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THOUGHT WITHOUT WORDS

Two of the standard, long-time, unsettled problems of the Nature of Man and the Nature of Human Thought concern the questions whether thought is possible without words, and the problem of Nature vs. Nurture, or which comes first in importance, heredity or environment?

I have a strong hunch the two problems are interrelated and can be discussed only jointly if a rational—not necessarily logical!—solution is to be achieved.

First, consider the problem of thought-without-words in this way: A newborn baby does not have "words" or "language" in the sense of "a system of arbitrary, mutually agreed-on symbols." When we say that a baby "has learned to talk" we do *not* mean what we mean when we say a parrot "has learned to talk." There is a certain neuromuscular-mechanical skill required to produce the symbol-system of vocal sounds; this skill can be learned by a parrot, and must be learned

by a human baby before he can "talk" in the full meaning of the term. But to be able to form the sounds of human speech is not the point in question; what is important is learning to use speech-sounds as a system of arbitrary, mutually-agreed-on symbols. This a parrot cannot do, and we cannot yet build a machine that can do it—though Edison's original phonograph, and Bell's original telephone both demonstrated the ability to recreate human speech sounds.

There's a happy little idea that a baby learns words "by association." That's one of those slap-happy, unconsidered statements that sounds as though it really meant something, until you try to find out what it does mean. So baby learns to use sound-symbols by having the object pointed to while it's sound-symbol is produced?

Try pointing to "wood" while you say the sound for baby. Oh, that's "wood," is it? Hm-m-m . . . yesterday you said it was "table."

Which do you mean? Or does any handy sound refer to anything you happen to be pointing to? And this morning I heard you say that you "wood be home early." *That's* wood? But ten minutes ago you said it was "tree."

Go on, friend . . . point to "wood." I dare you!

"Wood" is a sound-symbol referring to an abstract concept; objects may be *made of wood*, but they *are not wood*. A wood, be it noted, is also a collection of growing trees. The identical sound-symbol is also used as a verb, where it has an even more abstract and not-point-at-able meaning.

Then, of course, there are interesting terms like "improbable." Having tried to define the term explicitly for a seven-year-old-girl, I am in a position to realize the exceedingly high-order abstraction involved. It has the most interesting characteristic that if you *can* point at the objective manifestation, it is *not* improbable; it is then "true."

Yes, children learn to talk by "learning to associate" sound-symbols with . . . yes, with what? Abstract conceptions, obviously. The only valid association that exists is between a certain sound-symbol and a certain arbitrarily designated abstract concept. And where does the ten-month old baby get this abstract concept to tie the word-symbol on? You can't hand it to him, that's obvious. You can't point to it, either. Baby has to generate the abstraction for himself, and only when he has

succeeded in doing that is it possible to form an association between the concept and the sound-symbol.

Baby, in other words, has to have a remarkable and wonderful ability to do an order of thinking that we can't even define in language before he can learn any language whatever!

Baby also has a number of other abilities that no scientist, philosopher, technician or advanced thinker can describe or define specifically. Memory, for example, or the ability to heal a wound. These aren't learned abilities; they're inherent—genetic gifts from the Gods of three thousand megayears of trial and error evolution.

This is, of course, where the Nature vs. Nurture dispute fits in. You can *not* teach a chimpanzee to talk. It's been tried. The objection that a chimpanzee's vocal organs aren't suitable was ruled out by the simple process of having the human teachers study chimpanzee sounds, and devise a language using chimpanzee sounds as the sound-symbols assigned arbitrary "language" value. The chimpanzee could mimic the sounds all right—but he couldn't generate the abstractions within himself; he couldn't learn to talk even a chimpanzee-sound language.

The human baby is born with an inherent abstraction-generating mechanism; only because that gift of Nature is present can the baby learn to talk. But, say the Nurture advocates, the baby will not learn to talk if left to itself; it has to be taught!

(Continued on page 161)



CRITICAL DIFFERENCE

It just happens that the kind of planet human beings want—an "Earthlike world"—is one resting right on the sharp edge of a phase-change. It takes just a little difference...

BY MURRAY LEINSTER

I

Massy waked that morning when the only partly-opened port of his sleeping-cabin closed of itself and the room-warmer began to whirl. He

found himself burrowed deep under his covering, and when he got his head out of it the already-bright room was bitterly cold and his breath made a fog about him.

He thought uneasily, *It's colder*



Illustrated by van Dongen

than yesterday! But a Colonial Survey officer is not supposed to let himself seem disturbed, in public, and the only way to follow that rule is to follow it in private, too. So Massy composed his features, while gloom filled him. When one has just received senior service rating and is on one's very first independent survey of a new colonial installation, the unexpected can be appalling. The unexpected was definitely here, on Lani III.

He'd been a Survey Candidate on Khali II and Taret and Arepo I, all of which were tropical, and a Junior Officer on Menes III and

Thotmes—one a semiarid planet and the other temperate-volcanic—and he'd done an assistant job on Saril's solitary world, which was ninety-ninths water. But this first independent survey on his own was another matter. Everything was wholly unfamiliar. An ice planet with a minus point one habitability rating was upsetting in its peculiarities. He knew what the books said about glacial-world conditions, but that was all.

The denseness of the fog his breath made seemed to grow less as the room-warmer whirred and whirred. When by the thinness of

the mist he guessed the temperature to be not much under freezing, he climbed out of his bunk and went to the port to look out. His cabin, of course, was in one of the drone-hulls that had brought the colony's equipment to Lani III. The other emptied hills were precisely ranged in order outside. They were duly connected by tubular galleries, and very painstakingly leveled. They gave an impression of impassioned tidiness among the upheaved, ice-coated mountains all about.

He gazed down the long valley in which the colony lay. There were monstrous slanting peaks on either side. They partly framed the morning sun. Their sides were ice. The flanks of every mountain in view were ice. The sky was pale. The sun had four sun-dogs placed geometrically about it. It shone coldly upon this far-out world. Normal post-midnight temperatures in this valley ranged around ten below zero—and this was technically summer. But it was colder than ten below zero now. At noon there were normally tiny trickling rills of surface-thaw running down the sunlit sides of the mountains—but they froze again at night and the frost replaced itself after sunset. And this was a sheltered valley—warmer than most of the planet's surface. The sun had its sun-dogs every day, on rising. There were nights when the brighter planets had star-pups, too.

The phone-plate lighted and dimmed and lighted and dimmed.

They did themselves well on Lani III—but the parent world was in this same solar system. That was rare. Massy stood before the plate and it cleared. Herndon's face peered unhappily out of it. He was even younger than Massy, and inclined to lean heavily on the supposedly vast experience of a Senior Officer of the Colonial Survey.

"Well?" said Massy—and suddenly felt very undignified in his sleeping-garments.

"We're picking up a beam from home," said Herndon anxiously, "but we can't make it out."

Because the third planet of the sun Lani was being colonized from the second, inhabited world, communication with the colony's base was possible. A tight beam could span a distance which was only light-minutes across at conjunction, and not much over a light-hour at opposition—as now. But the beam communication had been broken for the past few weeks, and shouldn't be possible again for some weeks more. The sun lay between. One couldn't expect normal sound-and-picture transmission until the parent planet had moved past the scrambler-fields of Lani. But something had come through. It would be reasonable for it to be pretty well hashed when it arrived.

"They aren't sending words or pictures," said Herndon uneasily. "The beam is wabby and we don't know what to make of it. It's a signal, all right, and on the regular frequency. But there are all sorts

of stray noises, and still in the midst of it there's some sort of signal we can't make out. It's like a whine, only it stutters. It's a broken-up sound of one pitch."

Massy rubbed his chin reflectively. He remembered a course in information theory just before he'd graduated from the Service Academy. Signals made by pulses, and pitch-changes and frequency-variations. Information was what couldn't be predicted without information. And he remembered with gratitude a seminar on the history of communication, just before he'd gone out on his first field job as a Survey Candidate.

"Hm-m-m," he said with a trace of self-consciousness. "Those noises—the stuttering ones. Would they be, on the whole, of no more than two different durations? Like—hm-m-m—*Bzz bzz bzzzzzz bzz?*"

He felt that he lost dignity by making such ribald sounds. But Herndon's face brightened.

"That's it!" he said relievedly. "That's it! Only they're high-pitched like—" His voice went falsetto. "*Bzz bzz bzzzzzz bzz bzz!*"

It occurred to Massy that they sounded like two idiots. He said with dignity:

"Record everything you get, and I'll try to decode it." He added: "Before there was voice communication there were signals by light and sounds in groups of long and short units. They came in groups, to stand for letters, and things were spelled out. Of course there were

larger groups which were words. Very crude system, but it worked when there was great interference, as in the early days. If there's some emergency, your home world might try to get through the sun's scrambler-field that way."

"Undoubtedly!" said Herndon, with even greater relief. "No question, that's it!"

He regarded Massy with great respect as he clicked off. His image faded. The plate was clear.

He thinks I'm wonderful, thought Massy wryly. Because I'm Colonial Survey. But all I know is what's been taught me. It's bound to show up sooner or later. Damn!

He dressed. From time to time he looked out the port again. The intolerable cold of Lani III had intensified, lately. There was some idea that sunspots were somehow the cause. He couldn't make out sunspots with the naked eye, but the sun did look pale, with its accompanying sun-dogs. Massy was annoyed by them. They were the result of microscopic ice-crystals suspended in the air. There was no dust on this planet, but there was plenty of ice! It was in the air and on the ground and even under it. To be sure, the drills for the foundation of the great landing-grid had brought up cores of frozen humus along with frozen clay, so there must have been a time when this world had known clouds and seas and vegetation. But it was millions, maybe hundreds of millions of years ago.

Right now, though, it was only warm enough to have an atmosphere and very slight and partial thawings in direct sunlight, in sheltered spots, at midday. It couldn't support life, because life is always dependent on other life, and there is a temperature below which a natural ecological system can't maintain itself. The past few weeks, the climate had been such that even human-supplied life looked dubious.

Massy slipped on his Colonial Survey uniform with its palm-tree insignia. Nothing could be much more inappropriate than palm-tree symbols on a planet with sixty feet of permafrost. Massy reflected wryly, *The construction gang calls it a blast, instead of a tree, because we blow up when they try to dodge specifications. But specifications have to be met! You can't bet the lives of a colony or even a ship's crew on half-built facilities!*

He marched down the corridor from his sleeping room, with the dignity he painstakingly tried to maintain for the sake of the Colonial Survey. It was a pretty lonely business, being dignified all the time. If Herndon didn't look so respectful, it would have been pleasant to be more friendly. But Herndon revered him. Even his sister Riki—

But Massy put her firmly out of his mind. He was on Lani III to check and approve the colony installations. There was the giant landing-grid for spaceships, which took power from the ionosphere to

bring heavily loaded space-vessels gently to the ground, and in between times took power from the same source to supply the colony's needs. It also lifted visiting spacecraft the necessary five planetary diameters out when they took off again. There was power-storage in the remote event of disaster to that giant device. There was a food-reserve and the necessary resources for its indefinite stretching in case of need. That usually meant hydroponic installations. There was a reason for the colony, which would make it self-supporting—here a mine. All these things had had to be finished and operable and inspected by a duly qualified Colonial Survey officer before the colony could be licensed for unlimited use. It was all very normal and official, but Massy was the newest Senior Survey Officer on the list, and this was the first of his independent operations. He felt inadequate, sometimes.

He passed through the vestibule between this drone-hull and the next. He went directly to Herndon's office. Herndon, like himself, was newly endowed with authority. He was actually a mining-and-minerals man and a youthful prodigy in that field, but when the director of the colony was taken ill while a supply ship was aground, he went back to the home planet and command devolved on Herndon. *I wonder, thought Massy, if he feels as shaky as I do?*

When he entered the office, Herndon
ASTOUNDING SCIENCE FICTION

don sat listening to a literal hash of noises coming out of a speaker on his desk. The cryptic signal had been relayed to him, and a recorder stored it as it came. There were cracklings and squeals and moaning sounds, and sputters and rumbles and growls. But behind the façade of confusion there was a tiny, interrupted, high-pitched noise. It was a monotone whining not to be confused with the random sounds accompanying it. Sometimes it faded almost to inaudibility, and sometimes it was sharp and clear. But it was a distinctive sound in itself, and it was made up of short whines and longer ones of two durations only.

"I've put Riki at making a transcription of what we've got," said Herndon with relief as he saw Massy. "She'll make short marks for the short sounds, and long ones for the long. I've told her to try to separate the groups. We've got a full half hour of it, already."

Massy made an inspired guess.

"I would expect it to be the same message repeated over and over," he said. He added. "And I think it would be decoded by guessing at the letters in two-letter and three-letter words, as clues to longer ones. That's quicker than statistical analysis of frequency."

Herndon instantly pressed buttons under his phone-plate. He relayed the information to Riki, his sister, as if it were gospel. Massy remembered guiltily that it wasn't gospel. It was simply a trick recalled from

his boyhood, when he was passionately interested in secret languages. His interest had faded when he realized he had no secrets to record or transmit.

Herndon turned from the phone-plate.

"Riki says she's already learned to recognize some groups," he reported, "but thanks for the advice. Now what?"

Massy sat down. He'd have liked some coffee, but he was being treated with such respect that the role of demigod was almost forced on him.

"It seems to me," he observed, "that the increased cold out here might not be local. Sunspots—"

Herndon jittered visibly. He silently handed over a sheet of paper with observation-figures on top and a graph below them which related the observations to each other. They were the daily, at-first-routine, measurements of the solar constant from Lani III. The graph-line almost ran off the paper at the bottom.

"To look at this," he admitted, "you'd think the sun was going out. Of course it can't be," he added hastily. "Not possibly! But there is an extraordinary number of sunspots. Maybe they'll clear. But meanwhile the amount of heat reaching us is dropping. As far as I know there's no parallel to it. Night temperatures are thirty degrees lower than they should be. Not only here, either, but at all the robot weather stations that have been spotted around the planet. They average forty below zero minimum, instead

of ten. And—there is that terrific lot of sunspots . . .”

He looked hopefully at Massy. Massy frowned. Sunspots are things about which nothing can be done. Yet the habitability of a borderline planet, anyhow, can very well depend on them. An infinitesimal change in sun heat can make a serious change in any planet's temperature. In the books, the ancient mother planet Earth was said to have entered glacial periods through a drop of only three degrees in the planet-wide temperature, and to have been tropic almost to its poles from a rise of only six. It had been guessed that glacial periods in the planet where humanity began had been caused by coincidences of sunspot maxima.

This planet was already glacial to its equator. There was a genuinely abnormal number of sunspots on Lani, its sun. Sunspots could account for worsening conditions here, perhaps. *That message from the inner planet could be bad*, thought Massy, *if the solar constant drops and stays down a while*. But aloud he said:

“There couldn't be a really significant permanent change. Not quickly, anyhow. Lani's a Sol-type star, and they aren't variables, though of course any dynamic system like a sun will have cyclic modifications of one sort or another. But they usually cancel out.”

He sounded encouraging, even to himself. But there was a stirring behind him. Riki Herndon had come

silently into her brother's office. She looked pale. She put papers down on her brother's desk.

“But,” she said evenly, “while cycles sometimes cancel, sometimes they enhance each other. They heterodyne. That's what's happening.”

Massy scrambled to his feet, flushing. Herndon said sharply:

“What? Where'd you get that stuff, Riki?”

She nodded at the sheaf of papers she'd just laid down.

“That's the news from home.” She nodded again, to Massy. “You were right. It was the same message, repeated over and over. And I decoded it like children decode each other's secret messages. I did that to Ken once. He was twelve, and I decoded his diary, and I remember how angry he was that I'd found out he didn't have any secrets.”

She tried to smile. But Herndon wasn't listening. He read swiftly. Massy saw that the under sheets were rows of dots and dashes, painstakingly transcribed and then decoded. There were letters under each group of marks.

Herndon was very white when he'd finished. He handed the sheet to Massy. Riki's handwriting was precise and clear. Massy read:

“FOR YOUR INFORMATION
THE SOLAR CONSTANT IS
DROPPING RAPIDLY DUE TO
COINCIDENCE OF CYCLIC
VARIATIONS IN SUNSPOT AC-
TIVITY WITH PREVIOUS UN-

OBSERVED LONG CYCLES APPARENTLY INCREASING THE EFFECT MAXIMUM IS NOT YET REACHED AND IT IS EXPECTED THAT THIS PLANET WILL BECOME UNINHABITABLE FOR A TIME ALREADY KILLING FROSTS HAVE DESTROYED CROPS IN SUMMER HEMISPHERE IT IS IMPROBABLE THAT MORE THAN A SMALL PART OF THE POPULATION CAN BE SHELTERED AND WARMED THROUGH DEVELOPING GLACIAL CONDITIONS WHICH WILL REACH TO EQUATOR IN TWO HUNDRED DAYS THE COLD CONDITIONS ARE COMPUTED TO LAST TWO THOUSAND DAYS BEFORE NORMAL SOLAR CONSTANT RECURS THIS INFORMATION IS SENT YOU TO ADVISE IMMEDIATE DEVELOPMENT OF HYDROPONIC FOOD SUPPLY AND OTHER PRECAUTIONS MESSAGE ENDS FOR YOUR INFORMATION THE SOLAR CONSTANT IS DROPPING RAPIDLY DUE TO COINCIDENCE OF CYCLIC—”

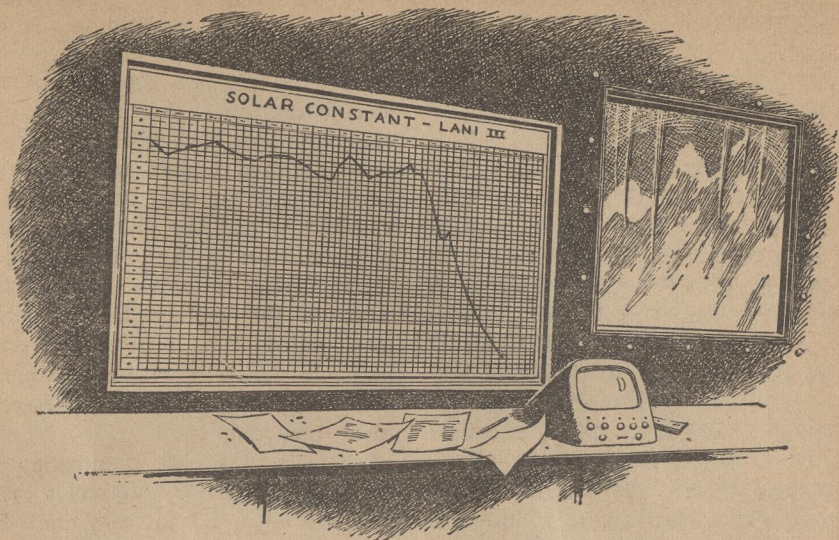
Massy looked up. Herndon's face was ghastly. Massy said in some grimness:

“Kent IV's the nearest world your planet could hope to get help from. A mail liner will make it in two months. Kent IV might be able to send three ships—to get here in two months more. That's no good!”

He felt sick. Human-inhabited planets are far apart. The average

distance of stars of all types—there is on an average between four and five light-years of distance between suns. They are two months' spaceship journey apart. And not all stars are sol-type or have inhabited planets. Colonized worlds are like isolated islands in an unimaginably vast ocean, and the ships that ply between them at thirty light-speeds seem merely to creep. In ancient days on the mother-planet Earth, men sailed for months between ports, in their clumsy sailing ships. There was no way to send messages faster than they could travel. Nowadays there was little improvement. News of the Lani disaster could not be transmitted. It had to be carried, as between stars, and carriage was slow and response to news of disaster was no faster.

The inner planet, Lani II, had twenty millions of inhabitants, as against the three hundred people in the colony on Lani III. The outer planet was already frozen, but there would be glaciation on the inner world in two hundred days. Glaciation and human life are mutually exclusive. Human beings can survive only so long as food and power hold out, and shelter against really bitter cold cannot be improvised for twenty million people! And, of course, there could be no outside help on any adequate scale. News of the need for it would travel too slowly. One other world might hear in two months, and send what aid it could in four. But the next would not hear for four months, and could



not send help in less than eight. It would take five Earth-years to get a thousand ships to Lani II—and a thousand ships could not rescue more than one per cent of the population. But in five years there would not be nearly so many people left alive.

Herdon licked his lips. There were three hundred people in the already-frozen colony. They had food and power and shelter. They had been considered splendidly daring to risk the conditions here. But all their home world would presently be like this. And there was no possibility of equipping everybody there as the colonists were equipped.

"Our people," said Riki in a thin voice, "all of them... Mother and father and—the others. Our cousins.

All our friends. Home is going to be like... like that!"

She jerked her head toward a port which let in the frigid colony-world's white daylight. Her face worked.

Massy was aware of an extreme unhappiness on her account. For himself, of course, the tragedy was less. He had no family. He had very few friends. But he could see something that had not occurred to them as yet,

"Of course," he said, "it's not only their trouble. If the solar constant is really dropping like that... why things out here will be pretty bad too. A lot worse than they are now. We'll have to get to work to save ourselves!"

Riki did not look at him. Herdon bit his lips. It was plain that their own fate did not concern them

immediately. But when one's home world is doomed, one's personal safety seems a very trivial matter.

There was silence save for the crackling, tumultuous noises that came out of the speaker on Herndon's desk. In the midst of that confused sound there was a wavering, whining, high-pitched note which swelled and faded and grew distinct again.

"We," said Massy without confidence, "are right now in the conditions they'll face a good long time from now."

Herndon said dully:

"But we couldn't live here without supplies from home. Or even without the equipment we brought. But they can't get supplies from anywhere, and they can't make such equipment for everybody! They'll die!" He swallowed, and there was a clicking noise in his throat. "They . . . they know it, too. So they . . . warn us to try to save ourselves because . . . they can't help us any more."

There are many reasons why a man can feel shame that he belongs to a race which can do the things that some men do. But sometimes there are reasons to be proud, as well. The home world of this colony was doomed, but it sent a warning to the tiny group on the colony-world, to allow them to try to save themselves.

"I . . . wish we were there to . . . share what they have to face," said Riki. Her voice sounded as if her throat hurt. "I . . . don't want to

keep on living if . . . everybody who . . . ever cared about us is going to die!"

Massy felt lonely. He could understand that nobody would want to live as the only human alive. Nobody would want to live as a member of the only group of people left alive. And everybody thinks of his home planet as all the world there is. *I don't think that way*, thought Massy. *But maybe it's the way I'd feel about living if Riki were to die.* It would be natural to want to share any danger or any disaster she faced. Which he was.

"L-look!" he said, stammering a little "You don't see! It isn't a case of your living while they die! If your home world becomes like this, what will this be like? We're farther from the sun! We're colder to start with! Do you think we'll live through anything they can't take? Food supplies or no, equipment or no, do you think we've got a chance? Use your brains!"

Herndon and Riki stared at him. And then some of the strained look left Riki's face and body. Herndon blinked, and said slowly:

"Why . . . that's so! We were thought to be taking a terrific risk when we came here. But it'll be as much worse here— Of course! We are in the same fix they're in!"

He straightened a little. Color actually came back into his face. Riki managed to smile. And then Herndon said almost naturally:

"That makes things look more sensible! We've got to fight for our

lives, too! And we've very little chance of saving them! What do we do about it, Massy?"

II

The sun was halfway toward mid-sky, and still attended by its sun-dogs, though they were fainter than at the horizon. The sky was darker. The mountain peaks reached skyward, serene and utterly aloof from the affairs of men. This was a frozen world, where there should be no inhabitants. The city was a fleet of metal hulks, neatly arranged on the valley floor, emptied of the material they had brought for the building of the colony. At the upper end of the valley the landing-grid stood. It was a gigantic skeleton of steel, rising from legs of unequal length bedded in the hillsides, and reaching two thousand feet toward the stars. Human figures, muffled almost past recognition, moved about a catwalk three-quarters of the way up. There was a tiny glittering below where they moved. They were, of course, men using sonic ice-breakers to shatter the frost which formed on the framework at night. Falling shards of crystal made a liquidlike flashing. The landing-grid needed to be cleared every ten days or so. Left uncleared, it would acquire an increasingly thick coating of ice. In time it could collapse. But long before that time it would have ceased to operate, and without its operation there could be no space travel. Rockets for lifting spaceships were im-

possibly heavy, for practical use. But the landing-grids could lift them out to the unstressed space where Lawlor drives could work, and draw them to ground with cargoes they couldn't possibly have carried if they'd needed rockets.

Massy reached the base of the grid on foot. It was not far from the village of drone-hulls. He was dwarfed by the ground-level upright beams. He went through the cold-lock to the small control-house at the grid's base.

He nodded to the man on standby as he got painfully out of his muffling garments.

"Everything all right?" he asked.

The standby operator shrugged. Massy was Colonial Survey. It was his function to find fault, to expose inadequacies in the construction and operation of colony facilities. *It's natural for me to be disliked by men whose work I inspect*, thought Massy. *If I approve it doesn't mean anything, and if I protest, it's bad.* He had always been lonely, but it was a part of the job.

"I think," he said painstakingly, "that there ought to be a change in maximum no-drain voltage. I'd like to check it."

The operator shrugged again. He pressed buttons under a phone-plate.

"Shift to reserve power," he commanded, when a face appeared in the plate. "Gotta check no-drain juice."

"What for?" demanded the face in the plate.

"You-know-who's got ideas," said

the grid operator scornfully. "Maybe we've been skimping something. Maybe there's some new specification we didn't know about. Maybe anything! But shift to reserve power."

