Consequently, I'd like to see an editorial from you outlining those needs, an editorial that might start, "Is there a Fairy Chess Player in the house?"—Martin M. Miroff, 701 East 84th Street, Chicago 19, Illinois.

H. G. Wells' movie "Things To Come" was Grade A prophecy—but hadn't the slightest effect in stopping the war.

Dear Mr. Campbell:

While Astounding readers have some picture of Atomic War II, the general public doesn't—but must. Accepting recent proposals to atom bomb a test United States city—or facsimile—as an impractical gesture in the right direction, the question is: What practical medium exists to convey the picture of War III to a public whose imagination seems to have been only slightly stimulated by Hiroshima? The answer: The movies.

If Hollywood is hesitant about portraying what must be the inevitable result of Powerpolitic Nationalism, some stimulus, such as a flood of letters, should be applied. If this fails, I would suggest that if enough people contributed a small sum, a picture could be made. (These contributions being in the form of a regular investment with any profits being returned.)

Political implications can be avoided by having some Nazi survivors plot to atom-bomb America in the expectation that all the major countries would annihilate each other in retribution, enabling the Nazis to seize power. They destroy some city—I think Chicago or some "protected" city would be most effective. Flashes of normal life and other devices could be used to heighten the realism.

Possibly the picture should start out in the present and show the general apathy. For squeamish patrons it might all be a dream with a moral. Most of it could be a routine spy picture with a city instead of an individual in danger. —Irwin J. Bioss.

Expert Opinion

Dear John:

I have just read the various letters about that picture of the flight path of a V-2 in "Brass Tacks" and I agree with the suggestion supplied by you to Mr. Buchanan's letter that it was the JET that was jumping around, not the rocket.

V-2 had two sets of control vanes, four external control vanes made of sheet aluminum and attached to the lower ends of the stabilizing fins and four internal control vanes. The internal vanes were *at right angles* to the external vanes, being arranged tangentially to the—supposed—cylinder of the exhaust jet and operating by pressing against the exhaust jet, not by moving inside of it as most descriptions carelessly state.

They were round, about 80 mm in diameter and looked to me as if they were not made of metal but of what the Germans call *Retortenkohle,* the kind of carbon of which you fashion the carbon sticks for electric arc lamps. Of course they were backed by metal. The zigzag shown on the picture is probably the jet being pushed aside, or splashing off these internal vanes.

Incidentally, the external vanes were so ineffective that most examiners of the V-2 still wonder why the Germans bothered to put them on, they might as well be eliminated at a great saving of dead weight. I'll explain the precise arrangement and a few related things in a forthcoming article.—Willy Ley.

Things aren't that simple. Battleships are designed to have the center of gravity above the center of flotation!

Dear Mr. Campbell:

First, a kind word. I've admired Astounding Science Fiction for a number of years. Truthfully, I consider it the only science-fiction magazine worth reading. The writing is usually excellent, the stories are fine agents for promoting mental relaxation, and the whole outlook is very stimulating.

Now, the business. I noticed several letters concerning V-2 rockets in your March issue, so here's my contribution. I recently saw a captured moving picture—full color—of V-2 rockets being test-flown. In the light of this film I've been revising some of our intuitive beliefs about rockets. (Quoted remarks following are from your article, "The Road to Space.)

The "inherent instability" of engine-in-rear rockets appears to be a fallacy. A boat having the center of gravity above the center of buoyancy is inherently unstable because, since the force of gravity and the buoyant force remain vertical and parallel regardless of the position of the boat, any slight roll results in a force couple which tends to increase the roll. Conversely, rolling of a boat in which the center of gravity is below the center of buoyancy results in a restoring force couple. In the case of a rocket, on the other hand, the direction of the thrust is not independent of the position of the rocket. That is, no matter how the rocket deviates from its course, the thrust remains directed along the axis of the rocket, and, since the center of gravity certainly lies on that line, the thrust and the force of gravity will always be concurrent, and so can never form a couple tending to increase slight deviations. This, of course, in a vacuum. Similarly, the result-

ant drag in atmosphere will probably always be concurrent with the thrust. It would seem, therefore, that a rear engine rocket is no more unstable than a tractor type, as long as the exhaust nozzle is accurately lined up with the rocket axis, and a rear engine position, as you have pointed out, simplifies greatly the problem of disposing of the exhaust.

I had always thought that a rocket take-off would be a scene of great confusion and violence. It isn't! After starting there is a period of several seconds while the pumps driven by a 500 hp steam turbine with a designed life of only a few minutes—come up to speed, then ignition, accompanied by a slight puff of smoke, after which the jet settles down to a steady short white flame. Finally the rocket begins very *slowly* and *steadily* to rise straight up. I say steadily; these rockets gave the appearance of climbing up an invisible steel pillar!