The face in the screen grumbled. Massy swallowed. It was not a Survey officer's privilege to maintain discipline. But there was no particular virtue in discipline here and now. He watched the current-demand dial. It stood a little above normal day-drain, which was understandable. The outside temperature was down. There was more power needed to keep the dwellings warm, and there was always a lot of power needed in the mine the colony had been formed to exploit. The mine had to be warmed for the men who worked to develop it.

The demand-needle dropped abruptly, and hung steady, and dropped again and again as additional parts of the colony's power-usages were switched to reserve. The needle hit bottom. It stayed there.

Massy had to walk around the standby man to get at the voltmeter. It was built around standard, old-fashioned vacuum tubes—standard for generations, now. Massy patiently hooked it up and warmed the tubes and tested it. He pushed in the contact-plugs. He read the no-drain voltage. He licked his lips and made a note. He reversed the leads, so it would read backward. He took another reading. He drew in his breath very quietly.

"Now I want the power turned on in sections," he told the opera-

tor. "The mine first, maybe. It doesn't matter. But I want to get voltage-readings at different power take-offs."

The operator looked pained. He spoke with unnecessary elaboration to the face in the phone-plate, and grudgingly went through with the process by which Massy measured the successive drops in voltage with power drawn from the ionosphere. The current available from a layer of ionized gas is, in effect, the current-flow through a conductor with marked resistance. It is possible to infer a gas' ionization from the current it yields.

The cold-lock door opened. Riki Herndon came in, panting a little.

"There's another message from home," she said sharply. Her voice seemed strained. "They picked up our answering-beam and are giving the information you asked for."

"I'll be along," said Massy. "I just got some information here."

He got into his cold-garments again. He followed her out of the control-hut.

"The figures from home aren't good," said Riki evenly, when mountains visibly rose on every hand around them. "Ken says they're much worse than he thought. The rate of decline in the solar constant's worse than we figured or could believe."

"I see," said Massy, inadequately.

"It's absurd!" said Riki fiercely. "It's monstrous! There've been sunspots and sunspot cycles all along! I learned about them in school! I

learned myself about a four-year and a seven-year cycle, and that there were others! They should have known! They should have calculated in advance! Now they talk about sixty-year cycles coming in with a hundred-and-thirty-year cycle to pile up with all the others— But what's the use of scientists if they don't do their work right and twenty million people die because of it?"

Massy did not consider himself a scientist, but he winced. Riki raged as they moved over the slippery ice. Her breath was an intermittent cloud about her shoulders. There was white frost on the front of her cold-garments.

He held out his hand quickly as she slipped, once.

"But they'll beat it!" said Riki in a sort of angry pride. "They're starting to build more landing-grids, back home. Hundreds of them! Not for ships to land by, but to draw power from the ionosphere! They figure that one ship-size grid can keep nearly three square miles of ground warm enough to live on! They'll roof over the streets of cities. Then they'll plant food-crops in the streets and gardens, and do what hydroponic growing they can. They are afraid they can't do it fast enough to save everybody, but they'll try!"

Massy clenched his hands inside their bulky mittens.

"Well?" demanded Riki. "Won't that do the trick?"

Massy said: "No."

"Why not?" she demanded.

"I just took readings on the grid, here. The voltage and the conductivity of the layer we draw power from, both depend on ionization. When the intensity of sunlight drops, the voltage drops and the conductivity drops, too. It's harder for less power to flow to the area the grid can tap—and the voltage-pressure is lower to drive it."

"Don't say any more!" cried Riki. "Not another word!"

Massy was silent. They went down the last small slope. They passed the opening of the mine—the great drift which bored straight into the mountain. They could look into it. They saw the twin rows of brilliant roof-lights going toward the heart of the stony monster.

They had almost reached the village when Riki said in a stifled voice:

"How bad is it?"

"Very," admitted Massy. "We have here the conditions the home planet will have in two hundred days. Originally we could draw less than a fifth the power they count on from a grid on Lani II."

Riki ground her teeth.

"Go on!" she said challengingly.

"Ionization here is down ten per cent," said Massy. "That means the voltage is down—somewhat more. A great deal more. And the resistance of the layer is greater. Very much greater. When they need power most, on the home planet, they won't draw more from a grid than we do now. It won't be enough."

They reached the village. There were steps to the cold-lock of Herndon's office-hull. They were ice-free, because like the village walk-ways they were warmed to keep frost from depositing on them. Massy made a mental note.

In the cold-lock, the warm air pouring in was almost stifling. Riki said defiantly:

"You might as well tell me now!"

"We could draw one-fifth as much power, here, as the same sized grid would yield on your home world," he said grimly. "We are drawing—call it sixty per cent of normal. A shade over one-tenth of what they must expect to draw when the real cold hits them. But their estimates are nine times too high." He said heavily. "One grid won't warm three square miles of city. About a third of one is closer. But—"

"That won't be the worst!" said Riki in a choked voice. "Is that right? How much good will a grid do?"

Massy did not answer.

The inner cold-lock door opened. Herndon sat at his desk, even paler than before, listening to the hash of noises that came out of the speaker. He tapped on the desktop, quite unconscious of the action. He looked almost desperately at Massy.

"Did she . . . tell you?" he asked in a numb voice. "They hope to save maybe half the population. All the children anyhow—"

"They won't," said Riki bitterly.

"Better go transcribe the new

stuff that's come in," said her brother dully. "We might as well know what it says."

Riki went out of the office. Massy laboriously shed his cold-garments. He said uncomfortably:

"The rest of the colony doesn't know what's up yet. The operator at the grid didn't, certainly. But they have to know."

"We'll post the messages on the bulletin board," said Herndon apathetically. "I wish I could keep it from them. It's not fun to live with. I . . . might as well not tell them just yet."

"To the contrary," insisted Massy. "They've got to know right away! You're going to issue orders and they'll need to understand how urgent they are!"

Herndon looked absolutely hopeless.

"What's the good of doing anything?" When Massy frowned, he added as if exhausted: "Seriously, is there any use? You're all right. A Survey ship's due to take you away. It's not coming because they know there's something wrong, but because your job should be finished about now. But it can't do any good! It would be insane for it to land at home. It couldn't carry away more than a few dozen refugees, and there are twenty million people who're going to die. It might offer to take some of us. But . . . I don't think many of us would go. I wouldn't. I don't think Riki would."

"I don't see—"

"What we've got right here," said

Herndon, "is what they're going to have back home. And worse. But there's no chance for us to keep alive here! You are the one who pointed it out! I've been figuring, and the way the solar-constant curve is going—I plotted it from the figures they gave us—it couldn't possibly level out until the oxygen, anyhow, is frozen out of the atmosphere here. We aren't equipped to stand anything like that, and we can't get equipped. There couldn't be equipment to let us stand it indefinitely! Anyhow the maximum cold conditions will last two thousand days back home—six Earth-years. And there'll be storage of cold in frozen oceans and piled-up glaciers— It'll be twenty years before home will be back to normal in temperature, and the same here. Is there any point in trying to live—just barely to survive—for twenty years before there'll be a habitable planet to go back to?"

Massy said irritably:

"Don't be a fool! Doesn't it occur to you that this planet is a perfect experiment-station, two hundred days ahead of the home world, where ways to beat the whole business can be tried? If we can beat it here, they can beat it there!"

Herndon said detachedly:

"Can you name one thing to try here?"

"Yes," snapped Massy. "I want the walk-heaters and the step-heaters outside turned off. They use power to keep walkways clear of

frost and doorsteps not slippery. I want to save that heat!"

Herndon said without interest:

"And when you've saved it, what will you do with it?"

"Put it underground to be used as needed!" Massy said angrily. "Store it in the mine! I want to put every heating-device we can contrive to work in the mine! To heat the rock! I want to draw every watt the grid will yield and warm up the inside of the mountain while we can draw power to do it with! I want the deepest part of the mine too hot to enter! We'll lose a lot of heat, of course. It's not like storing electric power! But we can store heat now, and the more we store the more will be left when we need it!"

Herndon thought heavily. Presently he stirred slightly.

"Do you know, that is an idea—" He looked up. "Back home there was a shale-oil deposit up near the icecaps. It wasn't economical to mine it. So they put heaters down in boreholes and heated up the whole shale deposit! Drill-holes let out the hot oil vapors to be condensed. They got out every bit of oil without disturbing the shale! And then . . . why . . . the shale stayed warm for years. Farmers bulldozed soil over it and raised crops with glaciers all around them! That could be done again. They could be storing up heat back home!"

Then he drooped.

"But they can't spare power to warm up the ground under cities.

They need all the power they've got to build roofs. And it takes time to build grids."

Massy snapped:

"Yes, if they're building regulation ones! By the time they were finished they'd be useless! The ionization here is dropping already. But they don't need to build grids that will be useless later! They can weave cables together on the ground and hang them in the air by helicopters! They wouldn't hold up a landing ship for an instant, but they'll draw power right away! They'll even power the helis that hold them up! Of course they've defects! They'll have to come down in high winds. They won't be dependable. But they can put heat in the ground to

come out under roofs, to grow food by, to save lives by. What's the matter with them?"

Herndon stirred again. His eyes ceased to be dull and lifeless.

"I'll give the orders for turning off the sidewalks. And I'll send what you just said back home. They... should like it."

He looked very respectfully at Massy.

"I guess you know what I'm thinking right now," he said awkwardly.

Massy flushed. It was not dignified for a Colonial Survey officer to show off. He felt that Herndon was unduly impressed. But Herndon didn't see that the device wouldn't solve anything. It would merely post-



pone the effects of a disaster. It could not possibly prevent them.

"It ought to be done," he said curtly. "There'll be other things to be done, too."

"When you tell them to me," said Herndon warmly, "they'll get done! I'll have Riki put this into that pulse-code you explained to us and she'll get it off right away!"

He stood up.

"I didn't explain the code to her!" insisted Massy. "She was already translating it when you gave her my suggestion!"

"All right," said Herndon. "I'll get this sent back at once!"

He hurried out of the office. *This, thought Massy irritably, is how reputations are made, I suppose. I'm getting one.* But his own reaction was extremely inappropriate. If the people of Lani II did suspend helicopter-supported grids of wire in the atmosphere, they could warm masses of underground rock and stone and earth. They could establish what were practically reservoirs of life-giving heat under their cities. They could contrive that the warmth from below would rise only as it was needed. But—

Two hundred days to conditions corresponding to the colony-planet. Then two thousand days of minimum-heat conditions. Then very, very slow return to normal temperature, long after the sun was back to its previous brilliance. They couldn't store enough heat for so long. It couldn't be done. It was

ironic that in the freezing of ice and the making of glaciers the planet itself could store cold.

And there would be monstrous storms and blizzards on Lani II as it cooled. As cold conditions got worse the wire grids could be held aloft for shorter and shorter periods, and each time they would pull down less power than before. Their effectiveness would diminish even faster than the need for effectiveness increased.

Massy felt even deeper depression as he worked out the facts. His proposal was essentially futile. It would be encouraging, and to a very slight degree and for a certain short time it would palliate the situation on the inner planet. But in the long run its effect would be zero.

He was embarrassed, too, that Herndon was so admiring. Herndon would tell Riki that he was marvelous. She might—though cagily—be inclined to agree. But he wasn't marvelous. This trick of a flier-supported grid was not new. It had been used on Saril to supply power for giant peristaltic pumps emptying a polder that had been formed inside a ring of indifferently upraised islands.

All I know, thought Massy bitterly, is what somebody's showed me or I've read in books. And nobody's showed or written how to handle a thing like this!

He went to Herndon's desk. Herndon had made a new graph on the solar-constant observations forwarded from home. It was a strictly typi-

cal curve of the results of coinciding cyclic changes. It was the curve of a series of frequencies at the moment when they were all precisely in phase. From this much one could extrapolate and compute—

Massy took a pencil, frowning unhappily. His fingers clumsily formed equations and solved them. The result was just about as bad as it could be. The change in brightness of the sun Lani would not be enough to be observed on Kent IV—the nearest other inhabited world—when the light reached there four years from now. Lani would never be classed as a variable star, because the total change in light and heat would be relatively minute. But the formula for computing planetary temperatures is not simple. Among its factors are squares and cubes of the variables. Worse, the heat radiated from a sun's photosphere varies not as the square or cube, but as the fourth power of its absolute temperature. A very small change in the sun's effective temperature, producible by sunspots, could make an altogether disproportionate difference in the warmth its worlds received.

Massy's computations were not pure theory. The data came from Sol itself, where alone in the galaxy there had been daily solar-constant measurements for three hundred years. The rest of his deductions were based ultimately on Earth observations, too. Most scientific data had to refer back to Earth to get an adequate continuity. But there was

no possible doubt about the sunspot data, because Sol and Lani were of the same type and nearly equal size.

Using the figures on the present situation, Massy reluctantly arrived at the fact that here, on this already-frozen world, the temperature would drop until CO₂ froze out of the atmosphere. When that happened, the temperature would plummet until there was no really significant difference between it and that of empty space. It is carbon dioxide which is responsible for the greenhouse effect, by which a planet is in thermal equilibrium only at a temperature above its surroundings—as a greenhouse in sunlight is warmer than the outside air.

The greenhouse effect would vanish soon on the colony world. When it vanished on the mother planet—

Massy found himself thinking, *If Riki won't leave when the Survey ship comes, I'll resign from the Service. I'll have to if I'm to stay. And I won't go unless she does.*

III

"If you want to come, it's all right," said Massy ungraciously.

He waited while Riki slipped into the bulky cold-garments that were needed out-of-doors in the daytime, and were doubly necessary at night. There were heavy boots with inches-thick insulating soles, made in one piece with the many-layered trousers. There was the air-puffed, insulated over-tunic with its hood and mittens

which were a part of the sleeves.

"Nobody goes outside at night," she said when they stood together in the cold-lock.

"I do," he told her. "I want to find out something."

The outer door opened and he stepped out. He held his arm for her, because the steps and walkway were no longer heated. Now they were covered with a filmy layer of something which was not frost, but a faint, faint bloom of powder. It was the equivalent of dust, but it was microscopic snow-crystals frozen out of the air by the unbearable chill of night.

There was no moon, of course, yet the ice-clad mountains glowed faintly. The drone-hulls arranged in such an orderly fashion were dark against the frosted ground. There was silence: stillness: the feeling of ancient quietude. No wind stirred anywhere. Nothing moved. Nothing lived. The soundlessness was enough to crack the eardrums.

Massy threw back his head and gazed at the sky for a very long time. Nothing. He looked down at Riki.

"Look at the sky," he commanded.

She raised her eyes. She had been watching him. But as she gazed upward she almost cried out. The sky was filled with stars in innumerable variety. But the brighter ones were as stars had never been seen before. Just as the sun in daylight had been accompanied by its sun-dogs—pale phantoms of itself ranged about it—so the brighter distant suns now

shone from the center of rings of their own images. They no longer had the look of random placing. Those which were most distinct were patterns in themselves, and one's eyes strove instinctively to grasp the greater pattern in which such seeming artifacts must belong.

"Oh . . . beautiful!" cried Riki softly, yet almost afraid.

"Look!" he insisted. "Keep looking!"

She continued to gaze, moving her eyes about hopefully. It was such a sight as no one could have imagined. Every tint and every color; every possible degree of brightness appeared. And there were groups of stars of the same brilliance which almost made triangles, but not quite. There were rose-tinted stars which almost formed an arc, but did not. And there were arrays which were almost lines and nearly formed squares and polygons, but never actually achieved them.

"It's . . . beautiful!" said Riki breathlessly. "But what must I look for?"

"Look for what isn't there," he ordered.

She looked, and the stars were unwinking, but that was not extraordinary. They filled all the firmament, without the least space in which some tiny sparkle of light was not to be found. But that was not remarkable, either. Then there was a vague flickering grayish glow somewhere indefinite. It vanished. Then she realized.

"There's no aurora!" she exclaimed.

"That's it," said Massy. "There've always been auroras here. But no longer. We may be responsible. I wish I thought it wise to turn everything back to reserve power for a while. We could find out. But we can't afford it. There was just the faintest possible gray flickering just now. But there ought to be armies of light marching across the sky. The aurora here—it was never missing! But it's gone now."

"I . . . looked at it when we first landed," admitted Riki. "It was unbelievable! But it was terribly cold, out of shelter. And it happened every night, so I said to myself I'd look tomorrow, and then tomorrow again. So it got so I never looked at all."

Massy kept his eyes where the faint gray flickering had been. And once one realized, it was astonishing that the former nightly play of ghostly colors should be absent.

"The aurora," he said dourly, "happens in the very upper limits of the air . . . fifty . . . seventy . . . ninety miles up, when God-knows-what emitted particles from the sun come streaking in, drawn by the planet's magnetic field. The aurora's a phenomenon of ions. We tap the ionosphere a long way down from where it plays, but I'm wondering if we stopped it."

"We?" said Riki, shocked. "We—humans?"

"We tap the ions of their charges," he said somberly, "that the

sunlight made by day. We're pulling in all the power we can. I wonder if we've drained the aurora of its energy, too."

Riki was silent. Massy gazed, still searching. But he shook his head.

"It could be," he said in a carefully detached voice. "We didn't draw much power by comparison with the amount that came. But the ionization is an ultraviolet effect. Atmospheric gases don't ionize too easily. After all, if the solar constant dropped a very little, it might mean a terrific drop in the ultraviolet part of the spectrum—and that's what makes ions of oxygen and nitrogen and hydrogen and such. The ion-drop could easily be fifty times as great as the drop in the solar constant. And we're drawing power from the little that's left."

Riki stood very still. The cold was horrible. Had there been a wind, it could not have been endured for an instant. But the air was motionless. Yet its coldness was so great that the inside of one's nostrils ached, and the inside of one's chest was aware of chill. Even through the cold-garments there was the feeling as of ice without.

"I'm beginning," said Massy, "to suspect that I'm a fool. Or maybe I'm an optimist. It might be the same thing. I could have guessed that the power we could draw would drop faster than our need for power increased. If we've drained the aurora of its light, we're scraping the bottom of the barrel. And it's a

shallower barrel than one would suspect."

There was stillness again. Riki stood mousy-quiet. *When she realizes what this means*, thought Massy grimly, *she won't admire me so much. Her brother's built me up. But I've been a fool, figuring out excuses to hope. She'll see it.*

"I think," said Riki quietly, "that you're telling me that after all we can't store up heat to live on, down in the mine."

"We can't," agreed Massy grimly. "Not much, nor long. Not enough to matter."

"So we won't live as long as Ken expects?"

"Not nearly as long," said Massy evenly. "He's hoping we can find out things to be useful back on Lani II. But we'll lose the power we can get from our grid long before even their new grids are useless. We'll have to start using our reserve power a lot sooner. It'll be gone—and us with it—before they're really in straits for living-heat."

Riki's teeth began to chatter.

"This sounds like I'm scared," she said angrily, "but I'm not! I'm just freezing! If you want to know, I'd a lot rather have it the way you say! I won't have to grieve over anybody, and they'll be too busy to grieve for me! Let's go inside while it's still warm!"

He helped her back into the cold-lock, and the outer door closed. She was shivering uncontrollably when the warmth came pouring in.

They went into Herndon's office. He came in as Riki was peeling off the top part of her cold-garments. She still shivered. He glanced at her and said to Massy:

"There's been a call from the grid-control shack. It looks like there's something wrong, but they can't find anything. The grid is set for maximum power-collection, but it's bringing in only fifty thousand kilowatts!"

"We're on our way back to savagery," said Massy, with an attempt at irony.

It was true. A man can produce two hundred and fifty watts from his muscles for a reasonable length of time. When he has no more power, he is a savage. When he gains a kilowatt of energy from the muscles of a horse, he is a barbarian—but the new power cannot be directed wholly as he wills. When he can apply it to a plow he has high barbarian culture, and when he adds still more he begins to be civilized. Steam power put as much as four kilowatts to work for every human being in the first industrialized countries, and in the mid-twentieth century there was sixty kilowatts per person in the more advanced nations. Nowadays, of course, a modern culture assumed five hundred as a minimum. But there was less than half that in the colony on Lani II. And its environment made its own demands.

"There can't be any more," said Riki, trying to control her shivering. "We're even using the aurora

and there isn't any more power. It's running out. We'll go even before the people at home, Ken."

Herndon's features looked very pinched.

"But we can't! We mustn't!" He turned to Massy. "We do them good, back home! There was panic. Our report about cable grids has put heart in people. They're setting to work—magnificently! So we're some use! They know we're worse off than they are, and as long as we hold on they'll be encouraged! We've got to keep going somehow!"

Riki breathed deeply until her shivering stopped. Then she said calmly:

"Haven't you noticed, Ken, that Mr. Massy has the viewpoint of his profession? His business is finding things wrong with things. He was deposited in our midst to detect defects in what we did and do. He has the habit of looking for the worst. But I think he can turn the habit to good use. He did turn up the idea of cable-grids."

"Which," said Massy, "turns out to be no good at all. They'd be some good if they weren't needed, really. But the conditions that make them necessary make them useless!"

Riki shook her head.

"They are useful!" she said firmly. "They're keeping people at home from despairing. Now, though, you've got to think of something else. If you think of enough things, one will do good the way you want—more than making people feel better."

"What does it matter how people feel?" he demanded bitterly. "What difference do feelings make? Facts are facts! One can't change facts!"

Riki said with no less firmness:

"We humans are the only-creatures in the universe who don't do anything else! Every other creature accepts facts. It lives where it is born, and it feeds on the food that is there for it, and it dies when the facts of nature require it to. We humans don't. Especially we women! We won't let men do it, either! When we don't like facts—mostly about ourselves—we change them. But important facts we disapprove of—we ask men to change for us. And they do!"

She faced Massy. Rather incredibly, she grinned at him.

"Will you please change the facts that look so annoying just now, please? Please?" Then she elaborately pantomimed an over-feminine girl's look of wide-eyed admiration. "You're so big and strong! I just know you can do it—for me!"

She abruptly dropped the pretense and moved toward the door. She half-turned then, and said detach- edly:

"But about half of that is true."

The door slid shut behind her. Massy thought bitterly, *Her brother admires me. She probably thinks I really can do something!* It suddenly occurred to him that she knew a Colonial Survey ship was due to stop by here to pick him up. She be-



lieved he expected to be rescued, even though the rest of the colony could not be, and most of it wouldn't consent to leave their kindred when the death of mankind in this solar system took place. He said awkwardly:

"Fifty thousand kilowatts isn't enough to land a ship."

Herndon frowned. Then he said:

"Oh. You mean the Survey ship that's to pick you up can't land? But it can go in orbit and put down a rocket landing-boat for you."

Massy flushed.

"I wasn't thinking of that. I'd something more in mind. I... rather like your sister. She's... pretty wonderful. And there are some other women here in the colony, too. About a dozen all told. As a matter of self-respect I think we ought to get them away on the Survey ship. I agree that they wouldn't consent to go. But if they had no choice—if we could get them on board the grounded ship, and they suddenly found themselves... well... kidnaped and outward-bound not by their own fault... They could be faced with the accomplished fact that they had to go on living."

Herndon said evenly:

"That's been in the back of my mind for some time. Yes. I'm for that. But if the Survey ship can't land—"

"I believe I can land it regardless," said Massy doggedly. "I can find out, anyhow. I'll need to try things. I'll need help... work done."

But I want your promise that if I can get the ship to ground you'll conspire with her skipper and arrange for them to go on living."

Herndon looked at him.

"Some new stuff—in a way," said Massy uncomfortably. "I'll have to stay aground to work it. It's also part of the bargain that I shall. And, of course, your sister can't know about it, or she can't be fooled into living."

Herndon's expression changed a little.

"What'll you do? Of course it's a bargain."

"I'll need some metals we haven't smelted so far," said Massy. "Potassium if I can get it, sodium if I can't, and at worst I'll settle for zinc. Cesium would be best, but we've found no traces of it."

Herndon said thoughtfully:

"No-o-o. I think I can get you sodium and potassium, from rocks. I'm afraid no zinc. How much?"

"Grams," said Massy. "Trivial quantities. And I'll need a miniature landing-grid built. Very miniature."

Herndon shrugged his shoulders.

"It's over my head. But just to have work to do will be good for everybody. We've been feeling more frustrated than any other humans in history. I'll go round up the men who'll do the work. You talk to them."

The door closed behind him. Massy very deliberately got out of his cold-clothing. He thought, *She'll rave when she finds her*

brother and I have deceived her. Then he thought of the other women. *If any of them are married, we'll have to see if there's room for their husbands. I'll have to dress up the idea. Make it look like reason for hope, or the women would find out. But not many can go—*

He knew very closely how many extra passengers could be carried on a Survey ship, even in such an emergency as this. Living quarters were not luxurious, at best. Everything was cramped and skimped. Survey ships were rugged, tiny vessels which performed their duties amid tedium and discomfort and peril for all on board. But they could carry away a very few unwilling refugees to Kent IV.

He settled down at Herndon's desk to work out the thing to be done.

It was not unreasonable. Tapping the ionosphere for power was something like pumping water out of a pipe-well in sand. If the water-table was high, there was pressure to force the water to the pipe, and one could pump fast. If the water-table were low, water couldn't flow fast enough. The pump would suck dry. In the ionosphere, the level of ionization was at once like the pressure and the size of the sand-grains. When the level was high, the flow was vast because the sand-grains were large and the conductivity high. But as the level lessened, so did the size of the sand-grains. There was less to draw, and more resistance to its flow.

But there had been one tiny flicker of auroral light over by the horizon. There was still power aloft. If Massy could in a fashion prime the pump: if he could increase the conductivity by increasing the ions present around the place where their charges were drawn away—why—he could increase the total flow. It would be like digging a brick-well where a pipe-well had been. A brick-well draws water from all around its circumference.

So Massy computed carefully. It was ironic that he had to go to such trouble simply because he didn't have test-rockets like the Survey uses to get a picture of a planet's weather-pattern. They rise vertically for fifty miles or so, trailing a thread of sodium-vapor behind them. The trail is detectable for some time, and ground-instruments record each displacement by winds blowing in different directions at different speeds, one over the other. Such a rocket with its loading slightly changed would do all Massy had in mind. But he didn't have one, so something much more elaborate was called for.

She'll think I'm clever, he reflected wryly, but all I'm doing is what I've been taught. I wouldn't have to work it out if I had a rocket.

Still, there was some satisfaction in working out this job. A landing-grid has to be not less than half a mile across and two thousand feet high because its field has to reach out five planetary diameters to handle ships that land and take off.

To handle solid objects it has to be accurate—though power can be drawn with an improvisation. To thrust a sodium-vapor bomb anywhere from twenty to fifty miles high—why—he'd need a grid only six feet wide and five high. It could throw much higher, of course. It could hold, at that. But doubling the size would make accuracy easier.

He tripled the dimensions. There would be a grid eighteen feet across and fifteen high. Tuned to the casing of a small bomb, it could hold it steady at seven hundred and fifty thousand feet—far beyond necessity. He began to make the detail drawings.

Herndon came back with half a dozen chosen colonists. They were young men, technicians rather than scientists. Some of them were several years younger than Massy. There were grim and stunned expressions on some faces, but one tried to pretend nonchalance, and two seemed trying to suppress fury at the monstrous occurrence that would destroy not only their own lives, but everything they remembered on the planet which was their home. They looked almost challengingly at Massy.

He explained. He was going to put a cloud of metallic vapor up in the ionosphere. Sodium if he had to, potassium if he could, zinc if he must. Those metals were readily ionized by sunlight—much more readily than atmospheric gases. In effect, he was going to supply a

certain area of the ionosphere with material to increase the efficiency of sunshine in providing electric power. As a sideline, there would be increased conductivity from the normal ionosphere.

"Something like this was done centuries ago, back on Earth," he explained carefully. "They used rockets, and made sodium-vapor clouds as much as twenty and thirty miles long. Even nowadays the Survey uses test-rockets with trails of sodium-vapor. It will work to some degree. We'll find out how much."

He felt Herndon's eyes upon him. They were almost dazedly respectful. But one of the technicians said coldly:

"How long will those clouds last?"

"That high, three or four days," Massy told him. "They won't help much at night, but they should step up power-intake while the sun shines on them."

A man in the back said crisply: "Hup!" The significance was, "Let's go!" Then somebody said feverishly, "What do we do? Got working drawings? Who makes the bombs? Who does what? Let's get at this!"

Then there was confusion, and Herndon had vanished. Massy suspected he'd gone to have Riki put this theory into dot-and-dash code for beam-transmission back to Lani II. But there was no time to stop him. These men wanted precise information, and it was half an hour before the last of them had gone

out with free-hand sketches, and had come back for further explanation of a doubtful point, and other men had come in hungrily to demand a share in the job.

When he was alone again, Massy thought, *Maybe it's worth doing because it'll get Riki on the Survey ship. But they think it means saving the people back home!*

Which it didn't. Taking energy out of sunlight is taking energy out of sunlight, no matter how you do it. Take it out as electric power, and there's less heat left. Warm one place with electric power, and everywhere else is a little colder. There's an equation. On this colony-world it wouldn't matter, but on the home world it would. The more there was trickery to gather heat, the more heat was needed. Again it might postpone the death of twenty million people, but it would never, never, never prevent it.

The door slid aside and Riki came in. She stammered a little.

"I . . . just coded what Ken told me to send back home. It will . . . it will do everything! It's wonderful! I . . . wanted to tell you!"

Massy writhed internally. It wasn't wonderful.

"Consider," he said in a desperate attempt to take it lightly, "consider that I've taken a bow."

He tried to smile. It was not a success. And Riki suddenly drew a deep breath and looked at him in a new fashion.

"Ken's right," she said softly.

"He says you can't get conceited. You're not satisfied with yourself even now, are you?" She smiled, rather gravely. Then she said, "But what I like is that you aren't really smart. A woman can make you do things. I have!"

He looked at her uneasily. She grinned.

"I, even I, can at least pretend to myself that I help bring this about! If I hadn't said please change the facts that are so annoying, and if I hadn't said you were big and strong and clever—I'm going to tell myself for the rest of my life that I helped make you do it!"

Massy swallowed.

"I'm afraid," he said miserably, "that it won't work again."

She cocked her head on one side.

"No?"

He stared at her apprehensively. And then with a bewildering change of emotional reaction, he saw that her eyes were filled with tears. She stamped her foot.

"You're . . . horrible!" she cried. "Here I come in, and . . . and if you think you can get me kidnaped to safety . . . without even telling me that you 'rather like' me, like you told my brother, or that 'I'm pretty wonderful'— If you think."

He was stunned, that she knew. She stamped her foot again.

"For Heaven's sake!" she wailed. "Do I have to *ask* you to kiss me?"

IV

During the last night of prepara-

tion, Massy sat by a thermometer registering the outside temperature. He hovered over it as one might over a sick child. He watched it and sweated, though the inside temperature of the drone-hull was lowered to save power. There was nothing he could actually do. At midnight the thermometer said it was seventy degrees below zero Fahrenheit. At halfway to dawn it was eighty degrees below zero Fahrenheit. The hour before dawn it was eighty-five degrees below zero. Then he sweated profusely. The meaning of the slowed descent was that carbon dioxide was being frozen out of the upper layers of the atmosphere. The frozen particles were drifting slowly downward, and as they reached lower and faintly warmer levels they returned to the state of gas. But there was a level, above the CO₂, where the temperature was plummeting.

The height to which carbon-dioxide existed was dropping—slowly, but inexorably. And above the carbon-dioxide level there was no bottom limit to the temperature. The greenhouse effect was due to CO₂. Where it wasn't, the cold of space moved down. If at ground-level the thermometer read ever so slightly lower than one hundred and nine below zero—why—everything was finished. Without the greenhouse effect, the night-side of the planet would lose its remaining heat with a rush. Even the day-side, once cold enough, would lose heat to emptiness as fast as it came from the

sun. Minus one hundred and nine point three was the critical reading. If it went down to that, it would plunge to a hundred and fifty—two hundred degrees below zero! And it would never come up again.

There would be rain at nightfall—a rain of oxygen frozen to a liquid and splashing on the ground. Human life would be quite simply impossible, in any shelter and under any conditions. Even spacesuits would not protect against an atmosphere sucking heat from it at that rate. A spacesuit can be heated against the loss of temperature due to radiation in a vacuum. It could not be heated against nitrogen which would chill it irresistibly by contact.

But, as Massy sweated over it, the thermometer steadied at minus eighty-five degrees. When the dawn came, it rose to seventy. By mid-morning, the temperature in bright sunshine was no lower than sixty-five degrees below zero.

But there was no bounce left in Massy when Herndon came for him.

"Your phone-plate's been flashing," said Herndon, "and you didn't answer. Must have had your back to it. Riki's over in the mine, watching them get things ready. She was worried that she couldn't call you. Asked me to find out what was the trouble."

Massy said heavily:

"Has she got something to heat the air she breathes?"

"Naturally," said Herndon. He

added curiously, "What's the matter?"

"We almost took our licking," Massy told him. "I'm afraid for tonight, and tomorrow night, too. If the CO₂ freezes—"

"We'll have power!" Herndon insisted. "We'll build ice tunnels and ice domes. We'll build a city under ice, if we have to. But we'll have power. We'll be all right!"

"I doubt it very much," said Massy. "I wish you hadn't told Riki of the bargain to get her away from here when the Survey ship comes!"

Herndon grinned.

"Is the little grid ready?" asked Massy.

"Everything's set," said Herndon exuberantly. "It's in the mine-tunnel with radiant heaters playing on it. The bombs are ready. We made enough to last for months, while we were at it. No use taking chances!"

Massy looked at him queerly. Then he said:

"We might as well go out and try the thing, then."

But he was very tired. He was not elated. *Riki can't be gotten away*, he thought wearily, *and I'm not going to go because it isn't quite fitting to go and leave her. They'll all be rejoicing presently, but nothing's settled.* Then he thought with exquisite irony, *She thinks I was inspired to genius by her, when I haven't done a thing I wasn't taught or didn't get out of books!*

He put on the cold-garments as

they were now modified for the increased frigidity. Nobody could breathe air at minus sixty-five degrees without getting his lungs frost-bitten. So there was now a plastic mask to cover one's face, and the air one breathed outdoors was heated as it came through a wire-gauze snout. But still it was not wise to stay out of shelter for too long a time.

Massy went out-of-doors. He stepped out of the cold-lock and gazed about him. The sun seemed markedly paler, and now it had lost its sundogs again. Ice crystals no longer floated in the almost congealed air. The sky was dark. It was almost purple, and it seemed to Massy that he could detect faint flecks of light in it. They would be stars, shining in the daytime.

There seemed to be no one about at all, only the white coldness of the mountains. But there was a movement at the mine-drift, and something came out of it. Four men appeared, muffled up like Massy himself. They rolled the eighteen-foot grid out of the mine-mouth, moving it on those inflated bags which are so much better than rollers for rough terrain. They looked absurdly like bears with steaming noses, in their masks and clothing. They had some sort of powered pusher with them, and they got the metal cage to the very top of a singularly rounded stone up-crop which rose in the center of the valley.

"We picked that spot," said

Herndon's muffled voice through the chill, "because by shifting the grid's position it can be aimed, and be on a solid base. Right?"

"Quite all right," said Massy. "We'll go work it."

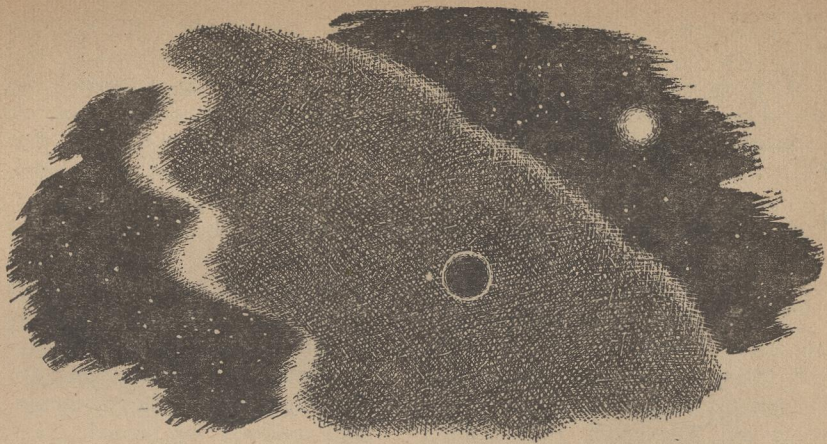
He moved heavily across the valley, in which nothing moved except the padded figures of the four technicians. Their wire-gauze breathing-masks seemed to emit smoke. They waved to him in greeting.

I'm popular again, he thought drearily, but it doesn't matter. Getting the Survey ship to ground won't help now, since Riki's forewarned. And this trick won't solve anything permanently on the home planet. I'll just postpone things.

He had a very peculiar ache inside. A Survey officer is naturally lonely. Massy had been lonely before he even entered the Service. He hadn't had a feeling of belonging anywhere, or with anyone, and no planet was really his home. Now he could believe that he belonged with someone. But there was the slight matter of a drop in the solar constant of an unimportant sol-type sun, and nothing could come of it.

Even when Riki—muffled like the rest—waved to him from the mouth of the tunnel, his spirits did not lift. The thing he wanted was to look forward to years and years of being with Riki. He wanted, in fact, to look forward to forever. And there might not be a tomorrow.

"I had the control board rolled out here," she called breathlessly



through her mask. "It's cold, but you can watch!"

It wouldn't be much to watch. If everything went all right, some dial-needles would kick over violently, and their readings would go up and up. But they wouldn't be readings of temperature. Presently the big grid would report increased power from the sky. But tonight the temperature would drop a little farther. Tomorrow night it would drop farther still. When it reached one hundred and nine point three degrees below zero at ground-level—why it would keep on falling indefinitely. Then it wouldn't matter how much power could be drawn from the sky. The colony would die.

One of the figures that looked like a bear now went out of the mine-mouth, trudging toward the grid. It carried a muffled, well-

wrapped object in its arms. It stooped and crept between the spokes of the grid. It put the object on the stone. Massy traced cables with his eyes. From the grid to the control board. From the board back to the reserve-power storage cells, deep in the mountain.

"The grid's tuned to the bomb," said Riki breathlessly, close beside him. "I checked that myself!"

The bearlike figure out in the valley jerked at the bomb. There was a small rising cloud of grayish vapor. It continued. The figure climbed hastily out of the grid. When the man was clear, Massy threw a switch.

There was a very tiny whining sound, and the wrapped, ridiculously smoking object leaped upward. It seemed to fall toward the sky. There was no more of drama than that. An object the size of a basket-

ball fell upward, swiftly, until it disappeared. That was all.

Massy sat quite still, watching the control-board dials. Presently he corrected this, and shifted that. He did not want the bomb to have too high an upward velocity. At a hundred thousand feet it would find very little air to stop the rise of the vapor it was to release.

The field-focus dial reached its indication of one hundred thousand feet. Massy reversed the lift-switch. He counted and then switched the power off. The small, thin whine ended.

He threw the power-intake switch, which could have been on all the time. The power-yield needle stirred. The minute grid was drawing power like its vaster counterpart. But its field was infinitesimal by comparison. It drew power as a soda straw might draw water from wet sand.

Then the intake-needle kicked. It swung sharply, and wavered, and then began a steady, even, climbing movement across the markings on the dial-face. Riki was not watching that.

"They see something!" she panted. "Look at them!"

The four men who had trundled the smaller grid to its place, now stared upward. They flung out their arms. One of them jumped up and down. They leaped. They practically danced.

"Let's go see," said Massy.

He went out of the tunnel with Riki. They gazed upward. And di-

rectly overhead, where the sky was darkest blue and where it had seemed that stars shone through the daylight—there was a cloud. It seemed to Massy, very quaintly, that it was no bigger than a man's hand. But it grew. Its edges were yellow—saffron-yellow. It expanded and spread. Presently it began to thin. As it thinned, it began to shine. It was luminous. And the luminosity had a strange, familiar quality.

Somebody came panting down the tunnel, from inside the mountain.

"The grid—" he panted. "The big grid! It's . . . pumping power! Big power! BIG power!"

He went pounding back, to gaze raptuously at the new position of a thin black needle on a large white dial, and to make incoherent noises of rejoicing as it moved very, very slowly toward higher and ever higher readings.

But Massy looked puzzledly at the sky, as if he did not quite believe his eyes. The cloud now expanded very slowly, but still it grew. And it was not regular in shape. The bomb had not shattered quite evenly, and the vapor had poured out more on one side than the other. There was a narrow, arching arm of brightness—

"It looks," said Riki breathlessly, "like a comet!"

And then Massy froze in every muscle. He stared at the cloud he had made aloft, and his hands clenched in their mittens, and he swallowed convulsively behind his cold-mask.

"Th-that's it," he said in a very queer voice indeed. "It's . . . very much like a comet. I'm glad you said that! We can make something even more like a comet. We . . . we can use all the bombs we've made, right away, to make it. And we've got to hurry so it won't get any colder tonight!"

Which, of course, sounded like insanity. Riki looked apprehensively at him. But Massy had just thought of something. And nobody had taught it to him and he hadn't gotten it out of books. But he'd seen a comet.

The new idea was so promising that he regarded it with anguished unease for fear it would not hold up. It was an idea that really ought to change the facts resulting naturally from a lowered solar constant in a sol-type star.

Half the colony set to work to make more bombs when the effect of the second bomb showed up. They were not very efficient, at first, because they tended to want to stop work and dance, from time to time. But they worked with an impassioned enthusiasm. They made more bomb-casings, and they prepared more sodium and potassium metal and more fuses, and more insulation to wrap around the bombs to protect them from the cold of airless space.

Because these were to go out to airlessness. The miniature grid could lift and hold a bomb steady in its field-focus at seven hundred

and fifty thousand feet. But if a bomb was accelerated all the way out to that point, and the field was then snapped off— Why, it wasn't held anywhere. It kept on going with its attained velocity. And it burst when its fuse decided that it should, whereupon immediately a mass of sodium and potassium vapor, mixed with the fumes of high explosive, flung itself madly in all directions, out between the stars. Absolute vacuum tore the compressed gasified metals apart. The separate atoms, white-hot from the explosion, went swirling through sunlit space. The sunlight was dimmed a trifle, to be sure. But individual atoms of the lighter alkaline-earth metals have marked photoelectric properties. In sunshine these gas-molecules ionized, and therefore spread more widely, and did not coalesce into even microscopic droplets.

They formed, in fact, a cloud in space. An ionized cloud, in which no particle was too large to be responsive to the pressure of light. The cloud acted like the gases of a comet's tail. It was a comet's tail, though there was no comet. And it was an extraordinary comet's tail because it is said that you can put a comet's tail in your hat, at normal atmospheric pressure. But this could not have been put in a hat. Even before it turned to gas, it was the size of a basketball. And, in space, it glowed.

It glowed with the brightness of the sunshine on it, which was light

that would normally have gone away through the interstellar dark. And it filled one corner of the sky. Within one hour it was a comet's tail ten thousand miles long, which visibly brightened the daytime heavens. And it was only the first of such reflecting clouds.

The next bomb set for space exploded in a different quarter, because Massy'd had the miniature grid wrestled around the upcrop to point in a new and somewhat more carefully chosen line. The third bomb spattered brilliance in a different section still. And the brilliance lasted.

Massy flung his first bombs recklessly, because there could be more. But he was desperately anxious to hang as many comet tails as possible around the colony-planet before nightfall. He didn't want it to get any colder.

And it didn't. In fact, there wasn't exactly any real nightfall on Lani III that night.

The planet turned on its axis, to be sure. But around it, quite close by, there hung gigantic streamers of shining gas. At their beginning, those streamers bore a certain resemblance to the furry wild-animal tails that little boys like to have hanging down from hunting-caps. Only they shone. And as they developed they merged, so that there was an enormous shining curtain about Lani III. There were draperies of metal-mist to capture sunlight that should have been wasted, and to diffuse very much of it

to Lani II. At midnight there was only one spot in all the night-sky where there was really darkness. That was directly overhead—directly outward from the planet from the sun. Gigantic shining streamers formed a wall, a tube, of comet-tail material, yet many times more dense and therefore brighter—which shielded the colony world against the dark and cold, and threw upon it a brilliant, warming brightness.

Riki maintained stoutly that she could feel the warmth from the sky, but that was improbable. But certainly heat did come from somewhere. The thermometer did not fall at all, that night. It rose. It was up to fifty below zero at dawn. During the day—they sent out twenty more bombs that second day—it was up to twenty degrees below zero. By the day after, there was highly competent computation from the home planet, and the concrete results of abstruse speculation, and the third day's bombs were placed with optimum spacing for heating purposes.

And by dawn of the fourth day the air was a balmy five degrees below zero, and the day after that there was a small running stream in the valley at midday.

There was talk of stocking the stream with fish, on the morning the Survey ship came in. The great landing-grid gave out a deep-toned, vibrant, humming note, like the deepest possible note of the biggest organ that could be imagined. A

speck appeared very, very high up in a pale-blue sky with trimmings of golden gas-clouds. The Survey ship came down and down and settled as a shining silver object in the very center of the gigantic red-painted landing-grid.

Later, her skipper came to find Massy. He was in Herndon's office. The skipper struggled to keep sheer blankness out of his expression.

"What . . . what the hell?" he demanded querulously of Massy. "This is the damnest sight in the whole galaxy, and they tell me you're responsible! There've been ringed planets before, and there've been comets and who-knows what! But shining gas pipes aimed at the sun, half a million miles across . . . What the? There are two of them! Both the occupied planets!"

Herndon explained with a bland succinctness why the curtains hung in space. There was a drop in the solar constant—

The skipper exploded. He wanted facts! Details! Something to report! And dammit, he wanted to know!

Massy was automatically on the defensive when the skipper shot his questions to him. A Senior Colonial Survey officer is not revered by the Survey ship-service officers. Men like Massy can be a nuisance to a hard-working ship's officer. They have to be carried to unlikely places for their work of checking over colonial installations. They have to be put down on hard-to-get-at colonies, and they have to be called for, sometimes, at times and places which are incon-

venient. So a man in Massy's position is likely to feel unpopular.

"I'd just finished the survey here," he said defensively, "when a cycle of sunspot cycles matured. All the sunspot periods got in phase, and the solar constant dropped. So I naturally offered what help I could to meet the situation."

The skipper regarded him incredulously.

"But . . . it couldn't be done!" he said blankly. "They told me how you did it, but . . . it couldn't be done! Do you realize that these vapor-curtains will make fifty borderline worlds fit for use? Half a pound of sodium vapor a week!" He gestured helplessly. "They tell me the amount of heat reaching the surface here has been upped by fifteen per cent! D'you realize what *that* means?"

"I haven't been worrying about it," admitted Massy. "There was a local situation and something had to be done. I . . . er . . . remembered things, and Riki suggested something I mightn't have thought of, and it's worked out like this." Then he said abruptly: "I'm not leaving. I'll get you to take my resignation back. I . . . I think I'm going to settle here. It'll be a long time before we get really temperate-climate conditions here, but we can warm up a valley like this for cultivation, and . . . well . . . it's going to be a rather satisfying job. It's a brand-new planet with a brand-new ecological system to be established—"

The skipper of the Survey ship sat down hard. Then the sliding door of Herndon's office opened and Riki came in. The skipper stood up again. Massy rather awkwardly made the introduction. Riki smiled.

"I'm telling him," said Massy, "that I'm resigning from the Service to settle down here."

Riki nodded. She put her hand in proprietary fashion on Massy's arm. The Survey skipper cleared his throat.

"I'm not going to take it," he said doggedly. "There've got to be detailed reports on how this business works. Dammit, if vapor-clouds in space can be used to keep a planet warm, they can be used to shade a planet, too! If you resign, somebody else will have to come out here to make observations and work out the details of the trick! Nobody could be gotten here in less than a year! You need to stay here to build up a report—and you ought to be available for consultation when this thing's to

be done somewhere else! I'll report that I insisted as a Survey emergency—"

Riki said confidently:

"Oh, that's all right! He'll do that! Of course! Won't you?"

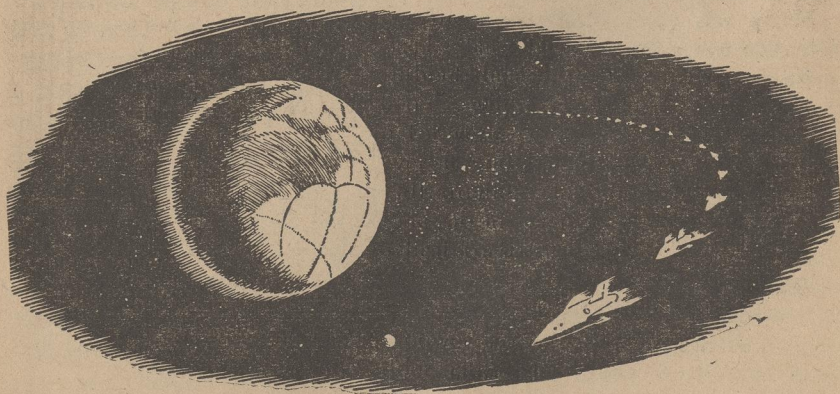
Massy nodded dumbly. He thought, *I've been lonely all my life. I've never belonged anywhere. But nobody could possibly belong anywhere as thoroughly as I'll belong here when it's warm and green and even the grass on the ground is partly my doing. But Riki'll like for me still to be in the Service. Women like to see their husbands wearing uniforms.*

Aloud he said:

"Of course. It . . . really needs to be done. Of course, you realize that there's nothing really remarkable about it. Everything I've done has been what I was taught, or read in books."

"Hush!" said Riki. "You're wonderful!"

THE END



WILD MODESTY

There's more than one way that a vicious danger can be unseeable. What if it genuinely isn't there when you can see it?

BY ALLEN LANG

Illustrated by Emsch



Ernie Meyers struggled out of his fatigues and dropped them on the floor by the corner of my desk. "Morning, Doc," he said. "It's started raining again."

"That should make the violets grow," I said.

"All it will do out there is make the mud muddier and the slugs happier. I need some sun." Ernie shrugged off his tee-shirt, snapped a pair of goggles over his eyes, and sprawled out on the sun table. "I sent Hewett into the muck a couple hours ago to check Mapmaker Three," he said.

I set the lamp's alarm for ten minutes and switched it on. Meyers, one of these untannable redheads, took on new colors in the mixed yellow and violet light of the lamp. His back looked like a contour map in green and blue, speckled with freckles like purple bench marks. "What's the matter with the Mapmaker?" I asked.

"It stopped transmitting. We don't know where it is or what it's doing. How will we ever get this black planet mapped, depending on four robot tanks to do the job?"

"They can do more with their radar and infrared than an engineer could with a flashlight," I said.

Scottie came in with a pad of message forms. He glanced at Ernie Meyers, jaybird naked under the lamp, and decided that our C.O. had taken off his authority with his eagles. "Got a message from Hewett, Doc," he said, holding the pad out to me.

Ernie rolled onto his back to warm his belly in the artificial sunlight. "Read it to me, Scottie," he said. "I can't see beans through these Hollywood goggles."

"O.K., Ernie. Here's what Hewett said: 'Found the Mapmaker, got it stopped in the middle of a marble orchard.'"

"What?" Ernie asked.