During the initial stages control is provided by four small carbon vanes in the exhaust nozzle. Opposite vanes act together or differentially, as required to control pitch, yaw, and roll. The vanes are driven by small d.c. selsyns—battery powered—and are controlled by a modified standard German gyro-pilot. After some speed has been attained, small trimming tabs on the stabilizing fins, driven also by the selsyns that drive the internal vanes, become effective.

After reasonable altitude has been attained the gyro-pilot combined with a radio-controlled jet shut-off utilizing the Doppler effect sets the rocket on the desired trajectory.

As an explanation of the slow initial climb, and to confound your remarks about balancing telephone poles on Jupiter, the average acceleration can be calculated. To attain the maximum speed of one mile per second in the 70 seconds of powered flight requires an average acceleration of 75.4 feet per second, or less than two and a half gravities. The maximum acceleration is, of course, considerably higher.

Perhaps it is not so difficult after all to balance a rocket "on its ultimately unstable support — a jet of incandescent gas." Judging from the film, the old space-dog's trick of "balancing her down on the jets" would not be much of a job, provided the gyro-pilot was in good shape.

It may be that the jagged trail shown in your photograph was the result of a faulty gyro—there were some—or of a blowout through the side of the oxygen tank due to a frozen relief valve, or of damage from an alcohol explosion due to a leaky weld—they had those, too—or of a hole burned in one side of the tail pipe due to a plugged cooling spray. (The V-2 combustion chamber and venturi were both jacket-cooled and spray-cooled with pre-combustion alcohol.)

For the honor of the profession I must disagree with your assumption of the "inherent instability of any chemical reaction as violent as that involved in a rocket motor." After all, the V-2 engine handled less than three hundred pounds of mixture per second, and had eighteen burners to divide up the job. An engi-

neer, whether he is designing a rocket engine or a bank of oil burners is not going to turn out an inherently unstable design if the job requires stability. That's what makes him an engineer instead of a politician.—John B. Duryea, 1536 Santa Fe Street, Schenectady 3, New York.

Hm-m-m. Now tell us what type of star does explode!

Dear Mr. Campbell:

I read with more than casual interest the story in your issue of January, 1946, entitled "N-Day," by Philip Latham. Aside from a few minor technical errors — one of which is that only special types of stars widely different from the sun ever explode — it was a tolerably convincing yarn.

This week I have just finished observing on Mount Wilson the largest sunspot ever recorded in modern times. On the 17-inch image of the sun at the 150-foot tower the spot-group looks enormous, extending across 30 degrees of solar longitude.

When I first saw it I thought immediately of the huge sunspot in "N-Day" which was the first sign of instability in the sun. Like the spot in the story, this one was in high latitude. It also caused a great magnetic storm and upset radio and teletype service.

Latham tells of the great outburst or flare which he observed in the spot. On the afternoon of Sunday, February 10th, I witnessed the brightest flare I have ever seen over a sunspot by far. The D3 line of helium blazed like a yellow torch. But although I looked long and hard, unlike Professor Latham, I was unable to detect so much as a trace of 4686 of ionized helium.

A huge sunspot like this does give you the uneasy feeling that anything might happen, that some day a flare such as this one instead of subsiding after half an hour might keep on and on.

Reporters also kept us busy calling up first about the sunspot and then about Nova T Corona Borealis. But so far haven't gotten in bad with the head of the institution yet! —Robert S. Richardson.

The "why" is easy. I don't insist on "saving" him—but I do want a whole skin myself!

Dear Mr. Campbell:

I was more than usually struck by your editorial of the April '46 Astounding. Especially the statement of the problem "some sincere, noble soul, a martyr to his own desire to save the world as quickly as possible in the way *he* knows best, is going to commit suicide with some—atomic—gadget, and remove Washington—or New York-Wall Street, depending on his particular twisted philosophy—from the Earth. *It's up to psychology to develop means of finding such unstable people and adjusting them to fit the world as it is.* And I hope that someone, somehow, figures out a way to keep the newly developed powers of psychology from being used to correct the

thoughts of people who don't need it."

I remembered this when I came to William Bade's letter on page 171 of the same issue, "we practically wallow in potential great discoveries that we can't see because we simply don't know where to look or how to focus our eyes. I'll bet that we're overlooking a lot of first-rate tricks that are within our reach but not our sight," because they seem to shed some light on each other. In the history of our particular civilization, mankind has often learned things that had always been right under his nose, even whole new kinds of things, dating from 1090, 1520, 1776, 19???.

Unless I'm wrong, the only thing we can do for schizophrenia, besides making it a little easier for natural adjustability to go to work, is shock treatment, and we don't understand that. We don't know how to cure it or cancer, even though there's been a lot of work done on them. Probably the cure isn't even the same *kind* of thing that's been tried. And the ideas you're worrying about are schizophrenic.