"Marble orchard . . . he must mean a bunch of those stone Cylinders. Here's the rest, sir," he said. I could tell Scottie was irritated at Ernie's interruption. He had to be, to call anyone "sir." "I'm four-point-six-six miles due west of Base, backing home at ten miles an hour. Keep supper hot. This machine has been hurt pretty bad. Something has clipped off the transmitting antenna, smashed the radar cone, and stove in the whole infrared camera and flash unit. I'm shutting off my lights to save the batteries. My, it's dark out here!" Scottie folded up his pad and stuck it into his back pocket. "He should be here in about ten minutes."

"We'll go out to the garage to meet him," Ernie said. "I'd like to see what that damage looks like. It sounds as though something had tried to blind Mapmaker Three. Radar gone, infrared smashed, and the radio-mast busted. Bad." The alarm went off, and I snapped off the sunlamp. Ernie flipped to his feet and got dressed. "Get back to the radio room, Scottie. Hewett may have something more to say before

he gets here. Doc, let's go to the garage."

We switched on all the lights in the big aluminum-paneled garage. I went down to the end and opened the double doors so that Hewett could take over from the Mapmaker's autopilot and guide her right in where he wanted her. I stood just inside the door. It was raining, as Ernie had told me, the hard-hitting rain of Venus. The light from the garage got about ten feet from the door, and there dissolved in the rain and darkness.

"Here he comes," Ernie announced. I heard the slap and grind of the Mapmaker's treads, the mud splashing out of their way as the machine pounded toward us at ten miles an hour. "He'd better slow her down," Ernie said. "He's going to miss—"

We jumped to the far end of the garage. Mapmaker Three plowed into the south wall of the garage and stalled in a tangle of torn metal like a baffled, blinded Polyphemus. "What the hell, Hewett?" Ernie roared.

I beat him around to the front of the machine, and was sorry for my haste. Hewett, chopped in two, sprawled there, held to the seat by a loop of wire he must have intended as his safety belt.

Ernie and I closed the garage doors as best we could. The rain still found its way in through the gaps folded around the back of the Mapmaker. I untied what was left

of Hewett and let it slide from the seat to the floor. I tried to forget that I'd played cards, joked with this man; allowing myself to think only, how had this happened? What on Venus could tear a man this way? We slicked the tarpaulin off our jeep and threw it over the scrap on the floor. Ernie went to the water cooler and tossed down three cups to chill his stomach into obedience. I swallowed hard to control my own.

Then Ernie picked up the hand-piece of the wall phone and dialed Scottie. "This is Meyers," he said. "Have everyone come over to the garage right away. Who? Hell, yes. Wake him up. And get over here yourself as soon as you've got the word to all the others."

We heard phones ringing all over the area. A couple of minutes later the men started coming in. Joe Wish, our chief cartographer, came in wearing his morale pyjamas, a set bought with another aspect of Venus in mind. He began at once to climb over his Mapmaker like an organ-grinder's monkey on holiday in the park, covering himself with mud. The two cooks, grim in the knowledge that dinner's cans were yet to be cut open, looked at their watches and jittered. Then we were all there. Scottie walked around the tarp, staring at the lump at its center.

There were twelve of us there, the men of Venus Base Ace. Thirteen, if you counted the scrap under the tarpaulin. Ernie silently lifted the canvas. Looking at the men's faces, I didn't think that dinner

attendance would strain our rations much. Ernie covered the body. "Something out in the dark wrecked Mapmaker Three," he said. "Hewett went out to see what was wrong. Then something wrecked Hewett."

"Are you going to toss up a Bottle, tell Earth?" Scottie asked.

"What could we tell them, Scottie? We don't know what's sitting out there till we find it. Earth can't help us do that. Once we've got the answer, then we'll toss a Bottle to tell Earth. You radiomen can be getting that Bottle ready." Ernie paused. "I need two volunteers to go out with me," he said.

"Do you mean two besides me," I asked, "or just me and one other guy?"

"We need you at Base, Doc," Ernie snapped. "What if one of these bright young Americans had a bellyache while you were slopping around five miles away?"

"Hasn't been one medical emergency in the five months we've been here," I reminded him. "Unless, of course, you count the time Zack Price got his nose stuck in a beer can. Besides, I've had experience in the dark, Ernie."

"I just bet you've had, Doc," Ernie smiled. "O.K. Who else?"

They all wanted to go. Hewett had been one of the best-liked men of the Base; a good mechanic and a genius cardplayer, a raconteur who hadn't repeated a single outrageous story in all the time we'd known him. "You'll need a man who can handle a gun," Scottie said. "Though

I say it who shouldn't, I'm one hell of a shot."

"Get your wet-weather gear. We'll be gone about five hours. Price, you and Taldi get the jeep outside. Put the top up. Scottie, draw three .45's from Stores. Doc, leave your black bag here. If what got Hewett gets us, your pills won't help. Think of any other gear we'll need?"

"Flashlights," I said. I took six off the shelf and picked up half a case of dry cells and a box of extra bulbs. Ernie left, and returned wearing a leather jacket, over which he pulled his raincape and hood. Scottie and I hurried to quarters and pulled on our raincoats over our fatigues. Scottie got the guns, and we went back to the garage.

Ernie gave the jeep a quick check as we went outside, kicking the two five-gallon jerrycans set into the fenders to make sure we had enough gas to stay out a while. Taldi tossed a handful of K-ration boxes on the back seat. "Going to drive all the way to Frisco?" Zack Price grinned, watching these preparations.

"We're going in that direction," Ernie nodded. He pulled the drawstring of his hood tighter to keep out the prying rain. "You'd best set up a Bottle, Zack. I'll want to toss it up as soon as we get back with the scalp of the Something that killed Hewett." Zack Price was Scottie's relief radio operator. He nodded and threw his cape over his head to dash for the radio shack.

Ernie drove, taking us due west over the path Hewett and the Mapmaker had taken. The jeep's headlights drew cones that we followed into the darkness. Scottie and I threw the beams of our flashlights out at the sides. We bounced over the slick rock, lava ridged and waving like a stretch of frozen ocean, everywhere slimed with mud a few inches deep. "See anything?" Ernie asked, cutting the engine.

"Cylinders. Half a dozen of them over here," I told him.

Ernie locked the emergency brake to hold us on the upsurge of a long wave of granite. "Scottie, take the wheel. Doc, let's look at those Cylinders."

I tugged my hood and raincape tight and followed Ernie out into the mud. Our flashlights picked up a few corpses on the way: those four-inch slugs that no one had ever seen alive, eyeless creatures of the eternal dark. There were six Cylinders standing close together, like a conference of totem poles. About three feet tall, a foot in thickness, gray, these Cylinders were typical of their species. What they were, we had no idea, though they'd been the first landmarks we'd found on Venus. Ernie was playing his flashlight around the base of one of the artifacts. "O.K.," he said. "Pick it up."

Screwing my feet into the mud for purchase, I hoisted the Cylinder and set it aside. It must have weighed about seventy pounds. Ernie was on his knees in the slime, looking

at the spot where the Cylinder had been standing. "It's wet underneath," he said, "though it's been raining only an hour or so."

"So?" I asked.

"So it's moved within that hour or so," Ernie said. "Come on. Let's go a little farther west. It was about a mile from here that Hewett radioed in from Mapmaker Three." We clambered back into the jeep. Scottie, keeping the WEST on the compass under the needle, drove ahead into the drizzling, rippling sameness of Venus. Little gleams in the darkness came back as our lights struck the dead bodies of the little slugs. Every now and then we sighted a lone Cylinder standing to watch us pass.

"I wish we had some hint of what they are," Ernie said. "No one has ever seen a Cylinder move. We know they do, though. Every one of them the Mapmakers find is x-ed into place on the Master Map. They don't stay on their x's, though. They're like pawns that are moved only in the dark, part of a chess game that is played only when we kibitzers are out of sight."

"It's this planet," Scottie growled. "If the clouds would split just once, let through just a spoonful of that sunlight spilling up above us, I could stand Venus. We'll never see light here, though. This place will always be as dark as a dungeon."

"We're like blind burglars in a foreigner's house," Ernie said. "What do we know about Venus after five months Braille-ing her surface? We know the patterns on

eighty square miles of mud-covered rock. We've found some little slugs that died the instant before we found them, and a group of Cylinders that move around when we're not looking."

"This expedition cost as much as the United States Pacific Fleet," I said. "It's a shame we haven't found our beans yet."

"What are you guys griping about?" Scottie asked. "You're drawing Overseas Pay, aren't you?" He glanced at the mileage indicator next to the compass on the jeep's dash and ground down on the brake. He locked the emergency.

"What's the matter?" Ernie asked.

"This is where Hewett stopped the Mapmaker," Scottie explained, pointing to the reading on the dial. "Want to look around?"

"May as well," Ernie agreed. We all climbed out, leaving the lights on and the engine humming in idle.

We were in the midst of what Hewett had called his marble orchard. As the lights of the jeep reflected off a dozen of the Cylinders, and our flashlights off hundreds more on either side, I thought how apt Hewett's simile was. This place was like an ill-kept cemetery, the scattered headstones glinting in the midnight rain. Scottie walked in and out among the Cylinders, as though he were looking for an inscription on one of them, poking about with his flashlight. "Hey, Doc!" he shouted, arcing the beam of his light to show me where he was.

I stumbled among the headstones till I reached Scottie. Hewett's cap was on the ground in the center of the circle of light from our flashlights. The cap was twisted, blood-smearred, gouted with mucoid streaks. It looked as though it had been spat out by some filthy animal. Next to the cap, half-buried in the mud, was Hewett's hand radio, split open as though it had been hit by an ax. Meyers joined us. He picked up Hewett's cap and stared at it. "He must have died a dirty death," he said.

The rain was petering out. In an hour or so, the lowest clouds would be gone for a day or so. Still the day, sealed away from the sun above us, would be darker than the darkest night of Earth. The sky of Venus, like Salome, has seven veils, or maybe more. Christmas, New Year's, Midsummer Eve—they all are as black here as the darkest Walpurgis Night that ever was.

Scottie walked to the jeep and switched off the lights and cut the engine.

"Why did you do that?" Ernie demanded, tilting his light up into Scottie's face.

Scottie shielded his eyes. "Ernie, there's an island in the South Pacific where a plant called Wild Modesty grows. Wild Modesty has a flower that's really white, but turns bright red the instant anyone looks at it." Scottie switched off his flashlight.

Ernie Meyers swung around with his light, staring at the Cylinders nearest to us as though memorizing

their positions. "There's also a lizard called the basilisk," he said. "One glance from its eyes can turn a man to stone. If we turn off our lights, we may set the prisoners free." Ernie pulled out his .45, and snapped his light off. He and Scottie came to stand with their backs to mine, so that we formed an outward-looking triangle. "Go on, Doc," Ernie said to me. "Put out your light now."

I thought I heard a wet, impatient noise in the dark beyond my flashlight beam, the mud-kissing sound of a lizard slopping up onto a lake shingle. It might have been the rain, or my racing imagination. I drew the pistol from my raincoat pocket and flipped down the safety. Then I thumbed off my light.

There was no sound but the fine rain pittering into the mud at our feet, playing against the plastic shoulders of our raincoats. "Keep your lights ready," Ernie whispered. "Whatever is out here hates the light."

I squirmed my boots into the mud to set them firm against the rock three inches down. The dark was absolute as death. There was no horizon, no cupping sky, no cloud-mirrored flicker of distant lightning. We were as good as blind. It couldn't be darker than this inside my skull, I thought.

"Hit it!" Ernie screamed. There was an instant crash of metal on metal.

I toggled desperately at my flashlight. Scottie, quicker-thinking, fired

a round into the Cylinders before him. The flash of his pistol showed Ernie falling backwards as a Cylinder leaned toward him like a greedy totemic god.

We both had our lights on as Ernie scrambled to push the frozen Cylinder aside.

Thank God, we were quick enough.

The right sleeve of Ernie's raincape had been torn away. The leather jacket underneath had been dissolved along the right sleeve and chest. Ernie pulled himself up. He tugged off the jacket, threw it away, and pulled the torn raincape back on. "We turned off our lights," he panted. "The Cylinders moved. *Quod erat demonstrandum.*"

The Cylinders had come closer in the dark. They were the light-fearing Somethings, the slippers-through-the-mud. They were the murderers of Hewett.

"Get back to the jeep," Ernie snapped. "I want light—all the light we can make." Scottie leaped into the driver's seat, toggled the switch and toed the starter.

"Dead," he grunted, flat like a cussword.

"They hate light," Ernie Meyers said. "So they destroy the things that make light." He felt along the back seat for the boxes of dry cells and the carton of bulbs I'd put there, his fingers crawling ahead of his light. He brought out the bulbs, still set into the sockets of the cardboard carton. Each bulb had been crushed, its filament and lead-in

wires ripped from their undisturbed brass base. He tilted his light to the floor. Two dozen steel-cased flashlight cells lay there, each gutted of its chemical viscera as though it had had been torn by a steel-beaked hawk. The six spare flashlights were crushed into the steel floor of the jeep.

Scottie got out to open the hood. "Battery's split," he reported. "The generator is torn apart." I got out to look at the emasculated engine. Acid from the battery foamed on the metal.

"We'd better go home," I said. I unbuckled the five-gallon jerrycan of gas from its socket on the right front fender and dumped about half of it onto the seats of the jeep. "I'll carry this," I said, hoisting the can to my shoulder. "If the lights go out, fire may save us yet." I thought of our grandpappies, ringing the borders of their caves with fire to keep the saber-tooth at bay, and laughed out loud.

"What's funny, Doc?" Scottie asked.

"I was thinking we've come a long way from the caves," I said. "Twenty-five million miles we came; but still we're scared of the dark, need the comfort of the first invention. One of you two had better light the jeep. I'm pretty inflammable, with this can on my shoulder." I walked away, keeping myself covered by the light of Ernie Meyers' flashlight.

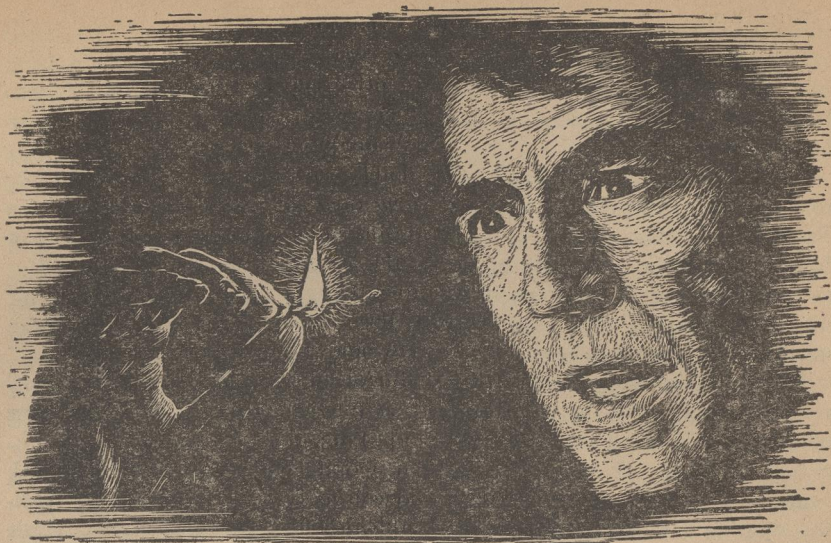
Scottie rustled under his raincape to find his lighter in the pocket of his fatigues. He got a pack of ciga-

rettes, too; and lit one as his badge of insouciance in the face of danger. "Let's go," he said, flipping his burning lighter into the jeep. It burst into flame like a Fourth of July set-piece, a jeep sketched in flaming squids. I thought I heard, over the sputter of the burning wet canvas and the hungry inhaling of the flames, a sound from the darkness, a sort of mineral moan. It was the creaking sound a supercooled lake might make, freezing solid the instant an ice crystal was tossed into it to show the way.

Then the jerrycan on the left side cut loose, spewing color into the wet sky, reflecting pink off the mattress-bulges of the low clouds. "We'll get a ways in that!" Ernie shouted. I set the jerrycan near in toward my neck, where it could rest on muscle instead of the bone of my shoulder-point, and jogged after Meyers and Scottie, away from the light.

When the gas tank of the jeep cut loose, we all halted for a last glance back. The Cylinders were ranged around the flaming jeep like soldiers in a fairy tale, frozen by enchantment. "Like fire plugs!" I shouted, pleased by that homely simile. Who, after all, could fear a forest of fire plugs?"

We started east. I walked to Ernie's right, Scottie to his left. "How did it happen, Doc?" Ernie asked. "What sort of life can't stand light, or heat? When you think of



life you think of light and warmth, life-giving warmth."

"Or of a place in the sun," I added. "These things have never had their place in the sun. No sunlight, no solar heat, no cosmic radiation has dribbled through the miles of clouds up there since Venus stole what heat she has on the day she was born out of the sun. There's probably heat below, radioactivity too deep to disturb the fire plugs on her surface."

Ernie swept his flashlight around us. "We're coming out of the Marble Orchard," he said. He glanced at his compass, keeping us on a back-azimuth to the course that had led us here. "It seems that there are more Cylinders here than there were when we came in," he said.

"We rode in," I pointed out. I knew that Ernie was right, though. The Cylinders now lined our path as though with a purpose. There was always at least one in our light. Waiting? The beam of Ernie's flashlight was weaker now, glowing red.

Ernie Meyers noticed this. "Scottie, hold your flashlight ready in your hand," he said. "We don't know how little light it takes to hold these fire plugs off. If anything moves, cut in your light."

"Right," Scottie said.

"A curious sort of evolution," I mused. "An animal which has never seen light might be as helpless before it as we are when exposed to naked gamma radiation. Perhaps infrared disturbs the Cylinders. Visible light would hurt like hell; and

ultraviolet would kill. Even radio waves, low down in the spectrum, might trigger them to protect their tender skins by freezing a shell around them."

"What would the Cylinders have to protect themselves against?" Ernie asked. "The danger of flashlights and radio transmitters, of infrared spewing Mapmakers, couldn't have bothered your fire plugs much before we got here."

It was a good question. What radiation was native to the surface of Venus? "I don't know," I admitted. "When this planet was younger, less staid and predictable, she must have had lightning in her skies. There may have been breaches in the clouds for minutes at a time, when killing sunlight could reach down to suck the mud dry and burn the life from the ancestors of these Cylinders."

"I wonder what our Wild Modesty looks like?" Ernie asked.

"Where was Moses when the lights went out?" Scottie countered. "We'll never know what they look like. The act of looking freezes what is being looked for into something different."

"What kind of life would use a Cylinder, a fire plug, as its spore-form? At the first hint of radiation, as the outermost cells of the body are warmed by a spark of light, these animals turn themselves into temporary fossils. They must have a reflex-arc infinitely more efficient than the best on Earth," I said. "To do them any good, it would have to

operate at a fraction of the speed of light." I held my watch in front of Ernie to see the dial. We'd been out three hours. It seemed impossible that it had been so short a time ago that we'd been bouncing along in our jeep like drunken soldiers straying through enemy lines. "How much farther to Base?" I asked.

"Only a couple of miles," Ernie said. "Switch on your flashlight, Scottie. Mine is getting pretty dim." I heard the click as Scottie shoved the switch forward. No light came out.

"Give that here!" Ernie snapped. Scottie handed him the dead flashlight. "It's lighter than mine," Ernie said, balancing it in his left hand. We stopped while Scottie took the burning light to hold over the post-mortem of his own. Ernie screwed off the base. A tiny hole was punched in one side of it, through which something had reached in to suck all moisture from the dry cells. What was left of the cells rattled in their steel jackets like the desiccated corpses of oysters dried in their shells on the beach.

"Yours," Ernie said, reaching for my light. I handed him it, knowing as I did that it was much too light. He tossed the two inert flashlights over his shoulder, into the dark behind him. "We'll have to go faster now. Scottie, take the can from Doc. We'll need it later."

I shifted the jerrycan onto Scottie's shoulder gladly enough, and felt as much animal pleasure in being able to move my head as though there

were a good chance of its staying where it was another hour.

By tacit consent we started trotting now, slipping now and then, scrambling up from the mud to keep going eastward, toward the lights and warmth of Base. The beam of Ernie's flashlight was now like a glassed-in candle flame. It hardly reached now to the double row of Cylinders that formed before us in the dark; hungry sentries waiting for the light to fail so they could fall upon us. Alien saber-tooth tigers, watching the fires die before the mouth of the cave, sniffing the human feast beyond. "You have fire for that gasoline?" Ernie puffed.

"Matches," I said. Ernie, not wasting his breath to speak, shoved me his leather-jacketed cigarette lighter. "Another minute, then we'll stop," he said. The bulb of his flashlight had only a spark in it now, like a fly trapped in amber. "Now," Ernie said. "Light a match, now."

I lit one. "How far are we from Base?" I asked.

"Half a mile, I judge. Thank God, the rain has nearly stopped! Visibility should be a few hundred feet by now. How many matches have you?"

I looked as I lighted another. "The box is full. Shall we go on, one match at a time?"

"We'll be safer, being wasteful," Ernie said. "One at a time, till the flashlight goes. Then one match and the lighter, burning together."

I started forward, carrying the

match like a cave-explorer with a candle. "There must be something better," I said. I patted the pockets under my raincape. No railway flares. No bits of beeswax to be molded into candles. A pack of chewing gum, instead, two sticks gone; and the typewriter eraser I'd picked up from my desk absent-mindedly and pocketed before we left. I wasn't the sort of sailor who'd find grains of corn in his trouser cuffs after a shipwreck. I'd find chewing gum, and eraser crumbs.

"Stop," Ernie said again. "Pour out some gas," he told Scottie.

"Wait." I unsleeved myself from my raincape and laid it on the mud.

"For Queen Elizabeth?" Scottie asked.

I grinned, invisible to him, and unbuttoned those coverall-fatigues they issue us, green-gray jumper-suits no first-grader would consent to wear to a playground, and tore off my tee shirt. "This will sponge up the gas," I said. I handed the matches to Ernie. He lit one and stood two yards away while Scottie slopped a quart of gas into my sweaty under-shirt. We dropped it onto my raincape. Scottie sealed the jerrycan, hoisted it back to his shoulder, and retreated to stand by Ernie. I was alone for five seconds, protected only by the dying glow of a flashlight and a match in the hand of a man six feet away. I pulled the jumper-sleeves back over my chilled arms and opened Ernie's lighter. I flicked it, touched the flame to the gas-soaked cloth. It burst alight, the

fire booming up to lick my naked chest. I jumped back, ran to Ernie and Scottie. I felt the sting and the stink of singed skin on my chest, the mark of fire, the mistress of Man.

We sprinted three hundred yards, till the flaming beacon we'd made was no bigger than the spark of the dying flashlight. Ernie's raincape flopped to the mud, and he sawed off the top of his fatigues with his pocket knife. We soaked it, lit it quick, and ran another three hundred yards of gauntlet between those silent lovers of darkness. "They can't move!" Scottie sobbed. I took the can from him as he stripped off his raincoat and sacrificed the top of his fatigues for our third flare. Another slopping, sliding run in darkness; the ancient fear in the backs of our necks; the utter fatigue of muscles goaded by adrenalin till they had no substance in them left for strength.

We dumped the last of the gasoline onto the mud, wicking it as it floated in widening circles with a bit of chewing-gum wrapper, and leaving the fume-filled jerrycan in the center of the puddle to explode. I slipped the stick of gum into my mouth, thinking of the gum chewers on the billboards. Like them, I was refreshed without being filled. The condemned man had a refreshing chew, I thought as I started running again.

This beacon flickered out before we'd gotten much east of its circle of heat. The empty can didn't explode, or even fizzle. Then, sudden-

ly, it was dark behind us. Ernie lit a match, and carefully laid the flashlight in the mud, tilting the lens upward. As we hurried on, I glanced back. The light still gleamed weakly, like a grounded, dying firefly.

We huddled together, breathing shallow not to disturb the tiny flames of the lighter and the match. The Cylinders boarded us more closely now, as though they'd got news from their comrades to the west that our light was nearly spent. It can't be too bad, I thought, looking at our executioners. If they eat as fast as they move, we'll never know it. I could lose an arm before the protest notes from the first nibbled finger reached my brain.

The lighter, hot in my hand, flicked out. There was an annoyed smell from the burning wick, and then its little spark deserted us. "Three more matches," Ernie said. He splintered the box in his hand and lighted one of these fragments next. Then the next-to-the-last match. Then the bottom tray of the box. Then the last match.

Ernie held it between his nails till the last bit of wood was burned and his fingers had the flame's course charred across them. Then the spark went out.

We were blinded, but we lived. Something touched me. I pulled back, then recognized the touch as a man's. I seized Ernie's hand, and he found Scottie's. Reaching out my left hand, I found the Cylinder that stood sentinel there. I tugged the others along till I found the next

Cylinder, and the next. Groping among enemies still frozen by an enchantment we couldn't see, we worked slowly eastward.

When Ernie shouted, I didn't realize at first what had happened. Taller than Scottie and I, he'd seen the tinting of the darkness ahead. He pulled us ahead. Then we could see, the few vagrant beams that came from the broken garage door as bright to us as a lighthouse. We let go our hands and ran toward it. I kicked open the lefthand door and wallowed in the light. We squeezed past the wrecked Mapmaker. The floor was empty. Hewett's body lay somewhere else now, waiting for the airhammers to grind a grave for it in the rock.

I looked at Ernie Meyers and Scottie. Naked to the waist, fatigues ragged where they'd been sawed off to make our flares, mud-covered from the splashing, slipping, falling, they were a ridiculous pair, little boys who'd misbehaved on a picnic. I looked down at myself, slimed with mud as they were, and shouted laughter.

Scottie didn't smile. "You were wrong, Doc," he accused me. "We were never in danger from the dark. It was a game to you: you made fools of us."

"We weren't made fools of," I said. "I was more frightened than I can tell; my guts are sore from naked scaredness. No, Scottie, it was no game. Something saved us when that last match died. Something made the Cylinders keep up their shells."

We walked toward the dining hall by mutual agreement. We didn't have any hunger yet, but we knew that to be the brightest room in the Base.

Ernie Meyers called in his adjutant to prepare his Bottle. I poured a cup of coffee, scalding my hands under the spigot to savor the warmth, and incidentally wash the mud away. One of the cooks, Taldi, handed me a napkin to blot dry on, and a sandwich. Scottie, still too angry to be tired, sat at my table only because it would have been more trouble to have gone somewhere else.

"Routine-length Bottle," Ernie said to the adjutant. He stopped long enough to pour down half a cup of black coffee. "This is the message: Lieutenant Robert Hewett killed in the line of duty. We have discovered the autochthons of Venus to be the previously-mentioned Cylinders. Probably a predatory slug of some sort in the dark, these are immobile in the presence of electromagnetic radiation. This defense phase seems analogous to sporulation in bacteria. The fact that this life form is intelligent enough to discern the sources of radiation harmful to it, and that it is able to shield itself effectively against such radiation, seems worthy of intensive research. I have allocated the emergency replacement thorium of our power pile to be placed, unshielded, in an area I shall designate as a Reservation for these natives, who shall be collected and concentrated there in their harmless Cylinder-

form. Request suitable research staff and replacement thorium be sent with our relief ship. Signed, ERNEST MEYERS, COLONEL USAF, COMMANDING."

The adjutant read back the message to Ernie, got it confirmed, and went to the radio room to have Zack Price tape it into a Bottle. This Bottle, a nitric-acid-hydrazine rocket weighing just over a hundred pounds, would lift Ernie's message above the clouds; and as many times as it could before it arced into the silence again, it would transmit that message to the listeners on Earth. I've always thought this messenger of ours is like a drowning man, bobbing up to shout for help as loud as he can before he sinks again.

The tables jittered for a moment, then were silent. Our Bottle was

cutting the clouds. In an instant, it would feel the sunlight.

Scottie was drumming his fingers on the tabletop. "Ernie, can you tell me something?" he asked at last.

"Maybe." Ernie filled his coffee cup and sat beside Scottie. "Shoot."

"You said in your note for the Bottle that radiation is the only thing that keeps these Cylinders quiet and safe as fence posts. If that's so, why didn't they smear us when that last match died?"

Ernie smiled. "I said I wanted a Bottle ready to toss up when we got back. Zack Price got the rocket fueled, and was testing the transmitter just before we got here. Scottie, we made our final sprint under cover of his, 'One . . . Two . . . Three . . . Testing.' For that, Zack Price was just made Staff Sergeant."

THE END

THE ANALYTICAL LABORATORY

The Lab is short this time—because of the length of the serial installment, we had only four fiction pieces in the April issue. Considering who wrote the four items, however, it was, naturally, a battle royal indeed. The scores came out:

PLACE	STORY	AUTHOR	POINTS
1.	Double Star (Conclusion)	Robert A. Heinlein	1.43
2.	Legwork	Eric Frank Russell	2.43
3.	The Dead Past	Isaac Asimov	2.62
4.	The Man Who Always Knew	Algis Budrys	3.50

Competition for places in the April issue was not on an amateur level, shall we say.

THE EDITOR.

MACHINE COMPLEX

Concerning a simple little job that a brilliant young engineer couldn't possibly handle—because it was a simple little job!

BY RANDALL GARRETT

Illustrated by Freas

Conway Bell watched quietly, almost holding his breath, while the man on the other side of the desk looked over the array of records in front of him. He watched for several minutes, keeping his face perfectly calm while his mind buzzed back and forth on a tightrope of suspense.

He concentrated hard on being accepted for the job, hoping to convince the personnel officer by pure mental power. It was almost as if he were praying.

Finally, the personnel man nodded without looking up.

"Good," he said. "Very good. Doctorate in physics and a good background in engineering to go with it. Just what we need."

Conway had to suppress a grin, despite the tension within him. He was well aware that it was just what Project Elsewhere needed. He'd studied for the job for years.

"The thing that interests me," the personnel officer went on, "is the

interest you've shown in philosophy and psychology. That's rather unusual in an engineer."

Conway glanced at the plaque on the desk for a quick check on the man's name.

"Do you think so, Mr. Lochmeister? A good many men at Tech took the same courses."

"Not to the same extent," Lochmeister pointed out. He tapped the sheaf of papers. "You could have had a Bachelor of Arts in philosophy, for instance."

Conway wondered what the man was driving at. Was there any objection to philosophy? He tried to read the bland expression on the man's heavy, solid face, but the gray eyes betrayed nothing.

"Primarily, I'm a research engineer," Conway said, "but I believe it helps to know more than just one field of thought."

The more he thought about it, the more he liked that answer.

"Hm-m-m," Lochmeister said, "I

see." He looked back down at the sheets. "You've done quite well on the general tests, too." He paused again, then: "Very well, Dr. Bell; you'll have to take the physical, but if you pass that, we have a position for you."

"One thing," Conway said quietly, "what does it pay?"

Lochmeister lifted his eyebrows and grinned. "Did we forget that part of it? Sorry. Well, if you can handle the job, it pays fifteen thousand a year. That's as a starter. From then on, who knows?"

"I . . . I see." Conway Bell blinked. Half that sum would have surprised him; three-quarters of it would have shocked him. The total just left him numb.

Lochmeister handed Conway a slip of paper.

"Take this down to the thirty-seventh floor and give it to Dr. Dyers. And I want to thank you again for applying to the Project, Dr. Bell. We need men of your caliber."

He pumped Conway's hand, smiled cordially, and made it evident that he wanted to be alone.

Conway nodded, attempted to smile, said something he hoped was polite, and headed out the door toward the elevator.

As soon as the door closed, Lochmeister activated his intercom. "Willis? Lochmeister. I think we've got our boy. I want him tailed every minute of every day from now on. I want recordings and movies of everything he does or says.

"He's getting on the elevator from here. You can pick him up on the clinic level."

"Right," came the answer. "What's he like?"

"Tall, good-looking blond, wearing a blue zipsuit. Boy genius type. Twenty-four years old, unmarried, but with prospects. Psychologically, he's just what we want."

"Good. I hope it works."

"It will," Lochmeister said, trying to keep his voice from betraying doubt.

He cut the connection and tried another.

"Dr. Miller?"

"This is Miller," said the speaker.

"Lochmeister here. Your boy is going down to see Dyers now."

"Good," said Miller. "I was afraid his record might not be exactly what the engineers wanted."

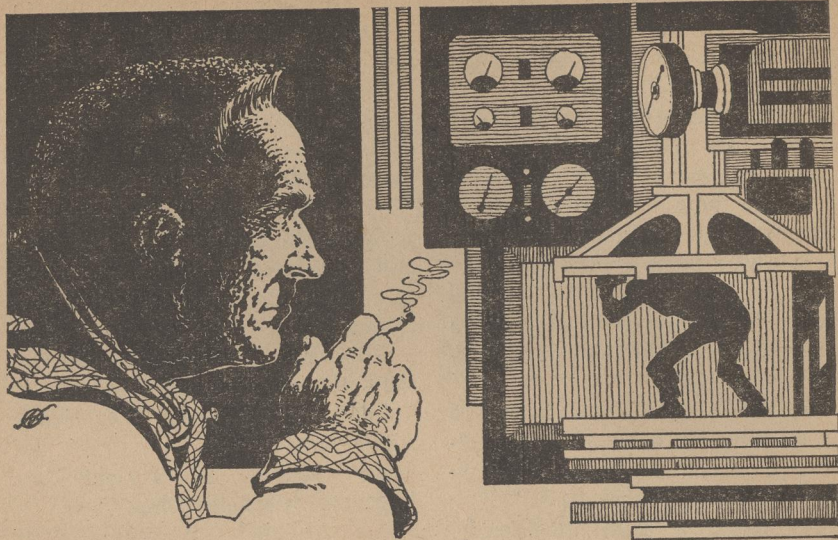
"He'll do fine," Lochmeister told him. "From now on, he's your baby. Get in there and clobber him."

I passed the physical! I got the job!

Conway Bell stepped into the elevator and debated whether he should go down to the first floor and walk, or go on to the basement and grab a taxi in the underground.

It's such a beautiful day, I think I'll walk.

He got off at the first floor, showed his card to the guard at the door, and stepped out into the street. It was miserably foggy out, and was beginning to drizzle a little, but Conway just grinned and head-



ed uptown on Madison Avenue. In spite of the weather, there were swarms of people on the street, milling around in purposeful confusion. The soft sounds of a million conversations and a million feet walking over the spongy plastic of the streets blended with the smothered roar of the underground motor traffic to produce the eternal life-throb of New York.

Fifteen thousand dollars a year! Fantastic! Why, with two weeks' salary, he could get a carplane of his own! He hadn't realized that Government Projects paid that much. It was supposed to be kept quiet of course, and everyone knew they paid well—but *fifteen thousand!*

Almost automatically, he looked

up at the sky, even though he knew he couldn't possibly see through the fog. But he knew that somewhere up there, circling in an orbit high above the atmosphere, was one of the greatest feats of science-engineering mankind had ever attempted.

His granddad had helped work on the three space stations several decades back, but that had been of minor importance in comparison with Project Elsewhere.

He was snapped out of his reverie as someone bumped into his shoulder, partially knocking him off balance.

"Whyn'cha look where ya goin', bud? Ain't nothin' to look at up there!" the man growled.

"Sorry," Conway said. *Why don't*

you look where you're going, too? Conway thought.

He walked into a bar around the corner on Forty-sixth Street. The doorman checked his ID card and nodded his acceptance. Conway pushed his way through the crowd of people who had sense enough to come in out of the rain and made for a phone booth in the rear.

He fed a nickel into the slot and dialed. When the screen lit up, a pretty, dark-eyed brunette was looking out at him.

She didn't give him a chance to say anything. "Conway!" It was almost a shout of despair. "You haven't called in three days!"

He raised a hand imperiously. "Calm yourself, Princess. I have my reasons." He was bubbling inside with the desire to shout the news in a frenzy of excited joy, but he wanted to play the part right.

"But, *what* reasons? I tried to call you, and you weren't in your apartment. Where were you?"

"My question first." His voice became suddenly tender. "Will you marry me, Patricia?"

Her face lost its worried look; she smiled softly. "Of course I will, silly. I told you that two years ago. And a dozen times since. But it's nice to hear you ask."

"I mean *now*," he said. "Right now. This afternoon."

She looked startled, and her voice dropped to a whisper. "Yes . . . yes, Conway. If you think we can get along—"

Again he assumed the imperious

pose. "I think we might be able to get along—with scrimping and saving, of course—on fifteen thousand a year."

She didn't say anything. She didn't believe him, but she couldn't quite say so.

"Pat," he went on, "you are now gazing upon Dr. Conway Bell, presently employed by the Government as a research engineer on Project Elsewhere."

This time, in spite of his banter, she knew he meant it.

"Project Elsewhere? *The interstellar ship?*"

He nodded. "That's right, darling; the interstellar ship."

At nine the next morning, he reported for duty at the Government Project Building. He was still feeling fine, although the euphoric tingle had worn off. Pat had very sensibly decided to arrange for a "really nice" wedding in a month instead of taking a plane to Nevada on the spur of the moment, and Conway actually hadn't been too hard to convince.

Lochmeister shook his hand warmly and indulged in small talk while the elevator lifted them up to the seventieth floor. They walked down the hall through a door marked:

SPECIAL PRODUCTIONS
DIVISION

and into an office within, where the door was labeled:

J. W. MILLER
DIVISION CHIEF

Seated behind the desk was a

broad-shouldered, determined-looking man who looked up sharply as Lochmeister and Conway came in.

"Dr. Miller," Lochmeister said, "this is Dr. Conway Bell. You've seen his dossier."

As Miller stood up, Conway was startled to see that the man was at least two inches shorter than himself. He had expected it to be the other way around.

"Glad to meet you, Dr. Bell," he said, extending his hand. His voice was a comfortable baritone. "I must say that I'm quite impressed with your record."

"Thank you, Dr. Miller." Conway accepted the hand and the compliment firmly and honestly.

"Dr. Miller will be your immediate superior," Lochmeister said. "At least for the time being. And with that short introduction, I'll leave. I've got umpteen jillion papers to sign. Good luck, Dr. Bell."

When he had gone, Miller said: "I assume you know what sort of work you have come here to do, Dr. Bell, but Standard Operating Procedure is to outline the Project to a new employee, since the information released to the public is not always complete. And it's sometimes distorted in the process of being relayed to John Q. Public."

He waved at a chair. Conway pulled it up to the desk and sat down. Because of the formality of the atmosphere, he still felt some tension, but Miller's relaxed atti-

tude tended to temper the tension somewhat.

"First, let me ask you what you know of Braunberg's Equations," Miller said. "I mean, give me as good an interpretation of them as you can in English."

Conway frowned. "Well...uh...essentially, they're based on earlier work which shows that space is a concept of—"

Miller held up a hand. "I don't want an historical background, Dr. Bell; boil it down. What do they mean in terms of physical possibilities—in terms of engineering?"

Conway's frown didn't change. "Simply, I should say that the equations show that space... distance... is a concept which can be eliminated under the proper conditions."

"Fine. And what does this mean?"

"As far as the human race is concerned, it means that it is no farther from here to M-31 than it is from you to me."

"And the conditions?"

Conway felt as though he were being asked questions in elementary physics by someone who didn't have the brains to understand him. Well, if Miller wanted it that way, that's the way he'd get it.

"Distance is a function of time," he said carefully. "If I walk due east for ten minutes, I'll arrive at a certain place. If I take a taxi due east, I'll get to another place. If I take a plane in the same direction, I'll be somewhere else. But as far

as I am concerned, these places are all the same distance away. The only difference is the subjective-objective time differential shown in the Einstein Equations, which Braunberg—”

“O.K., O.K. Let’s not get technical.” Miller paused and looked thoughtful. “What Project Elsewhere is concerned with is to build the machines which will utilize the Braunberg equations: the so-called interstellar ship.” He paused, looking intently at the tip of his pen. “What do you know about the third derivations of the original equations?”

“Only that they’re the ones that the operation of the mass-time converter is based on,” Conway said.

“Can you derive them from Braunberg’s equations?”

“Yes, sir. I think I can follow the reasoning.”

“Good.” Miller stood up again. “Let’s go back to the reference stacks.”

Conway followed him through another door and into a well-lighted, dial-operated microfilm library.

“The entire work that has been done on Project Elsewhere is in here. You’ll be expected to familiarize yourself with the broad general picture, and to know what is being done specifically in whatever section of work you may be handling at any particular moment. I’d particularly like to have you work on field-matrix relationships, because that’s the sort of work you’ll be doing, for a while, at least.”

Conway nodded. “All right, sir; I’ll do my best.”

“Fine then. I think we’ll go back to the workshop; I’ll show you where your lab will be. How are you on precision equipment?”

As Conway walked with him into another hallway, he wondered briefly why Miller kept asking questions that he knew the answers to. Surely he’d read the Conway Bell dossier, hadn’t he?

“I’d say I was pretty good at precision work, sir,” he answered.

Miller pushed open a door which led into a large, well-lit room. “This will be your place, Dr. Bell. I’ll show you what we’ll want you to do.”

Conway looked around the room, trying to keep his eyes from bugging out.

“It was all full of drill-presses, small lathes, and tools,” he told Pat several days later. “The only things that made it look even remotely like a physics lab were the pieces of testing equipment along one wall.”

“But what sort of job is it?” Pat asked.

“I’m supposed to familiarize myself with the equipment,” he told her. There was a touch of bitterness in his voice.

They were walking along a path in Central Park, past the huge Tribute to Humanity display, their faces reflecting the sparkling, evanescent colors that played across its surface and glowed within it.

Conway stopped to light a ciga-

rette, and the raw red-orange of the lighter flame contrasted oddly with the glowing pastels of the big display.

"So far," he said, "they've got me building Kimball units."

"Is that difficult?"

"Good God, no! Any moron could do it. In the overall construction of the drive, each one of these units has to emit a vibration which is just a little different from the rest. The difference in frequency requires a slight difference in construction—slight differences in circuit lengths, resistances, and so on—but the things are all built to the same general pattern. After each one is built, it has to be tested, to make sure it emits the right frequency. Then I build another one. And another one."

"Is that *all* you do?" Her dark eyes, looking up at him, were pools of unchanging blackness in the shifting colors that moved round them.

Conway, looking down at her, had the sudden feeling that she had lost a little of her respect for him. After all, if the project didn't consider him fit for anything but a menial job—

"Oh, no; there's plenty to do besides that," he said. "When I get through with the assigned units for the day, I have plenty of studying to do. Building an interstellar ship is a pretty complex job; I've really got to specialize before I can be of any real help to the Project."

Oddly enough, the explanation satisfied his own doubts more than

he had thought it would. And certainly more than any effect it had on Patricia.

He blew out a plume of smoke that seemed to shine with a life of its own in the play of the display lights.

"After all," he said, "you can't just step into an executive position immediately, even if the paycheck does look like it. Within a month or so, I'll be ready to dig in and do something. I have some ideas already, but they may have been tried out and discarded long before I got there."

"Let's not worry about the job now," Pat said decisively. "We can pretty much let that take care of itself. After all, if they hired you, they're going to get their money's worth out of you."

Conway nodded. "You're right, sweetheart—as usual."

"Meanwhile," she went on, "we have a wedding to think about. Dad phoned down from Boston this afternoon and wanted to know whether we wanted the ceremony here or in Boston."

"I'd say Boston," Conway told her. "After all, it's your mother's only daughter who's getting married, and she'll want to see it. I know we could get a circuit rigged so that she could see it at home, but that would cost more than our going to Boston would cost."

"I knew you'd see it that way," Pat said. "That's what I told Dad."

"Good," Conway said quietly. "Good." He dropped his cigarette

to the pavement and crushed it with a savage twist of his foot.

In the next two weeks, Conway actually got used to the job. The construction of the Kimball units became so automatic that he could concentrate on the information he had studied the afternoon before in the library. He found that he could put together a unit in a little less than twenty minutes, so his quota of thirty units a day left him two hours to study in.

Although the work would never be enjoyable, it at least became bearable—for a while.

It was four days before his wedding that Miller called him on the carpet. Conway didn't know he was being called up for a chewing out; he had no inkling that anything could be wrong.

He walked into Miller's office expecting a change of job.

Miller's eyes looked at him from beneath the dark brows. "Dr. Bell, I have here the inspection report on the Kimball units you turned out last week. I'd like to have you take a look at it." He handed over a few sheets of paper.

Conway took them and looked at them wordlessly. In the last week, eight of the units had tested out defective.

"Notice the variation on those test figures, Dr. Bell. Not only do your errors show a quantitative increase, but there is a qualitative increase in the amount of variation from the assigned frequency. I'm

afraid your work is showing some laxness in concentration. You're not watching what you're doing closely enough."

There was nothing Conway could say that didn't sound like an excuse, so he kept his mouth shut.

"Let me remind you, Dr. Bell," Miller continued, "that each of these pieces is unique. This is not a mass production process in which an excess of pieces may be built in order to account for defectives. I'm afraid that these units will have to be rebuilt." He paused for a moment to emphasize the point, then said: "And please try to keep your mind on what you're doing."

"Yes, sir," said Conway tightly. "I'll try to do better."

He turned and walked back to the workshop, seething with anger. But what could he say? He was wrong; Miller was right. He realized that he hadn't actually given the units the attention they deserved; he realized that he had no excuse for turning out defective pieces.

He took a deep breath and tried to force his mind to calmness. There was, after all, nothing to do but do the job right. If he didn't, he might as well give up the hope of being able to work on the ship itself.

During the next four days, he worked with precision. Each unit that left his workshop was tested twice before it left. In addition, he managed to turn out the eight defectives he had built during the previous week.

When Friday came, his record was one hundred per cent perfect. He walked out of the Government Project Building with a check for twelve hundred dollars in his pocket and an aching throb in his head.

Patricia was already in Boston—had been for a week. When he reached his own apartment, there was a telestat waiting for him in the receiving slot of his phone. It was from Edward J. MacHunt, Boston, Massachusetts, and read:

CONGRATULATIONS TO MY
NEW SON ON HIS WEDDING
NIGHT. DON'T BE NERVOUS:
WE ALL HAVE TO GO
THROUGH IT.

DAD

Conway went into the kitchen, got out a bottle of bourbon and some ice cubes, and took them into his study with the telestat. He mixed a drink and then very carefully pasted the 'stat into the latest volume of his scrapbook.

The row of books contained every bit of precious paper that he had ever received. Here were the cut-outs from the newsfacs that mentioned his name; every one of them that he knew of, from his birth announcement, through his school days, up to the very latest one, which announced his appointment to Project Elsewhere. Here were the out-of-date membership cards in the various scientific societies to which he belonged, the program booklets of all the conventions he had attended, the photostats of his diplomas and awards, and the tear sheets from

articles he had written for the scientific journals.

He polished off his drink and fixed another. Then he began going through the scrapbooks, volume after volume. For almost every item, he could recall the glow of pleasure that had touched him at the achievement of another small goal in his life.

But somehow, there was no glow in having gotten his position with Project Elsewhere. That had been, a few short weeks ago, but he could not call it back.

Dammit, he wanted to do *re-search!* The other men in the division were doing important work, all of them. Why couldn't he?

He mixed another drink.

Conway Bell got off the New York-Boston Transport at five o'clock Saturday afternoon suffering from a horrible hangover, but by the time the hour for his wedding came at ten Sunday morning, he felt fine again.

The week off he had been allowed by the Project was entirely inadequate. He and Pat flew to Burton City, Africa, and stayed in a magnificent hotel overlooking the lake that was the source of the mighty Nile. For a solid week, they took almost childish pleasure in discovering the beauties of nature; the bright sparkle of the stars in the thin mountain air, the brilliant glow of the tropical moon reflected in the waters of the broad lake, and the

glint of sunlight on the frosted mountains.

But it ended all too soon. When he and Pat took the rocket back to New York, the honeymoon wasn't over yet. It had hardly begun.

Even so, Conway walked into the Division Monday morning feeling bright and cheerful. As he passed Miller's office, the Division Chief looked up and smiled.

"Back with us, Dr. Bell? How was the honeymoon?"

Conway grinned. "Beautiful, like a honeymoon ought to be."

"Fine. Glad to hear it. By the way, I want to talk to you later, when you've straightened everything out in your lab and got yourself squared away. See me about eleven—O.K.?"

"O.K.," Conway said.

He walked back to his workshop feeling mixed emotions.

Someone has illustrated "mixed emotions" by describing it as the way you feel when you watch your mother-in-law back off a cliff in your new Cadillac. Conway had no such negative emotions toward Patricia's mother, but he did feel that way about Miller at the moment.

Some of the other men in the Division made the usual good-natured, sly, knowing remarks that a new husband finds it his lot to put up with. Conway smiled, joked back, made a few remarks of his own, and went into his room.

For two hours, he worried about what Miller had to say. Was he going to have to put up with another

tail-chewing? And, if so, what for this time?

Or was he, perhaps, going to get another assignment?

At eleven, he went into Miller's office, and Miller was smiling. It couldn't be so bad, then.

"Dr. Bell, I want to say that I'm pleased with the work you did during the last four days you were here. I don't like to jump anybody about his work, and I feel that if he's done a good job, he ought to be told so.

"Frankly, I'm convinced you can do the job, and I was from the first; it just takes a little time, that's all. I'm glad you've shown us what you can do."

Conway thanked him, not knowing what else to say in the face of all that verbiage.

Miller's smile disappeared, and was replaced by a thoughtful look. "There are, of course, a few things to consider. You've been off a week, and we're getting a little behind on schedule.

"You've shown that you can handle a total of thirty-two units a day and turn them out perfectly. I'm afraid we'll have to up your quota to that—at least for a while."

He handed the quota sheet to Conway, and the smile came back. "How are you doing with your library work? Beginning to get the overall picture?"

"I think I'll get it eventually," said Conway dully.

"I'm sure you will. Well, good luck. And thanks for stopping by."

Conway went back to his workshop hating Miller, hating the world, hating himself.

Eight hours a day. Five days a week. Four-plus weeks to the month. The hours and days and weeks rolled by, marked by a series of Kimball units. And the months were marked by a series of inordinately large paychecks.

A soft snow drifted down over the city, filling the air with eddying whiteness, melting into shapeless dampness as it touched the induction-heated pedestrian ways. From a myriad of hidden speakers, carillon voices asked passers-by to "Hark!" because the herald angels were singing.

Conway walked down Madison Avenue toward Grand Central. He stopped in a liquor store and bought two-fifths of bourbon.

"Not much time till Christmas, eh, Dr. Bell?" said the counterman jovially as he took the money from Conway's hand.

"No," said Conway. "Not much."

"Well, if I don't see you between now and then, Merry Christmas!"

"Yeah. Thanks. Merry Christmas."

He walked on down to the corner and took the DOWN escalator to the auto traffic level, where he caught a cab. A few minutes later, he was entering the basement of the high-class apartment building in the most expensive section of Greenwich Village.



He took an elevator to the top floor and opened the door to the apartment with his key.

"Conway?" Pat's voice came from the kitchen.

"Yeah. It's me."

He took off his coat and hat, hung them in the closet, and turned on the drier. Then he took the bourbon into the kitchen and put the bottles into the refrigerator.

"You should have bought more than that," Pat said. "We'll need some gin and Scotch, too."

Conway frowned. "What for?"

"What for?" Her voice was sharp. "For the party. In case you don't remember, we're entertaining at eight."