But I can see two lines of attack on the problem. The first is to assume that "such", "unstable", and "the world as it is" are nonsense. If psychology could really handle those ideas, it might be able to do something. The second is to ask why. Wouldn't you or anyone else who did anything about it, as you point out, be one of the world-savers?—S. G. Thomas, Taft School, Watertown, Connecticut.

Concerning that intelligent shell.

Dear John:

This is a "Now it can be told" letter; a chance to open the safety-valve and emit a cloud of self-contained steam, and also invite you in on the joke. At long last the Radio Proximity Fuse has hit the newspapers with a thunderous roar.

The joke comes from the fact that Ye Editor's Page in the March 1942 Astounding contained interesting references to radio-controlled projectiles. The editorial discussed both standard and science-fiction types of ordnance, which seem to be approaching one another with the velocity of light (squared). You carried on about robombs and rockets, but pointed out that including a few radio parts in the business end of a shell was impossible.

You stated that an artillery shell undergoes a "setback" force of about twenty thousand times gravity. Very true. You stated that radio parts wouldn't take it. I read the editorial aloud at a conference meeting on the Proximity Fuse, but it did not seem to discourage anyone, probably because we were just entering a program of mass production. . . .

We admitted that twenty thousand G was not hay. We couldn't ignore it the way Jules Verne did when he was shooting his travelers to the Moon. We had measured it and knew it was there.

And, of course, the Square-Cube Law was there also.

A mouse dropped out of a second story window will get up and run away after the stun leaves. A small spider will not even care that he has been dropped. And rumor has it that at one time in the early stages of experiment, a fly was included in a test-shell, fired straight up at twenty thousand G, landed in a specially-prepared field, and dug up by the field crew. When the shell was opened, they lost the fly because it came out and flew away, probably shaking its head, blinking its multicellular eyes and whistling: "What a high wind!"

Instead of making the components massive in an effort to increase their strength, we made them very small. It is true that a one-pound object will weigh ten tons for the few milliseconds of set-back. It is equally true that a one-milligram wire will weigh twenty grams. How much would a half-inch of Number 22 copper wire weigh? Then to butter up the proposition, if it is nicely potted in a good grade of wax, it will be definitely held in position along with the rest of the wires, and the parts they connect. Yes, the tubes are of glass, but very small and quite strong and you yourself have pointed out the high tensile strength of glass. Snuggle them down in a form-fitting sock of rubber to prevent shock, and they are safe.

Set-back, incidentally, has its good points. It was used to close switches, crush vials of battery acid, and to open and close a series of gates and safeties that would make Rube Goldberg's finest work look like Gothic Art.

The spin of the shell such as used

with the Proximity Fuse is up around three hundred fifty revolutions per second. That exerts a good centrifugal force on the components that came in for its own share of comment. After the set-back force has done its work on the shell, the spin takes over and the centrifugal force is present from start to finish. Eliminating the troubles of set-back for an instant is one thing but making a gadget that will work when being whirled around at 350 R.P.S. constantly is another. Again the smallness of the parts aided, plus the fact that the more fragile parts were placed close to the center.

Filament-type tubes offer a singular trouble. When the filament heats, it expands. All filament type tubes have, integral, a spring-method of maintaining the straightness of the filament since a sagging filament means that it, the emitting surface, will be closer to certain parts of the grid than other parts, giving a variable-Mu effect. In the Proximity Fuse, the spin would "bow" such a filament and normal manufacturing variations would permit one filament to "bow" more than others under spin.

And there was serious, honest discussion as to the effect of spin on the gas in a thyratron. Is the spin high enough to cause nonhomogeneity in the gas? If the gas were sufficiently affected, the pressure-gradient from one side to the other would be steep, and the ionization-potential of the grid would

be changed with the pressure at the point where the grid was situated.

Then, like set-back, spin was available, and used to good advantage. After the vial of battery acid was broken by set-back, the spin centrifuged it out into the stack of battery plates. This was conveniently a safety-measure, since dropping one of the things merely broke the vial but could not spin the acid into the right place to complete the battery circuit. Spin was also used to open and close more safety gates, many of them interlocking with set-back gates so that both had to occur in the right sequence, power, and duration before the Fuse could trigger off the high explosive.

They were safe. Tumbling them in a barrel for half a day at a high rate of barrel-rotation left them completely safe. It is considered safe until it emerges from the business end of a gun, at which point they are not fit for human companionship. A lot of Kamikaze Boys are telling their honorable ancestors all about it right now.

The principle by which the Proximity Fuse knows when to go off is far from new, once the mechanical problem is licked. There was much light-hearted comment on the fact that several hundred long-haired physicists and engineers spent considerable time developing an oscillating detector driving two stages of resistance-coupled audio amplification.