"I don't feel like a party."

Her dark eyes looked as though they were about to burst into flame. "I know. You never feel like a party. You haven't taken me anywhere since our honeymoon. That's why I decided to have the party here."

He glared at her. "Cute. Real cute. I beat my brains out eight hours a day so that you can have a fancy apartment and fancy clothes, and I can't even rest when I get home."

"In case you don't remember, *Doctor Bell*, a lot of that money went into that fancy library and home laboratory for you. And you don't even read anything any more. At least I *use* the things I buy!"

"Yeah. You sure do." He opened the refrigerator, pulled out one of the bottles, and broke the seal.

"Conway!" Pat's voice was almost a wail. "You're not going to start drinking *now*! Can't you at least wait until the party starts?"

"And face all those smart-Aleck friends of yours without a drink under my belt? No, thanks. It's my bourbon, and I'll drink it when I please."

Conway finished the hefty drink he had poured for himself and then went back to the closet. The drier hadn't had time to do a complete job on the damp spots where the snow had melted on his shoulders, but he pulled the coat on anyway.

"Where are you going?" Pat asked.

"You said we needed some more liquor. I'm going out to get it."

She came out of the kitchen and looked at him with worried eyes. "I can just phone down to the store and have them send some up. It won't take too long."

Conway shrugged his coat into position and pulled his hat down on his head. "I'll go. I should have bought it. I'll go."

Pat looked even more worried. "You'll be right back, won't you?" "Sure."

When the door closed after him, Pat just stood there, biting her lower lip and trying to keep the tears out of her eyes.

It was seven-thirty when the door announcer chimed. Pat didn't press the nearest opener, but ran directly to the door. Conway was standing there with two huge bundles.

"I got some stuff, honey," he said.

Pat. took a deep breath of relief. He was sober. She wanted to ask where he had been, but she was afraid to. She didn't want to jolt him out of the mood he was in.

"Bring it in," she said, smiling gayly. "And then hurry in and get your party clothes on. Brawl in 'arf an hour."

Conway whistled cheerily as he helped her put the merchandise in the various cupboards and dispensers in the kitchen. Then he walked into the bedroom and got out a gold teflon-wool dinner suit.

He glanced in the mirror. There was an almost imperceptible smudge of lipstick on his ear. *I hope she doesn't know*, he thought, miserably rubbing it off. *I hope she never even suspects.*

The party was nerve-wracking, as Conway had thought it would be. Most of the guests were people whom Patricia had met in college or older men and women who were already well established in their various fields. There were two lawyers, a doctor, a book publisher, a well-known poet, a couple of novelists, and a whole group of lesser lights and their respective wives, husbands, lovers, mistresses, fiances, fiancees, and friends.

Conway passed among them, smiling in the accepted manner of the genial host for the first half hour, and then retired to the kitchen. He mixed himself an extra-powerful

dose of bourbon and sipped at it slowly as he morosely watched the snow swirling down through the air, each flake sparkling like a tiny diamond as it caught the light that streamed out from the window.

He put his forehead against the hard plastic, wishing he could feel the chill of the outdoors instead of the insulated warmth that made his skin feel sticky against the window.

He looked down at the glass in his hand. His knuckles were white from the pressure of the grip he had on it.

Relax! he told himself. *Relax. Don't be so tense.*

But he found he couldn't. He found that he was actually afraid he'd drop the glass if he didn't hold on tight.

He was still standing there when Pat came in.

"What's the matter, Conway?"

"Nothing," he said, forcing a smile. "Just a little nervous, that's all."

"Everybody's begun to wonder what's happened to you. Why don't you go out and start an interesting conversation somewhere—or join in one that's already started?"

"O.K. Sure. Good idea." He drained the drink and poured another before he went out. He couldn't argue with her now. Not after this evening.

He walked around the living room, trying to find a group he could talk to without hating them too much.

". . . And I'm firmly convinced

that that's our reason for not having the crime rate among juveniles that we had in this country a century ago," one man was saying.

Conway looked at the speaker. It was one of the lawyers, Egford, Eddford, something like that.

"A century ago," he went on, "we had no new frontiers. Our youth was frustrated. They had no place to go. Now they have Mars and Venus—two whole new planets to explore and make their own way on."

One of the men to whom he was speaking was the doctor, the other a fairly well-known writer named Aghill.

"I agree with you," said the doctor. "Juvenile crime is, in itself, an indication of frustration rather than material want. Historically, it can be shown that juvenile delinquents come from all walks of life during one of the periodic epidemics. They may have no reason to steal, but they steal, just the same. Frustration."

"But why does juvenile crime come in epidemics like that?" the writer asked. "Is it really a lack of physical frontiers that causes it? What is 'frustration,' anyway?"

The doctor grinned. "Do you want the psychosymbolic general equation for it, or will you be content with a very muddy verbal expression?"

The writer shook his head. "Don't get me involved in psychomath. Ever since psychologists stopped trying to be sociologists and began

working with the individual, their math has been over my head."

Conway decided to stick his oar in. "That's as it should be, with nearly four million variables to contend with."

The doctor nodded. "Right you are. And a variable amount of variables, at that."

"I didn't know you were a psychologist, doctor," said the lawyer.

"Properly speaking, I'm not," was the reply. "I don't do any actual treatment. I'm a psychometrist—a diagnostician, if you will. Although I don't tell people what's *wrong* with them; just what's *with* them."

"Hey, hey," said the writer. "Let's get back to my question. What is frustration? I've been told that a writer has to be frustrated in order to write. True?"

The doctor frowned. "I think that's a poor way of putting it. There are several orders of frustration. It's a little hard to explain, but I'll try.

"A person is frustrated if he's trying to do something he's been prevented from doing. Now, just how frustrated he is depends on whether or not he can get around his obstacle.

"I said that by definition, he was unable to do it. Suppose a man wants to spit on the moon, to take an absurd example. A century ago, he couldn't have done it. But he could get around that to a certain degree by writing about it or by spitting on the sidewalk. Today, all

he has to do is take a ship to Lunar City.

"But spitting on the moon *from here* is a case where the desire is *physically* impossible.

"Then there's the case of the guy who wants to spit on the moon, but he suffers from intense claustrophobia. He can't possibly take a ship to the moon because he can't bring himself to get inside one. It's become *psychically* impossible for him.

"And finally, there's the fellow who is trying to do something he can't possibly do, but he doesn't know it. Like the poor slob who writes poetry for years without ever knowing that he just plain can't write poetry."

"Do I detect a personal crack in that?" said a new voice. It was the poet.

"If the shoe fits—" the doctor said, grinning.

Conway strolled away from the group, back to the kitchen.

Frustration. What kind of frustration was his?

He rubbed his eyes and cursed inwardly. Didn't these people have anything better to do than sit around and drink all night?

He glanced casually around the room. Pat wasn't there. He could hear her voice in the dining room. He pushed open the kitchen door again and headed for the bourbon.

Frustration. Why?

He glanced again at the glass in his hand. Then he looked at the other hand, which was mashing the

end of a half-smoked cigarette. Why couldn't he relax?

Relax! he commanded his hand. *Relax!*

Patricia Bell opened the kitchen door when she heard the noise. She saw Conway kneeling down with a cloth, wiping the floor. She looked at the bemused smile on his face and said: "What happened, darling?"

"I dropped a drink on the floor," he said. "It didn't hurt a thing. Not a thing."

Then he stood up and walked over to her. He put both arms around her, held her tightly, and kissed her, firmly, lingeringly.

Suddenly her eyes opened wide, and she pulled away a little, surprise and eagerness on her face.

"Conway!"

He grinned at her. "Well, you don't need to look so surprised."

"You stay right here and mix yourself another drink," she said. "I'm going to chase our guests home."

While she was gone, Conway grinned to himself. He wouldn't tell her yet. He wouldn't tell her that he was going to tell the Project what they could do with their stinking job just as soon as the holidays were over.

The day after New Year's was lit by the cold brilliance of a winter sun shining in a clear sky. Conway Bell sat happily in the rear seat of an uptown taxi and counted his resources, just as he had done so many

times in the past week. He would work for the Project just one more month, long enough only to get another check. That would put enough money in the bank for him and Pat to live on until he got another job—perhaps a teaching position somewhere. It wouldn't pay as much, by a long shot, but they'd at least be happy together.

It was odd how he'd suddenly realized that they could do without the job. It wasn't absolutely necessary. There was the money, of course, but that didn't mean a devil of a lot, not in comparison with his happiness and Pat's.

It wasn't that he couldn't handle the job; any moron could do that. It was simply that it wasn't what he wanted. He was a research man, and he was going to do research, not some piddling little gadget-building job.

When he walked into Division, Miller greeted him with a "Happy New Year."

And for a full week, Conway actually believed it was.

His head was aching from an excess of Kimball units when Pat phoned him from home the following Thursday.

"Darling," she said softly, "I have a surprise for you. I meant to wait until you came home, but I couldn't wait. Guess what?"

He looked at her impish grin and shrugged. "I give up. What?"

"How would you like to live in Connecticut?" she asked.

"Connecticut? What in the devil for?"

"Well, I think a baby needs more room to grow in than he'd get in a city apartment. By next September we can have a nursery built and have the whole house fixed up beautifully."

"Baby? House? Pat, what's all this?"

It was a purely rhetorical question, really. He knew what she meant. There was a baby due in September, and Pat had bought a house in Connecticut. Very simple.

He tried to smile and act enthusiastic about the whole project, but it didn't go over very well. Ahead of him, Conway Bell saw a long marching line of Kimball units—stretching on into eternity.

Long after the screen was blank, he kept staring at it, wondering what life had done to him.

What was it the doctor had said, that night of the party? Frustration. An unsolvable problem. But a problem is unsolvable only because it is set up that way; in the real universe, there is no such thing.

Axiom: If a postulated situation has no solution, then it is not a problem.

Axiom: If a postulated situation is a problem, then the solution is inherent in the problem itself.

Assumption: The postulated situation in which Conway Bell now finds himself is unsolvable.

Q.E.D.: The postulated situation is not the real situation. Before he

could find the solution, he would have to find the problem.

Lochmeister punched a button on his intercom.

"Dr. Miller? This is Lochmeister. What's this about our star pupil?" He frowned at a sheaf of papers on his desk.

"I'm not quite sure," Miller said. "If we could give him another battery of tests, I could find out in a minute, but I don't see any excuse for doing so."

"Well, then, give me a professional guesstimate."

"All right," Miller agreed. "He's been digging harder and harder into the library. He's been copying material on the Q.T. and taking it home to use in a sleep-teacher. His selection of material has been completely random, as far as I can tell."

"How's his unit production?" Lochmeister asked.

"Low, but accurate. I called him on the carpet about not watching his quota, and he just said: 'I'm sorry, Dr. Miller; I'm doing the best I can.'"

"So what do you think he's up to?"

"I'd say it was one of two things. He's either guessed what we're trying to do, or he's trying to solve our problem before we give it to him. In either case, I'd say we'd better let him alone for a while. Psychology has come a lot closer to being a science than it was when it started, but human beings are still

individuals. Remember von Nagel's constant."

Lochmeister grinned. Modern psychology's own peculiar brand of mathematics had come up with the "personality factor," which was a variable and had to be tested for the individual to whom the more general formulas were to be applied. Since the basic work had been done by Heinrich von Nagel, the name von Nagel's constant had been tacked on by association.

"You've seen the films from the cameras in his apartment. Did you interpret the glass-dropping incident the way I did?" Lochmeister asked.

"What else?" said Miller. "He would have quit within the next few weeks if you hadn't put that high-pressure house salesman on his wife. The baby, of course, was just our good luck."

"If you want to call it that." Lochmeister rubbed the end of his nose thoughtfully. "Well, O.K., leave him alone, if you think so. According to your figures, he should have cracked by now, though."

"Sure. But remember, any prediction has to be based on the well-known 'if this goes on—' assumption. We can't keep Dr. Bell here under laboratory conditions, you know."

"You're right. Well, as I said, he's your baby. Do whatever you think is best."

"Thanks. I'll try to work it out."

"What's the matter, sweetheart? Headache again?"

Conway lifted his head from his hands. "No. I'm just thinking. There's something screwy here, and I can't quite see what it is."

Pat lit two cigarettes and handed one to him. "There's been something nutty with this job ever since you took it. I thought for a while there was something wrong with you."

"There was," he said, rubbing his temples. "There still is. But that's not what I'm talking about. I'm talking about the ship. This million-unit generator—it doesn't check out."

He bit at his lower lip. "I think I'll take a walk around the block. Mind?"

"Of course not. Just a second; I'll get your coat."

"Thanks. And, by the way, do you happen to have the phone number of that doctor... what's his name... Godwin? You know, the psychometrist."

"Sure," she said. "I'll write it down for you."

She jotted down the number and helped him on with his coat.

"I'll be back in an hour or so," he said.

The night was dark and clear. There was no one abroad at this hour of the night in the small Connecticut town, so Conway had the streets to himself. He paid no attention to where his feet were taking him; he just walked. Something was trying to tie itself up in his

mind, but the pieces just couldn't quite connect.

That million-unit field generator, for instance. The space allotted for it was much too small to hold a million Kimball units. The generator was supposed to measure a hundred units on a side, each unit oscillating at a slightly different rate to give the proper resonance to the field as a whole.

A Kimball unit measured eight inches on a side, and no matter what kind of math you used, the generator had to be at least a sixty-seven foot cube. But it wasn't, according to the plans. The million-unit generator was exactly twelve and a half feet on a side.

All of which didn't make one bit of sense.

And why put *him* on a job like this? It was stupid. Why pay a physicist fifteen thousand a year to do a simple, easy job like that? It wasn't because of the precision. Anyone could be taught to make something that simple—or could he?

He frowned suddenly when he saw where he was. The lights of the little country bar shone gleamingly through the plate glass window. He hadn't had a drink in weeks, and he didn't think he wanted one now.

He shoved his hands deeper in his coat pockets and felt of the piece of paper Pat had put there. The phone call. Sure.

The door slid open for him and he walked back to the phone booth. After he had dialed, the screen swizzled around and snapped an

image into place—an elderly man with graying hair.

"Hello, Dr. Godwin. This is Conway Bell."

"Why, hello, Dr. Bell," the psychometrist said, smiling. "What can I do for you?"

"I'd like to ask you a few questions, if you've got the time. You can bill me for it; it's a professional question."

The doctor shrugged, still smiling. "If I think it's billable, I'll bill you."

"Good. Do you remember that party at my place just before Christmas? You were talking about frustration."

Godwin frowned puzzledly. "I don't remember any such talk that night—"

"As I remember," Conway interrupted, "you said that frustration results when someone wants to do something he can't do. You said there were two different kinds—physical and psychological. Something like that."

"Oh, yes, I recall the conversation now. What about it?"

"Which one did you say was the most dangerous?"

The puzzled look returned. "I wouldn't say either of them was more dangerous than the other. The frustration is caused by what appears to be an insurmountable obstacle. In either case, the proper therapy can help the patient to reorient his thinking so that the problem disappears."

Conway nodded. "I remember

that, but you gave a third example. Something about a guy writing bad poetry."

"Oh, yes. I see what you mean. I think I was referring to the man who doesn't realize that his problem is insurmountable. Or, that is, who doesn't even realize he has a problem. Basically, his frustration can be of either of the two basic types."

Conway thought a minute. Then he said: "O.K., now suppose a man is frustrated in his work. The hours are good, the pay is good, his superiors are easy to get along with, the chance for advancement is very good, and the work's a snap. But he's still frustrated."

"Is this a personal question, Dr. Bell?"

"Yes," Conway admitted.

"Well, I don't like to give snap diagnosis over the phone. Perhaps you could come to my office tomorrow, and—"

Conway shook his head. "I'll come to your office, if necessary, later. Right now, I want a snap diagnosis. A general sort of thing, if you see what I mean."

The doctor looked at him steadily for a full thirty seconds. "Very well, Dr. Bell. Keep in mind that this is not necessarily true in your case. But you say the job is easy; therefore I assume that it isn't physically impossible. Nevertheless, I'd say that you'd been given a job you can't handle. Too much responsibility, perhaps, or—" He stopped. "What's the matter, Dr. Bell?"

Conway just stood there, blink-



ing. Then he began nodding slowly. "Doctor," he said, "I think you've got it."

"What do you mean, Dr. Bell? I think—" Again he stopped. He was talking to a dead screen.

A man walked over to a car parked on a dark sidestreet. He dialed a code number on a special phone and waited for the screen to light up. When it did, he said: "Lochmeister, Bell just made a call to New York,

It was from a public phone, so we couldn't tap it, but we've traced it down to a Dr. Lewis Godwin. He's a psychometrist, it seems, and a good one. Shall I do anything about questioning Godwin?"

Lochmeister shook his head. "No. If it's what I think it is, Godwin wouldn't answer any questions; he'd claim it was a privileged communication." He chewed at his upper lip and thought for a moment. "I may be taking a little too much for

granted, but I don't think you'd better let him get anywhere near Godwin tonight. If necessary, you can always detain him for questioning because he copied classified material from the stacks."

"O.K. Anything else?"

"No. Just keep tabs on him. I'm going to call Miller."

Lochmeister cut the circuit.

"Don't you think you'd better go to bed, Conway?"

Conway shook his head. "No; I've got some thinking to do. Just shut out the lights and go to bed yourself. Good night, sweetheart."

"Do you want some coffee—or something?"

Conway stood up and put his hands on her shoulders. "Look, honey," he said, in a half-tender, half-exasperated voice, "if I want coffee, I'll get it myself. And I'll go to bed when I am ready to go to bed. Conway is a big boy now, remember? Now *you* go to bed," he said, and she could tell he meant it.

She kissed him quickly and went to the bedroom, leaving him alone in the study.

Conway turned and walked over to his desk. He sat down, picked up a pencil, and began to doodle on the pad of paper in front of him.

Item: He had been given a job he hated at a salary he couldn't resist.

Item: A Kimball unit is a precision instrument.

Item: One million Kimball units

go into a field generator, and two of them are exactly alike.

Item: The space allotted in the ship couldn't possibly hold a million Kimball units.

Subconclusion: Someone had designed a smaller, more compact unit.

Question: Why did they have him building the big ones?

Conway looked at the paper for a long time before he suddenly crumpled it up and threw it in the wastebasket. Then he walked over to the bookshelf that spread across one wall and selected three textbooks.

Von Nagel's "Basics of Human Symbology."

Caldwyn's "The Mathematics of Inference Reasoning."

Kelly's "Advanced Psychomathematics."

He looked at them ruefully. He'd taken courses in the elements of psychomath, but he'd never gone into it deeply. Oh, well; no time like the present.

Then, a few reference works. This time, it was stuff he knew and knew well.

"Probability Calculus and Matrix Theory."

"Field-Matrix Relationships."

"Games Theory and Society."

"And that," he said aloud, "ought to provide enough recreation for the evening."

In a way, he was wrong; it kept him busy through the whole week-end. When Monday morning rolled around, he was not only ready to

face Miller—he was hopping mad.

He walked into Miller's office with a brief case under his arm and said: "Dr. Miller, I want to talk to you."

"Certainly, Dr. Bell. What is it?" He leaned back in his chair and lit a cigarette, as though he were waiting to see what would happen.

"I've solved your little puzzle," Conway said harshly. He slammed the brief case down on the desk and pulled out some papers.

"What puzzle do you mean?" Miller asked quietly.

"You wanted to see if I could design new types of robot machinery for making precision parts that vary from one another. I think I've done it. If I haven't, to hell with it."

Miller pulled himself to his desk again, a puzzled look on his face. "Robot machinery?" He frowned. "What are you talking about, Dr. Bell?"

Conway pulled up a chair and looked at his superior with an expression that was almost a glower. "Don't kid me, Miller. I'm not in a mood for it. Your psychologists almost ruined my marriage, and almost ruined me in the bargain.

"You put me on a job that logically ought to be handled entirely by automatic machinery. Unfortunately, it can't, because each piece has to be precision made, and still be different from the others.

"It's an old gag, Miller. Andrew Carnegie once said that if you want an improvement in a job, give it to a lazy man; he'll figure out an easier way to do it.

"So you gave me the job of building a type of Kimball unit that was so obsolete it had no use. My job was to figure out a way to produce the things without going ga-ga. Well, there you are. I hope you'll be good enough to give me a recommendation when I quit."

Miller said absolutely nothing as he began looking over the sheets of paper Conway had put before him. After several minutes, he looked up again. "I'm afraid I don't quite understand the principle involved here, Dr. Bell."

It was Conway's turn to look surprised. He started to say something, but Miller stopped him by punching a button on the intercom.

"I want to talk to Mr. Kimbrough, of Machine Engineering, and Dr. Paul, of Research. Ask them to come to my office. And see if Lochmeister of Personnel will come, too." He paused, then added, "And ask Dr. Paul to bring up one of the new micro-type Kimball units."

He cut the circuit, folded his hands in front of him, and looked at Conway. "Tell me, Dr. Bell, exactly how did you come to this conclusion—about the machinery, I mean."

"Simple," Conway told him. "I felt frustrated in my job. Obviously, I was being forced to do something I couldn't do, but I didn't know I couldn't do it. Now, it couldn't be the job itself, because anyone could do that sort of thing.

"It meant I was being given a

problem to solve, and I couldn't do it because I didn't know what the problem was. As soon as I attacked it along those lines, I came up with the answer.

"But I think that's a pretty rough way to get a man to do a job. You could have asked me to design the stuff, and you could have told me what others have done in the field. For all I know, this stuff I've designed is already obsolete. But at least you know I can do that sort of work, and that's what I expect you to put in my recommendation to my next employer, whoever he may be."

"Did it ever occur to you that this might be a test?" Miller asked.

"It did," said Conway, "and I consider that making a man almost psychotically miserable for several months is a lousy way to conduct any kind of test.

"The question is: Did I come up with what you wanted, or not?"

Miller started to answer, but someone came into the office. He was followed a few seconds later by another man, and finally by Lochmeister.

The first two men were, as it turned out, Kimbrough and Paul. Miller made introductions all around, and then said: "Dr. Bell, I'd appreciate it if you'd tell these men exactly how you intend to manufacture Kimball units automatically."

Dr. Paul, a smallish, fuzzy-haired man in a white lab coat, said, "Automatically?" and blinked.

The broad-shouldered, heavy-set Kimbrough said nothing.

Lochmeister glanced at Miller as though to ask a question, and then looked back at Conway.

What's going on here? thought Conway. *This doesn't look right at all.* But he cleared his throat self-consciously and began.

"Well, it's obvious that anything like this can't be made with precision machinery if you try to get the pieces just exactly the way you want them. A robot just can't be made to do that type of exact work; parts will begin to wear and the units would be off as soon as three or four had been made.

"The thing to do is make the robots *less* accurate, instead of trying to get them to perfection."

"Less perfect," said Dr. Paul. He almost sounded baffled.

"Sure. After all, what do you want? A set of one million Kimball units. They have to have a frequency spread of a thousand cycles, and each unit in the series must differ from the next by one millicycle, with an allowable variation of ten microcycles. But the total range of frequency of the generator as a whole can vary ten cycles or more.

"What you're looking for, then, is a matched set. So we set up the machines to build units which will vary over a certain range. Depending on the machine, we will have to build several thousand pieces for each position in order to be sure of having a matched set."

He picked some of his papers off of Miller's desk.

"Here's your bell-shaped probability curve for each setting of the machine. Notice how each setting overlaps the next one, so that, in effect, you will have a continuous spectrum if you build enough of them. At least, it will be continuous for our purposes.

"Naturally, the curve won't be a perfect bell; it will skew to the right because of machine wear, but the system automatically compensates for that.

"Now, the only piece of precision equipment you'll need will be a test resonator. Each one will have to be set exactly so that it will resonate to the proper units in order to get a matching set of one million out of all the units made. It's the equivalent of a go-no-go gauge. If the unit resonates, it's part of the set, if it doesn't, it's part of some other set, for another generator. You simply have to get a new setting for each generator, and that can be determined by chance, too, in order to be sure that all the pieces are eventually used. All you have to do is set the resonator for a piece picked at random. All the rest are selected automatically."

There was a heavy silence as Kimbrough and Dr. Paul looked over the figures and graphs. Then the physicist ran his fingers through his fuzzy, gray hair and looked up at Conway with a very peculiar expression on his face.

"My boy," he said softly, "you're

a genius." He turned to Lochmeister. "I want this young man. That is, if he wants to work with me. And I assume he does, or he wouldn't be working on material like this." He looked back at Conway. "Isn't that right, boy?"

Before Conway had a chance to say anything, Miller cut in smoothly: "Dr. Bell can make his decision later, Dr. Paul. He'll be in to see you as soon as Lochmeister and I have had a chance to talk to him."

"All right. But please hurry; we have so much to do."

Kimbrough spoke for the first time. "Yeah. Kind of hurry it up. I'll have to cancel half a dozen projects to get to work on this." He grinned admiringly at Conway and followed Dr. Paul out of the room.

"What's going on here?" Conway asked, thoroughly confused.

"I'm damned if I know," said Lochmeister. "I'm as rocky as you are."

Dr. Miller waved a hand negligently. "Let's not get all excited. Sit down, both of you."

They sat.

"I have long known," Miller said, "that the human mind was capable of almost anything, but this is one of the most dramatic proofs I've ever seen. Given the wrong motivation and the wrong data, you have come up with what appears to be the right answer."

"I still don't get it," said Conway.

"You've threatened to quit,"

Miller pointed out. "Now, suppose we up your salary to twenty thousand a year?"

Conway thought of working with Dr. Paul on the system he had designed and grinned sheepishly. "Well, I guess I'd take it, naturally. I just thought it was a dirty trick you pulled on me, that's all."

"And suppose the job we give you is to pick million-unit sets out of the units made by your machinery?"

Conway didn't hesitate. "No," he said. "Definitely not. Not if you offered me fifty thousand. It would drive me nuts."

"You mean you couldn't do it?" Miller's voice was quiet, but it sounded as though the question were vital to him.

"Well, I—" Conway began, then he paused. After a moment, he said: "I think I see what you mean. No. No, I couldn't do it." He was thinking of what Godwin, the psychometrist had said about psychological frustration.

"Why not?" Miller asked.

"Because I'm psychologically incapable of doing routine, monotonous work."

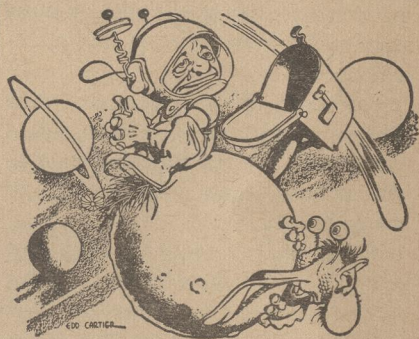
Miller leaned back in his chair and took a deep sigh of relief. "If you've learned that, then you've learned something that the average engineer knows but doesn't accept. You hear them say: 'I don't want that kind of job; any fool could do that.' And they're right, up to a certain point. Any fool might be able to do it, but *they* can't.

"Now, any job that a moron could do can be filled by automatic machinery. But there is a certain level of work which cannot be done by a moron because it's too complicated. On the other hand, it's too monotonous for the creative mind to handle.

"And that's the kind of job we had here. Until a few minutes ago, it was generally conceded that the interstellar ship was impossible to build."

"Impossible?" Conway still felt as though he were riding on a merry-go-round. "Why impossible?"

"Too complicated. You see, in building anything, you have to account for human error. Regardless of how careful you are, there are



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always going to be little mistakes in manufacture. And there is a certain type of person who either can't recognize a mistake when he sees it or is so afraid of making a mistake that he covers it up when he does recognize it.

"Adding more personnel as inspectors doesn't help; it simply adds to the human error already present, after a certain point of complexity is reached.

"Look at it this way. The Kimball generator for the mass-time converter has to have one million units in it. And *every single one* of those units has to be perfectly in tune.

"What we had to have was a man of precision, creative-quality mind to do the monotonous work of making every single one of those units and then putting them together."

Conway lit a cigarette while Miller paused, then he said: "And you couldn't get a precision man to do it, huh? Then why hire me to do it?"

"You weren't hired for that purpose," said Lochmeister. "Dr. Miller, here, had another idea."

"The trouble, at least the way I saw it," Miller went on, "lay in design. Our physicists said that the new micro-unit is as simple as the thing can possibly be made.

"We can't make it any simpler," they said. "And, anyhow, they're so simple now that any idiot could build them."

"And again, they were right.

They could be built in quantity if only one kind were required. But there were one million different kinds needed for each generator.

"What we wanted to do was show you that just because a creative mind can make *one* of them, it doesn't mean that another man can make a *million* of them correctly.

"But you have solved the problem in a completely different manner. You haven't simplified the Kimball unit any further; you've made a machine which will do the moron's work. And yet, all you've really done is push the solution one stage farther along."

Conway nodded his head slowly. "I see. We still need someone to do the precision work of selecting the units. But then—" Suddenly, he stopped and grinned.

"But that *is* your solution! With my method, we've taken the two extremes out of the problem. We no longer need the moron; the machine has replaced that type of work. And we don't need the creative mind, either, now. We've put the job in the hands of a man somewhere in between, who can handle it.

"The precision technician who checks for the units isn't going to have to do the monotonous work of a machine, and he isn't going to have to be distracted by every new idea that comes bubbling up inside his head, because he can control that, and the highly creative type can no more help thinking than he can help living."

"That's it, exactly," Miller

agreed. "But the average man in any class doesn't seem to realize the abilities and shortcomings of those in other classes. The average Joe Blow wonders where the creative man gets his ideas; the thinker wonders how Joe *keeps* from having ideas."

"Joe's lucky," said Conway. He was looking at the end of his fingertips without seeing them. "At least he gets some rest once in a while. He doesn't wake up in the middle of the night with an idea boiling around in his head that has to be put down on paper right away."

"Right," said Miller. "We need Joe, and we need him desperately because he can do something we can't."

Conway looked suddenly at Miller. "If you knew all this, Miller, why did I get the job? Why couldn't you have solved it? Or am I being personal?"

Miller looked at Lochmeister. Lochmeister grinned.

"How could he?" Lochmeister said. "Miller's no physicist. Except in general terms, he doesn't know an Allen wrench from the Zeeman effect."

"In fact," Miller added, smiling, "I thought an I-beam was the ray

of light that activates a photoelectric cell."

"He's a psychologist," Lochmeister said. "One of the top men in the field. This whole set-up was dummied for you."

Conway looked startled. Then, as he thought it over, he started laughing. "Played for a sucker, by golly! There's only one thing I object to, though."

"What's that?" Miller wanted to know.

"I don't think a psychologist is necessarily qualified to run an analogue computer."

"Me? No, but—"

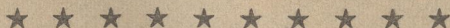
"And I resent being used as an analogue computer by incompetent personnel." He was grinning, but Miller couldn't figure it out.

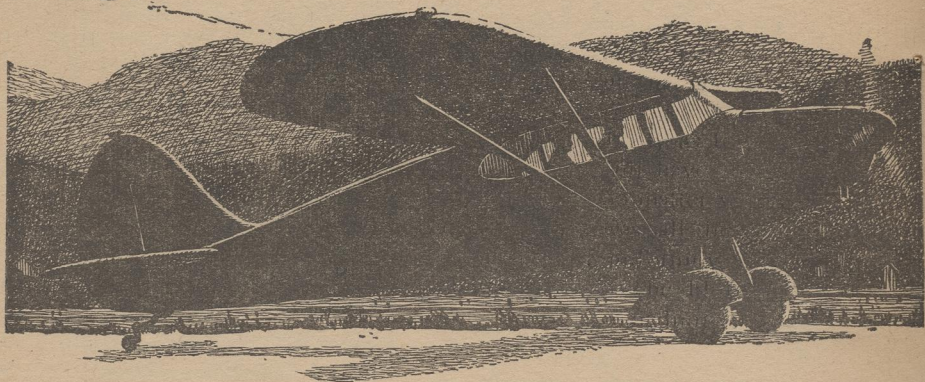
"You've got me, Bell. What are you talking about?"

"The whole project was frustrated because of what it thought was an insolvable problem," Conway said. "So what's the way to solve it? By analogy! Put a single man in place of a whole project. Give him the same insolvable problem—frustrate him—and see what he comes up with. And it worked."

A slow grin spread over Miller's face. "Well, I'll be damned!" he said.

THE END





TOMB TAPPER

The typical cybernetic control device is capable of carrying out explicit, logical instructions. Present ones are huge, massive, expensive, and not very reliable. If you're practical enough, there's a much cheaper substitute ...

BY JAMES BLISH

The distant glare of the atomic explosion had already faded from the sky as McDonough's car whirred away from the blacked-out town of Port Jervis and turned north. He was making fifty m.p.h.

on U.S. Route 209 using no lights but his parkers, and if a deer should bolt across the road ahead of him he would never see it until the impact. It was hard enough to see the road.



Illustrated by van Dongen

But he was thinking, not for the first time, of the old joke about the men who tapped train wheels.

He had been doing it, so the story ran, for thirty years. On every working day he would go up and down both sides of every locomotive that pulled into the yards and hit the wheels with a hammer: first the drivers, then the trucks. Each time, he would cock his head, as though listening for something in the sound. On the day of his retirement, he was given a magnificent dinner, as befitted a man with long seniority in the Brotherhood of Railway Trainmen—and somebody stopped to ask him what he had been tapping for all those years.

He had cocked his head as though

listening for something, but evidently nothing came. "I don't know," he said.

That's me, McDonough thought. I tap tombs, not trains. But what am I listening for?

The speedometer said he was close to the turnoff for the airport, and he pulled the dimmers on. There it was. There was at first nothing to be seen, as the headlights swept along the dirt road, but a wall of darkness deep as all night, faintly edged at the east by the low domed hills of the Neversink Valley. Then another pair of lights snapped on behind him, on the main highway, and came jolting after McDonough's car, clear and sharp in the dust clouds he had raised.

He swung the car to a stop beside the airport fence and killed the lights; the other car followed. In the renewed blackness the faint traces of dawn on the hills were wiped out, as though the whole universe had been set back an hour. Then the yellow eye of a flashlight opened in the window of the other car and stared into his face.

He opened the door. "Martinson?" he said tentatively.

"Right here," the adjutant's voice said. The flashlight's oval spoor swung to the ground. "Anybody else with you?"

"No. You?"

"No. Go ahead and get your equipment out. I'll open up the shack."

The oval spot of light bobbed across the parking area and came to

uneasy rest on the combination padlock which held the door of the operations shack secure. McDonough flipped the dome light of his car on long enough to locate the canvas sling which held the components of his electroencephalograph, and eased the sling out onto the sand.

He had just slammed the car door and taken up the burden when little chinks of light sprang into being in the blind windows of the shack. At the same time, cars came droning out onto the field from the opposite side, four of them, each with its wide-spaced unblinking slits of paired parking lights, and ranked themselves on either side of the landing strip. It would be dawn before long, but if the planes were ready to go before dawn, the cars could light the strip with their brights.

We're fast, McDonough thought, with brief pride. Even the Air Force thinks the Civil Air Patrol is just a bunch of amateurs, but we can put a mission in the air ahead of any other CAP squadron in this county. We can scramble.

He was getting his night vision back now, and a quick glance showed him that the windsock was flowing straight out above the black, silent hangar against the pearly false dawn. Aloft, the stars were paling without any cloud-dimming, or even much twinkling. The wind was steady north up the valley; ideal flying weather.

Small lumpy figures were running across the field from the parked cars

toward the shack. The squadron was scrambling.

"Mac!" Martinson shouted from inside the shack. "Where are you? Get your junk in here and get started!"

McDonough slipped inside the door, and swung his EEG components onto the chart table. Light was pouring into the briefing room from the tiny office, dazzling after the long darkness. In the briefing room the radio blinked a tiny red eye, but the squadron's communications officer hadn't yet arrived to answer it. In the office, Martinson's voice rumbled softly, urgently, and the phone gave him back thin unintelligible noises, like an unteachable parakeet.

Then, suddenly, the adjutant appeared at the office door and peered at McDonough. "What are you waiting for?" he said. "Get that mind reader of yours into the Cub on the double."

"What's wrong with the *Aeronca*? It's faster."

"Water in the gas; she ices up. We'll have to drain the tank. This is a hell of a time to argue." Martinson jerked open the squealing door which opened into the hangar, his hand groping for the light switch. McDonough followed him, supporting his sling with both hands, his elbows together. Nothing is quite so concentratedly heavy as an electronics chassis with a transformer mounted on it, and four of them make a back-wrenching load.

The adjutant was already hauling

the servicing platform across the concrete floor to the cowling of the Piper Cub. "Get your stuff set," he said. "I'll fuel her up and check the oil."

"All right. Doesn't look like she needs much gas."

"Don't you ever stop talkin'? Let's move!"

McDonough lowered his load to the cold floor beside the plane's cabin, feeling a brief flash of resentment. In daily life Martinson was a job printer who couldn't, and didn't, give orders to anybody, not even his wife. Well, those were usually the boys who let rank go to their heads, even in a volunteer outfit. He got to work.

Voices sounded from the shack, and then Andy Persons, the commanding officer, came bounding over the sill, followed by two sleepy-eyed cadets. "What's up?" he shouted. "That you, Martinson?"

"It's me. One of you cadets, pass me up that can. Andy, get the doors open, hey? There's a Russki bomber down north of us, somewhere near Howells. Part of a flight that was making a run on Schenectady."

"Did they get it?"

"No, they overshot, *way* over—took out Kingston instead. Stewart Field hit them just as they turned to regroup, and knocked this baby down on the first pass. We're supposed to—"

The rest of the adjutant's reply was lost in a growing, echoing roar, as though they were all standing

underneath a vast trestle over which all the railroad trains in the world were crossing at once. The sixty-four-foot organ-reeds of jets were being blown in the night zenith above the field—another hunting pack, come from Stewart Field to avenge the hydrogen agony that had been Kingston.

His head still inside the plane's greenhouse, McDonough listened transfixed. Like most CAP officers, he was too old to be a jet pilot, his reflexes too slow, his eyesight too far over the line, his belly muscles too soft to take the five-gravity turns; but now and then he thought about what it might be like to ride one of those flying blowtorches, cruising at six hundred miles an hour before a thin black wake of kerosene fumes, or being followed along the ground at top speed by the double wave-front of the "supersonic bang." It was a noble notion, almost as fine as that of piloting the one-man Niagara of power that was a rocket fighter.

The noise grew until it seemed certain that the invisible jets were going to bullet directly through the hangar, and then dimmed gradually.

"The usual orders?" Persons shouted up from under the declining roar. "Find the plane, pump the live survivors, pick the corpses' brains? Who else is up?"

"Nobody," Martinson said, coming down from the ladder and hauling it clear of the plane. "Middletown squadron's de-activat-

ed; Montgomery hasn't got a plane; Newburgh hasn't got a field."

"Warwick has Group's L-16—"

"They snapped the undercarriage off it last week," Martinson said with gloomy satisfaction. "It's our baby, as usual. Mac, you got your ghoul-tools all set in there?"

"In a minute," McDonough said. He was already wearing the Walter goggles, pushed back up on his helmet, and the detector, amplifier and power pack of the EEG were secure in their frames on the platform behind the Cub's rear seat. The "hair net"—the flexible network of electrodes which he would jam on the head of any dead man whose head had survived the bomber crash—was connected to them and hung in its clips under the seat, the leads strung to avoid fouling the plane's exposed control cables. Nothing remained to do now but to secure the frequency analyzer, which was the heaviest of the units and had to be bolted down just forward of the rear joystick so that its weight would not shift in flight. If the apparatus didn't have to be callimated after every flight, it could be left in the plane—but it did, and that was that.

"O.K.," he said, pulling his head out of the greenhouse. He was trembling slightly. These tomb-tapping expeditions were hard on the nerves. No matter how much training in the art of reading a dead mind you may have had, the actual experience is different, and cannot be duplicated from the long-stored corpses of the

laboratory. The newly-dead brain is an inferno, almost by definition.

"Good," Persons said. "Martinson, you'll pilot. Mac, keep on the air; we're going to refuel the *Airo-knocker* and get it up by ten o'clock if we can. In any case we'll feed you any spottings we get from the Air Force as fast as they come in. Martinson, refuel at Montgomery if you have to; don't waste time coming back here. Got it?"

"Roger," Martinson said, scrambling into the front seat and buckling his safety belt. McDonough put his foot hastily into the stirrup and swung into the back seat.

"Cadets!" Persons said. "Pull chocks! Roll 'er!"

Characteristically, Persons himself did the heavy work of lifting and swinging the tail. The Cub bumped off the apron and out on the grass into the brightening morning.

"Switch off!" the cadet at the nose called. "Gas! Brakes!"

"Switch off, brakes," Martinson called back. "Mac, where to? Got any ideas?"

While McDonough thought about it, the cadet pulled the prop backwards through four turns. "Brakes! Contact!"

"Let's try up around the Otisville tunnel. If they were knocked down over Howells, they stood a good chance to wind up on the side of that mountain."

Martinson nodded and reached a gloved hand over his head. "Contact!" he shouted, and turned the switch. The cadet swung the prop,

and the engine barked and roared; at McDonough's left, the duplicate throttle slid forward slightly as the pilot "caught" the engine. McDonough buttoned up the cabin, and then the plane began to roll toward the far, dim edge of the grassy field.

The sky got brighter. They were off again, to tap on another man's tomb, and ask of the dim voice inside it what memories it had left unspoken when it had died.

The Civil Air Patrol is, and has, been since 1941, an auxiliary of the United States Air Force, active in coastal patrol and in air-sea rescue work. By 1954—when its ranks totaled more than eighty thousand men and women, about fifteen thousand of them licensed pilots—the Air Force had nerved itself up to designating CAP as its Air Intelligence arm, with the job of locating downed enemy planes and radioing back information of military importance.

Aerial search is primarily the task of planes which can fly low and slow. Air Intelligence requires speed, since the kind of tactical information an enemy wreck may offer can grow cold within a few hours. The CAP's planes, most of them single-engine, private-flying models, had already been proven ideal aerial search instruments; the CAP's radio net, with its more than seventy-five hundred fixed, mobile and airborne stations, was more than fast enough to get information to wherever it was needed while it was still hot.

But the expected enemy, after all,

was Russia; and how many civilians, even those who know how to fly, navigate or operate a radio transmitter, could ask anyone an intelligent question in Russian, let alone understand the answer?

It was the astonishingly rapid development of electrical methods for probing the brain which provided the answer—in particular the development, in the late fifties, of flicker-stimulus aimed at the visual memory. Abruptly, EEG technicians no longer needed to use language at all to probe the brain for visual images, and read them; they did not even need to know how their apparatus worked, let alone the brain. A few moments of flicker into the subject's eyes, on a frequency chosen from a table, and the images would come swarming into the operator's toposcope goggles—the frequency chosen without the slightest basic knowledge of electrophysiology, as a woman choosing an ingredient from a cookbook is ignorant of—and indifferent to—the chemistry involved in the choice.

It was that engineering discovery which put tomb-tappers into the back seats of the CAP's putt-putts when the war finally began—for the images in the toposcope goggles did not stop when the brain died.

The world at dawn, as McDonough saw it from three thousand feet, was a world of long sculptured shadows, almost as motionless and three-dimensional as a lunar landscape near the daylight terminator.

The air was very quiet, and the Cub droned as gently through the blue haze as any bee, gaining altitude above the field in a series of wide climbing turns. At the last turn the plane wheeled south over a farm owned by someone Martinson knew, a man already turning his acres from the seat of his tractor, and Martinson wagged the plane's wings at him and got back a wave like the quivering of an insect's antenna. It was all deceptively normal.

Then the horizon dipped below the Cub's nose again and Martinson was climbing out of the valley. A lake passed below them, spotted with islands, and with the brown barracks of Camp Cejwin, once a children's summer camp but now full of sleeping soldiers. Martinson continued south, skirting Port Jervis, until McDonough was able to pick up the main line of the Erie Railroad, going northeast toward Otisville and Howells. The mountain through which the Otisville tunnel ran was already visible as a smoky hulk to the far left of the dawn.

McDonough turned on the radio, which responded with a rhythmical sputtering; the Cub's engine was not adequately shielded. In the background, the C.O.'s voice was calling them: "Huguenot to L-4. Huguenot to L-4."

"L-4 here. We read you, Andy. We're heading toward Otisville. Smooth as glass up here. Nothing to report yet."

"We read you weak but clear. We're dumping the gas in the *Airo-*

knocker crackle ground. We'll follow as fast as possible. No new AF spottings yet. If *crackle*, call us right away. Over."

"L-4 to Huguenot. Lost the last sentence, Andy. Cylinder static. Lost the last sentence. Please read it back."

"All right, Mac. If you see the bomber, *crackle* right away. Got it? If you see *crackle*, call us right away. Got it? Over."

"Got it, Andy. L-4 to Huguenot, over and out."

"Over and out."

The railroad embankment below them went around a wide arc and separated deceptively into two. One of the lines had been pulled up years back, but the marks of the long-ago stacked and burned ties still striped the gravel bed, and it would have been impossible for a stranger to tell from the air whether or not there were any rails running over those marks; terrain from the air can be deceptive unless you know what it is supposed to look like, rather than what it does look like. Martinson, however, knew as well as McDonough which of the two rail spurs was the discontinued one, and banked the Cub in a gentle climbing turn toward the mountain.

The rectangular acres wheeled slowly and solemnly below them, brindled with tiny cows as motionless as toys. After a while the deceptive spur-line turned sharply east into a woolly green woods and never came out again. The mountain got larger, the morning ground haze

rising up its nearer side, as though the whole forest were smoldering sullenly there.

Martinson turned his head and leaned it back to look out of the corner of one eye at the back seat, but McDonough shook his head. There was no chance at all that the crashed bomber could be on this side of that heavy-shouldered mass of rock.

Martinson shrugged and eased the stick back. The plane bored up into the sky, past four thousand feet, past four thousand, five hundred. Lake Hawthorne passed under the Cub's fat little tires, an irregular sapphire set in the pommel of the mountain. The altimeter crept slowly past five thousand feet; Martinson was taking no chances on being caught in the downdraft on the other side of the hill. At six thousand, he edged the throttle back and leveled out, peering back through the plexiglass.

But there was no sign of any wreck on that side of the mountain, either.

Puzzled, McDonough forced up the top cabin flap on the right side, buttoned it into place against the buffeting slipstream, and thrust his head out into the tearing gale. There was nothing to see on the ground. Straight down, the knife-edge brow of the cliff from which the railroad tracks emerged again drifted slowly away from the Cub's tail; just an inch farther on was the matchbox which was the Otisville siding shack. A sort of shaking of pepper around

the matchbox meant people, a small crowd of them—though there was no train due until the Eric's No. 6, which didn't stop at Otisville anyhow.

He thumped Martinson on the shoulder. The adjutant tilted his head back and shouted, "What?"

"Bank right. Something going on around the Otisville station. Go down a bit."

The adjutant jerked out the carburetor-heat toggle and pulled back the throttle. The plane, idling, went into a long, whistling glide along the railroad right of way.

"Can't go too low here," he said. "If we get caught in the downdraft, we'll get slammed right into the mountain."

"I know that. Go on about four miles and make an airline approach back. Then you can climb into the draft. I want to see what's going on down there."

Martinson shrugged and opened the throttle again. The Cub clawed for altitude, then made a half-turn over Howells for the bogus landing run.

The plane went into normal glide and McDonough craned his neck. In a few moments he was able to see what had happened down below. The mountain from this side was steep and sharp; a wounded bomber couldn't possibly have hoped to clear it. At night, on the other hand, the mouth of the railroad tunnel was marked on all three sides, by the lights of the station on the left, the neon sign of the tavern

which stood on the brow of the cliff in Otisville ("Pop. 3,000—High and Healthy"), and on the right by the Erie's own signal standard. Radar would have shown the rest: the long regular path of the embankment leading directly into that cul-de-sac of lights, the beetling mass of contours which was the mountain. All these signs would mean "tunnel" in any language.

And the bomber pilot had taken the longest of all possible chances: to come down gliding along the right of way, in the hope of shooting his fuselage cleanly into that tunnel, leaving behind his wings with their dangerous engines and fuel tanks. It was absolutely insane, but that was what he had done.

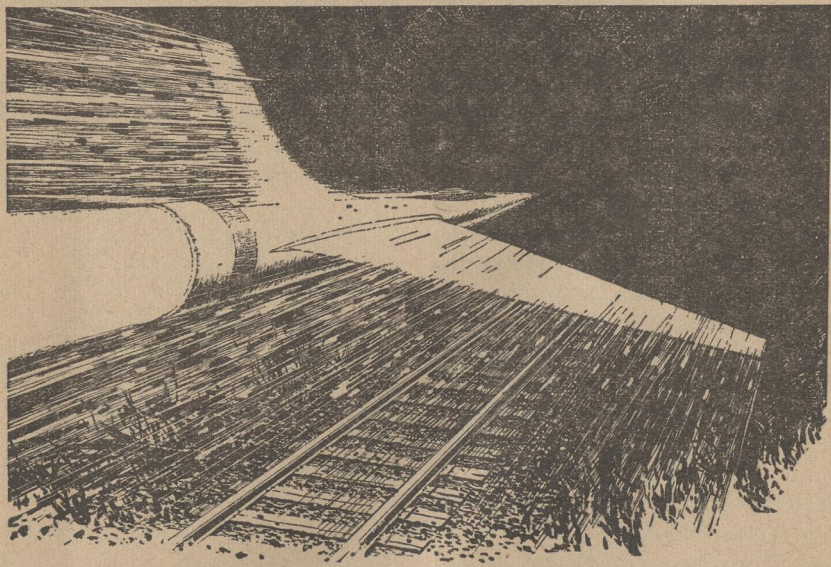
And, miracle of miracles, he had

made it. McDonough could see the wings now, buttered into two-dimensional profiles over the two pilasters of the tunnel. They had hit with such force that the fuel in them must have been vaporized instantly; at least, there was no sign of a fire. And no sign of a fuselage, either.

The bomber's body was inside the mountain, probably halfway or more down the tunnel's one-mile length. It was inconceivable that there could be anything intelligible left of it; but where one miracle has happened, two are possible.

No wonder the little Otisville station was peppered over with the specks of wondering people.

"L-4 to Huguenot. L-4 to Huguenot. Andy, are you there?"



"We read you, Mac. Go ahead."

"We've found your bomber. It's in the Otisville tunnel. Over."

"Crackle to L-4. You've lost your mind."

"That's where it is, all the same. We're going to try to make a landing. Send us a team as soon as you can. Out."

"Huguenot to L-4. Don't be a crackle idiot, Mac, you can't land there."

"Out," McDonough said. He pounded Martinson's shoulder and gestured urgently downward.

"You want to land?" Martinson said. "Why didn't you say so? We'll never get down on a shallow glide like this." He cleared the engine with a brief burp on the throttle, pulled the Cub up into a sharp stall, and slid off on one wing. The whole world began to spin giddily.

Martinson was losing altitude. McDonough closed his eyes and hung onto his back teeth.