In the nose of the fuse, there is an oscillating detector. Now an oscillating detector is a fine thing, excepting that it puts out a signal all by itself. Using one on the broadcast band will get you fine reception and also scowls from the neighbors, and perhaps a visit from the FCC. The outgoing signal fouls up the neighborhood and keeps everybody but the user from enjoying that particular program. It does not foul you up because it is in phase and in synchronism with itself.

A little thought will show that this is not only basic, it is fundamental.

But move your oscillating detector against a reflecting surface at high speed, and the frequency undergoes a doppler change. The difference will produce an audible beat-note between the intrinsic frequency of the oscillating detector and the frequency returning from the reflecting surface. As you approach the surface, the intensity increases because of the square-law radiation effect. And since you are approaching a reflector, the square law is doubled, and the intensity increases inversely proportional to the fourth power of the distance. That means a quick rise in the received signal as the reflector is approached.

The audible signal coming from the oscillating detector is amplified in a two-stage resistance coupled amplifier and the output is used to drive the grid of a thyratron.

A thyratron is a gas-filled tube that acts like a make-contact switch. It is wide open until the voltage on the grid exceeds a specified value. Then the tube ionizes, and will con-

duct current—regardless of what the grid does after ionization. The only way to stop it is to drop the plate voltage, or—

The thyratron fires through a dynamite cap of the same general type as the kind used in magneto-blasting. That's where the man in the leather puttees and the "engineer's hat" shoves down on a handle and the mountain comes tumbling down; it is quite familiar to the moving picture audience. In this case, the thyratron fires through the dynamite cap—

Why bother about the de-ionization of the thyratron?

Well, Astounding Science-Fiction seems to have met up with the Law of Diminishing Returns. Only a couple of the old guard gadgets of the science-fiction world remain uncovered, undeveloped, and unused—or military secrets. Radar is the meteor detector: "Nerves," "Blow-ups Happen," and "Solution Unsatisfactory"; V-1 and V-2; and the Bazooka seems to have made some sort of energy-screen desirable, whereby hangs the Missing Links.

I'm sticking around long enough to see how soon they will decide that a Venus Equilateral is needed so that I can go out and get me a job, for there seems to be little point in writing about it as fiction. For the Missing Links are the Time Machine, the Energy Projector, and the Space Warp.

Who among your readers have been working on *them,* huh?—George O. Smith.

The neutron is a collapsed hydrogen atom—and is less stable. Free neutrons decay to hydrogen in about twenty minutes.

Dear Mr. Campbell:

Re: The Smyth Report.

Just what is a neutron? Does mass always come associated with electric charge, or doesn't it? For purposes of simplicity, I prefer to assume that it does, and that a neutron is merely a collapsed hydrogen atom, bearing the same relation to the young expanded atom that a white dwarf bears to a red giant star.

The combined masses of proton and electron equal 1.00813 mass units, of which the electron represents only 0.00055 mass units. Now the mass of a neutron is 1.00893 mass units, which is only slightly heavier than the combined masses of an electron and proton, separately considered. The difference in mass between the neutron and the components of the hydrogen atom is 0.00080, which turns out to be only slightly greater than the mass of an electron, and calls for some sort of explanation. Three possible alternatives could be suggested. First, when organized into a neutron system, the electron retains its orbital motion about the proton, but at a fantastically small radius, and at a fantastically high speed, high enough to more than double the effective electron mass. Second, there may be a hitherto undiscovered mass-gravitational effect that varies mass with proximity, the mass being multiplied by unity plus a number which varies inversely as the nth power of the distance between the two particles, *n* being some fantastically great constant. Third, the young atom has more inherent stability than the collapsed neutron—but this is an analomy that I dislike—and the expanded atomic form consequently has less mass than has the neutronic collapsed form.

Since the Russians have established the existence, once and for all of contraterrene matter, in which positrons rotate about negatively charged nuclei, could it not be possible to bombard various elements with small heavy negatively charged particles such as contraterrene nuclei, and see what happens? It ought to be interesting. More penetrating than neutrons, to say the least, if the projectiles can once get past the negative swarm of orbital electrons.

The intense bombardment of ordinary water by neutrons, say from outlets on a plutonium production pile, might result in a cheap by-product enrichment of the water in deuterons, especially if the water is mixed with a little acid to separate the hydrogen ions.

I was also going to suggest the bombardment of water by positrons, but I am afraid that that would merely lead to the production of helium, the heavy water in the ordinary water turning its extra neutrons into protons to form helium ions.—Aaron B. Miller, Aboard the ship *Emile Berliner* at Callao, Peru.

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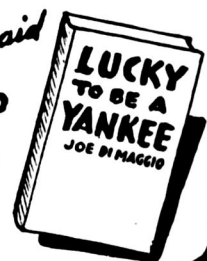

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