Martinson's drastic piloting got them down to a rough landing, on the wheels, on the road leading to the Otisville station, slightly under a mile away from the mountain. They taxied the rest of the way. The crowd left the mouth of the tunnel to cluster around the airplane the moment it had come to a stop, but a few moments' questioning convinced McDonough that the Otisvillians knew very little. Some of them had heard "a turrrible noise" in the early morning, and with the first light had discovered the bright metal

coating the sides of the tunnel. No, there hadn't been any smoke. No, nobody heard any sounds in the tunnel. You couldn't see the other end of it, though. Something was blocking it.

"The signal's red on this side," McDonough said thoughtfully while he helped the adjutant tie the plane down. "You used to run the PBX board for the Erie in Port, didn't you, Marty? If you were to phone the station master there, maybe we could get him to throw a block on the other end of the tunnel."

"If there's wreckage in there, the block will be on automatically."

"Sure. But we've got to go in there. I don't want the Number Six piling in after us."

Martinson nodded, and went inside the railroad station. McDonough looked around. There was, as usual, a motorized hand-truck parked off the tracks on the other side of the embankment. Many willing hands helped him set it on the right of way, and several huskies got the one-lung engine started for him. Getting his own apparatus out of the plane and onto the truck, however, was a job for which he refused all aid. The stuff was just too delicate, for all its weight, to be allowed in the hands of laymen—and never mind that McDonough himself was almost as much of a layman in neurophysiology as they were; he at least knew the collimating tables and the cookbook.

"O.K.," Martinson said, rejoining them. "Tunnel's blocked at both

ends. I talked to Ralph at the dispatcher's; he was steaming—says he's lost four trains already, and another due in from Buffalo in forty-four minutes. We cried a little about it. Do we go now?"

"Right now."

Martinson drew his automatic and squatted down on the front of the truck. The little car growled and crawled toward the tunnel. The spectators murmured and shook their heads knowingly.

Inside the tunnel it was as dark as always, and cold, with a damp chill which struck through McDonough's flight jacket and dungarees. The air was still, and in addition to its musty smell it had a peculiar metallic stench. Thus far, however, there was none of the smell of fuel or of combustion products which McDonough had expected. He found suddenly that he was trembling again, although he did not really believe that the EEG would be needed.

"Did you notice those wings?" Martinson said suddenly, just loud enough to be heard above the popping of the motor. The echoes distorted his voice almost beyond recognition.

"Notice them? What about them?"

"Too short to be bomber wings. Also, no engines."

McDonough swore silently. To have failed to notice a detail as gross as that was a sure sign that he was even more frightened than he had thought. "Anything else?"

"Well, I don't think they were aluminum; too tough. Titanium, maybe, or stainless steel. What have we got in here, anyhow? You *know* the Russkies couldn't get a fighter this far."

There was no arguing that. There was no answering the question, either—not yet.

McDonough unhooked the torch from his belt. Behind them, the white aperture of the tunnel's mouth looked no bigger than a nickel, and the twin bright lines of the rails looked forty miles long. Ahead, the flashlight revealed nothing but the slimy walls of the tunnel, coated with soot.

And then there was a fugitive bluish gleam. McDonough set the motor back down as far as it would go. The truck crawled painfully through the stifling blackness. The thudding of the engine was painful, as though his own heart were trying to move the heavy platform.

The gleam came closer. Nothing moved around it. It was metal, reflecting the light from his torch. Martinson lit his own and brought it into play.

The truck stopped, and there was absolute silence except for the ticking of water on the floor of the tunnel.

"It's a rocket," Martinson whispered. His torch roved over the ridiculously inadequate tail empenage facing them. It was badly crumpled. "In fair shape, considering. At the clip he was going, he

must have slammed back and forth like an alarm clapper."

Cautiously they got off the truck and prowled around the gleaming, badly dented spindle. There were clean shears where the wings had been, but the stubs still remained, as though the metal itself had given to the impact before the joints could. That meant welded construction throughout, McDonough remembered vaguely. The vessel rested now roughly in the center of the tunnel, and the railroad tracks had spraddled under its weight. The fuselage bore no identifying marks, except for a red star at the nose; or rather, a red asterisk.

Martinson's torch lingered over the star for a moment, but the adjutant offered no comment. He went around the nose, McDonough trailing.

On the other side of the ship was the death wound: a small, ragged tear in the metal, not far forward of the tail. Some of the raw curls of metal were partially melted. Martinson touched one.

"Flak," he muttered. "Cut his fuel lines. Lucky he didn't blow up."

"How do we get in?" McDonough said nervously. "The cabin didn't even crack. And we can't crawl through that hole."

Martinson thought about it. Then he bent to the lesion in the ship's skin, took a deep breath, and belatedly at the top of his voice:

"Hey in there! Open up!"

It took a long time for the echoes to die away. McDonough was para-

lyzed with pure fright. Anyone of those distorted, ominous rebounding voices could have been an answer. Finally, however, the silence came back.

"So he's dead," Martinson said practically. "I'll bet even his foot-bones are broken, every one of 'em. Mac, stick your hair net in there and see if you can pick up anything."

"N-not a chance. I can't get anything unless the electrodes are actually t-touching the skull."

"Try it anyhow, and then we can get out of here and let the experts take over. I've about made up my mind it's a missile, anyhow. With this little damage, it could still go off."

McDonough had been repressing that notion since his first sight of the spindle. The attempt to save the fuselage intact, the piloting skill involved, and the obvious cabin windshield all argued against it; but even the bare possibility was somehow twice as terrifying, here under a mountain, as it would have been in the open. With so enormous a mass of rock pressing down on him, and the ravening energies of a sun perhaps waiting to break loose by his side—

No, no; it was a fighter, and the pilot might somehow still be alive. He almost ran to get the electrode net off the truck. He dangled it on its cable inside the flak tear, pulled the goggles over his eyes, and flicked the switch with his thumb.

The Walter goggles made the

world inside the tunnel no darker than it actually was, but knowing that he would now be unable to see any gleam of light in the tunnel, should one appear from somewhere—say, in the ultimate glare of hydrogen fusion—increased the pressure of blackness on his brain. Back on the truck the frequency-analyzer began its regular, meaningless peeping, scanning the possible cortical output bands in order of likelihood: First the 0.5 to 3.5 cycles/second band, the delta wave, the last activity of the brain detectable before death; then the four to seven c.p.s. theta channel, the pleasure-scanning waves which went on even during sleep; the alpha rhythm, the visual scanner at eight to thirteen c.p.s.; the beta rhythms at fourteen to thirty c.p.s. which mirror the tensions of conscious computation, not far below the level of real thought; the gamma band, where—

The goggles lit.

... And still the dazzling sky-blue sheep are grazing in the red field under the rainbow-billed and pea-green birds ...

McDonough snatched the goggles up with a gasp, and stared frantically into the blackness, now swimming with residual images in contrasting colors, melting gradually as the rods and cones in his retina gave up the energy they had absorbed from the scene in the goggles. Curiously, he knew at once where the voice had come from; it had been his mother's, reading to him,

on Christmas Eve, a story called "A Child's Christmas in Wales." He had not thought of it in well over two decades, but the scene in the toposcope goggles had called it forth irresistibly.

"What's the matter?" Martinson's voice said. "Get anything? Are you sick?"

"No," McDonough muttered. "Nothing."

"Then let's beat it. Do you make a noise like that over nothing every day? My Uncle Crosby did, but then, *he* had asthma."

Tentatively, McDonough lowered the goggles again. The scene came back, still in the same impossible colors, and almost completely without motion. Now that he was able to look at it again, however, he saw that the blue animals were not sheep; they were too large, and they had faces rather like those of kittens. Nor were the enormously slow-moving birds actually birds at all, except that they did seem to be flying—in unlikely straight lines, with slow, mathematically even flappings of un-winglike wings; there was something vegetable about them. The red field was only a dazzling blur, hazing the feet of the blue animals with the huge, innocent kitten's faces. As for the sky, it hardly seemed to be there at all; it was as white as paper.

"Come on," Martinson muttered, his voice edged with irritation. "What's the sense of staying in this hole any more? You bucking for pneumonia?"

"There's... something alive in there."

"Not a chance," Martinson said. His voice was noticeably more ragged. "You're dreaming. You said yourself you couldn't pick up—"

"I know what I'm doing," McDonough insisted, watching the scene in the goggles. "There's a live brain in there. Something nobody's ever hit before. It's powerful—no mind in the books ever put out a broadcast like this. It isn't human."

"All the more reason to call in the AF and quit. We can't get in there anyhow. What do you mean, it isn't human? It's a Red, that's all."

"No 'it isn't," McDonough said evenly. Now that he thought he knew what they had found, he had stopped trembling. He was still terrified, but it was a different kind of terror: the fright of a man who has at last gotten a clear idea of what it is he is up against. "Human beings just don't broadcast like this. Especially not when they're near dying. And they don't remember huge blue sheep with cat's heads on them, or red grass, or a white sky. Not even if they come from the USSR. Whoever it is in there comes from some place else."

"You read too much. What about the star on the nose?"

McDonough drew a deep breath. "What about it?" he said steadily. "It isn't the insignia of the Red Air Force. I saw that it stopped you, too. No air force I ever heard of

flies a red asterisk. It isn't a cocarde at all. It's just what it is."

"An asterisk?" Martinson said angrily.

"No, Marty, I think it's a star. A symbol for a *real* star. The AF's gone and knocked us down a spaceship." He pushed the goggles up and carefully withdrew the electrode net from the hole in the battered fuselage.

"And," he said carefully, "the pilot, whatever he is, is still alive—and thinking about home, wherever *that* is."

In the ensuing silence, McDonough realized belatedly that Martinson was as frightened as he was.

Though the Air Force had been duly notified by the radio net of McDonough's preposterous discovery, it took its own time about getting a technical crew over to Otisville. It had to, regardless of how much stock it took in the theory. The nearest source of advanced Air Force EEG equipment was just outside Newburgh, at Stewart Field, and it would have to be driven to Otisville by truck; no AF plane slow enough to duplicate Martinson's landing on the road could have handled the necessary payload.

For several hours, therefore, McDonough could do pretty much as he liked with his prize. After only a little urging, Martinson got the Erie dispatcher to send an oxyacetylene torch to the Port Jervis side of the tunnel, on board a Diesel camelback. Persons, who had subse-

quently arrived in the *Aeronca*, was all for trying it immediately in the tunnel, but McDonough was restrained by some dim memory of high school experiments with magnesium, a metal which looked very much like this. He persuaded the C.O. to try the torch on the smeared wings first.

The wings didn't burn. They carried the torch into the tunnel, and Persons got to work with it, enlarging the flak hole.

"Is that what-is-it still alive?" Persons asked, cutting steadily.

"I think so," McDonough said, his eyes averted from the tiny sun of the torch. "I've been sticking the electrodes in there about once every five minutes. I get essentially the same picture. But it's getting steadily weaker."

"D'you think we'll reach it before it dies?"

"I don't know. I'm not even sure I want to."

Persons thought that over, lifting the torch from the metal. Then he said, "You've got something there. Maybe I better try that gadget and see what I think."

"No," McDonough said. "It isn't tuned to you."

"Orders, Mac. Let me give it a try. Hand it over."

"It isn't that, Andy. I wouldn't buck you, you know that; you made this squadron. But it's dangerous. Do you want to have an epileptic fit? The chances are nine to five that you would."

"Oh," Persons said. "All right.

It's your show." He resumed cutting.

After a while McDonough said, in a remote, emotionless voice: "That's enough. I think I can get through there now, as soon as it cools."

"Suppose there's no passage between the tail and the nose?" Martinson said. "More likely there's a firewall, and we'd never be able to cut through that."

"Probably," McDonough agreed. "We couldn't run the torch near the fuel tanks, anyhow, that's for sure."

"Then what good—"

"If these people think anything like we do, there's bound to be some kind of escape mechanism—something that blows the pilot's capsule free of the ship. I ought to be able to reach it."

"And fire it in *here*?" Persons said. "You'll smash the cabin against the tunnel roof. That'll kill the pilot for sure."

"Not if I disarm it. If I can get the charge out of it, all firing it will do is open the locking devices; then we can take the windshield off and get in. I'll pass the charge out back to you; handle it gently. Let me have your flashlight, Marty, mine's almost dead."

Silently, Martinson handed him the light. He hesitated a moment, listening to the water dripping in the background. Then, with a deep breath, he said, "Well. Here goes nothin'."

He clambered into the narrow opening.

The jungle of pipes, wires and pumps before him was utterly unfamiliar in detail, but familiar in principle. Human beings, given the job of setting up a rocket motor, set it up in this general way. McDonough probed with the light beam, looking for a passage large enough for him to wiggle through.

There didn't seem to be any such passage, but he squirmed his way forward regardless, forcing himself into any opening that presented itself, no matter how small and contorted it seemed. The feeling of entrapment was terrible. If he were to wind up in a cul-de-sac, he would never be able to worm himself backwards out of this jungle of piping—

He hit his head a sharp crack on a metal roof, and the metal resounded hollowly. A tank of some kind,

empty, or nearly empty. Oxygen? No, unless the stuff had evaporated long ago; the skin of the tank was no colder than any of the other surfaces he had encountered. Propellant, perhaps, or compressed nitrogen—something like that.

Between the tank and what he took to be the inside of the hull, there was a low freeway, just high enough for him to squeeze through if he turned his head sideways. There were occasional supports and ganglions of wiring to be writhed around, but the going was a little better than it had been, back in the engine compartment. Then his head lifted into a slightly larger space, made of walls that curved gently against each other: the front of the tank, he guessed, opposed to the floor of the pilot's capsule and the belly of the hull. Between the cap-



sule and the hull, up rather high, was the outside curve of a tube, large in diameter but very short; it was encrusted with motors, small pumps, and wiring.

An air lock? It certainly looked like one. If so, the trick with the escape mechanism might not have to be worked at all—if indeed the escape device existed.

Finding that he could raise his shoulders enough to rest on his elbows, he studied the wiring. The thickest of the cables emerged from the pilot's capsule; that should be the power line, ready to activate the whole business when the pilot hit the switch. If so, it could be shorted out—provided that there was still any juice in the batteries.

He managed to get the big nippers free of his belt, and dragged forward into a position where he could use them, with considerable straining. He closed their needlelike teeth around the cable and squeezed with all his might. The jaws closed slowly, and the cusps bit in.

There was a deep, surging hum, and all the pumps and motors began to whirr and throb. From back the way he had come, he heard a very muffled distant shout of astonishment.

He hooked the nippers back into his belt and inched forward, raising his back until he was almost curled into a ball. By careful, small movements, as though he were being born, he managed to somersault painfully in the cramped, curved space, and get his head and shoul-

ders back under the tank again, face up this time. He had to trail the flashlight, so that his progress backwards through the utter darkness was as blind as a mole's; but he made it, at long last.

The tunnel, once he had tumbled out into it again, seemed miraculously spacious—almost like flying.

"The damn door opened right up, all by itself," Martinson was chattering. "Scared me green. What'd you do—say 'Open sesame' or something?"

"Yeah," McDonough said. He rescued his electrode net from the handtruck and went forward to the gaping air lock. The door had blocked most of the rest of the tunnel, but it was open wide enough.

It wasn't much of an air lock. As he had seen from inside, it was too short to hold a man; probably it had only been intended to moderate the pressure-drop between inside and outside, not prevent such a drop absolutely. Only the outer door had the proper bank-vault heaviness of a true air lock. The inner one, open, was now nothing but a narrow ring of serrated blades, machined to a Johannsen-block finish so fine that they were air-tight by virtue of molecular cohesion alone—a highly perfected iris diaphragm. McDonough wondered vaguely how the pinpoint hole in the center of the diaphragm was plugged when the iris was fully closed, but his layman's knowledge of engineering failed him entirely there; he could come up with nothing better than a vision of the pilot

plugging that hole with a wad of well-chewed bubblegum.

He sniffed the damp, cold, still air. Nothing. If the pilot had breathed anything alien to Earth-normal air, it had already dissipated without trace in the organ pipe of the tunnel. He flashed his light inside the cabin.

The instruments were smashed beyond hope, except for a few at the sides of the capsule. The pilot had smashed them—or rather, his environment had.

Before him in the light of the torch was a heavy, transparent tank of iridescent greenish-brown fluid, with a small figure floating inside it. It had been the tank, which had broken free of its moorings, which had smashed up the rest of the compartment. The pilot was completely enclosed in what looked like an ordinary G-suit, inside the oil; flexible hoses connected to bottles on the ceiling fed him his atmosphere, whatever it was. The hoses hadn't broken, but something inside the G-suit had; a line of tiny bubbles was rising from somewhere near the pilot's neck.

He pressed the EEG electrode net against the tank and looked into the Walter goggles. The sheep with the kittens faces were still there, somewhat changed in position; but almost all of the color had washed out of the scene. McDonough grunted involuntarily. There was now an atmosphere about the picture which hit him like a blow, a feeling of

intense oppression, of intense distress—

"Marty," he said hoarsely. "Let's see if we can't cut into that tank from the bottom somehow." He backed down into the tunnel.

"Why? If he's got internal injuries—"

"The suit's been breached. It's filling with that oil from the bottom. If we don't drain the tank, he'll drown first."

"All right. Still think he's a man-from-Mars, Mac?"

"I don't know. It's too small to be a man, you can see that. And the memories aren't like human memories. That's all I know. Can we drill the tank some place?"

"Don't need to," Persons' echo-distorted voice said from inside the air lock. The reflections of his flashlight shifted in the opening like ghosts. "I just found a drain pet cock. Roll up your trouser cuffs, gents."

But the oil didn't drain out of the ship. Evidently it went into storage somewhere inside the hull, to be pumped back into the pilot's cocoon when it was needed again.

It took a long time. The silence came flooding back into the tunnel.

"That oil-suspension trick is neat," Martinson whispered edgily. "Cushions him like a fish. He's got inertia still, but no mass—like a man in free fall."

McDonough fidgeted, but said nothing. He was trying to imagine what the multi-colored vision of the

pilot could mean. Something about it was nagging at him. It was wrong. Why would a still-conscious and gravely injured pilot be solely preoccupied with remembering the fields of home? Why wasn't he trying to save himself instead—as ingeniously as he had tried to save the ship? He still had electrical power, and in that litter of smashed apparatus which he alone could recognize, there must surely be expedients which still awaited his trial. But he had already given up, though he knew he was dying.

Or did he? The emotional aura suggested a knowledge of things desperately wrong, yet there was no real desperation, no frenzy, hardly any fear—almost as though the pilot did not know what death was, or, knowing it, was confident that it could not happen to him. The immensely powerful, dying mind inside the G-suit seemed curiously uncaring and passive, as though it awaited rescue with supreme confidence—so supreme that it could afford to drift, in an oil-suspended floating-dream of home, nostalgic and unhappy, but not really afraid.

And yet it was dying!

"Almost empty," Andy Persons' quiet, garbled voice said into the tunnel.

Clenching his teeth, McDonough hitched himself into the air lock again and tried to tap the fading thoughts on a higher frequency. But there was simply nothing to hear or see, though with a brain so strong, there should have been, at

as short a range as this. And it was peculiar, too, that the visual dream never changed. The flow of thoughts in a powerful human mind is bewilderingly rapid; it takes weeks of analysis by specialists before its essential pattern emerges. This mind, on the other hand, had been holding tenaciously to this one thought—complicated though it was—for a minimum of two hours. A truly sub-idiot performance—being broadcast with all the drive of a super genius.

Nothing in the cookbook provided McDonough with any precedent for it.

The suited figure was now slumped against the side of the empty tank, and the shapes inside the toposcope goggles suddenly began to be distorted with regular, wrenching blurs: pain waves. A test at the level of the theta waves confirmed it; the unknown brain was responding to the pain with terrible knots of rage, real blasts of it, so strong and uncontrolled that McDonough could not endure them for more than a second. His hand was shaking so hard that he could hardly tune back to the gamma level again.

"We should have left the oil there," he whispered. "We've moved him too much. The internal injuries are going to kill him in a few minutes."

"We couldn't let him drown, you said so yourself," Persons said practically. "Look, there's a seam on this tank that looks like a torsion seal. If we break it, it ought to open

up like a tired clam. Then we can get him out of here."

As he spoke, the empty tank parted into two shell-like halves. The pilot lay slumped and twisted at the bottom, like a doll, his suit glistening in the light of the C.O.'s torch.

"Help me. By the shoulders, real easy. That's it; lift. Easy, now."

Numbly, McDonough helped. It was true that the oil would have drowned the fragile, pitiful figure, but this was no help, either. The thing came up out of the cabin like a marionette with all its strings cut. Martinson cut the last of them: the flexible tubes which kept it connected to the ship. The three of them put it down, sprawling bonelessly.

...AND STILL THE DAZZLING SKY-BLUE SHEEP ARE GRAZING IN THE RED FIELD...

Just like that, McDonough saw it.

A coloring book!

That was what the scene was. That was why the colors were wrong, and the size referents. Of course the sheeplike animals did not look much like sheep, which the pilot could never have seen except in pictures. Of course the sheep's heads looked

like the heads of kittens; everyone has seen kittens. Of course the brain was powerful out of all proportion to its survival drive and its knowledge of death; it was the brain of a genius, but a genius without experience. And of course, *this* way, the USSR could get a rocket fighter to the United States on a one-way trip.

The helmet fell off the body, and rolled off into the gutter which carried away the water condensing on the wall of the tunnel. Martinson gasped, and then began to swear in a low, grinding monotone. Andy Persons said nothing, but his light, as he played it on the pilot's head, shook with fury.

McDonough, his fantasy of spaceships exploded, went back to the handtruck and kicked his tomb-tapping apparatus into small shards and bent pieces. His whole heart was a fuming caldron of pity and grief. He would never knock upon another tomb again.

The blonde head on the floor of the tunnel, dreaming its waning dream of a colored paper field, was that of a little girl, barely eight years old.



ISLAND IN THE SKY

BY ROBERT S. RICHARDSON

It may be casually referred to as the "South Tropical Disturbance"—but anything that rates as a "disturbance" on a planet the size of Jupiter would constitute a science-fictional "planet-wrecker" for any normal world!

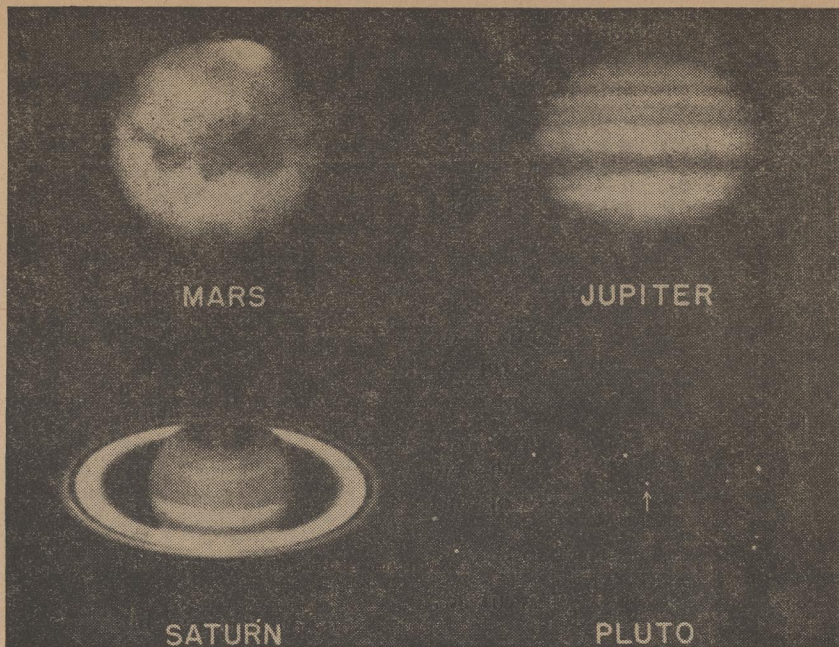
The tragedy of being a theoretical man is the practical certainty that in the end all your best ideas will turn out to be wrong. No matter how well entrenched a theory may be today after ten years it will either have been discarded entirely or else modified to such an extent as to be virtually unrecognizable. Toward the close of the last century Helmholtz's contraction theory of the maintenance of the sun's heat held the field absolutely. Helmholtz reasoned that as the sun loses heat by radiation it must contract, and this contraction acted much like friction to generate heat. Astronomers became so convinced of the truth of the contraction theory that they arbitrarily informed the geologists that the maximum age of the Earth was twenty-five million years, and to adjust their time scale accordingly. This the geologists flatly refused to do, as they had good reasons for believing the age of the Earth to be well over one hundred million years.

It is embarrassing today to think how wrong we astronomers were.

The age of the Earth—and sun—are now thought to be about 4,500 million years! The trouble was we thought we knew all there was to know on the subject when we really knew nothing about it whatever. Before you get sold on a theory it is a good idea to ask yourself, "Do I believe—really believe—that this theory in essentially its present form will still be accepted a thousand years from now?" If you are honest with yourself the answer will be an emphatic NO. You know perfectly well that a thousand years from now nobody will ever have heard of the darn thing.

All this is a roundabout way of saying that there is an object in the solar system which behaves in such a curious way that all our ideas about it are hardly more than the merest speculation. You don't have to wait a thousand years to find out if these ideas are wrong or not. You can bet your bottom dollar they're wrong right now.

If we took a poll on the planetary
ASTOUNDING SCIENCE FICTION



Mars and Pluto are called terrestrial planets since they are about the same size as the Earth and about the same density, and are probably composed of essentially the same materials. (The density of Pluto comes out abnormally high but this is believed to be due to uncertainty in its mass and possibly also its diameter.) But Jupiter and Saturn are bodies quite different from the earth, where the natural state of matter is either wholly unknown to us or can only be reproduced with great difficulty in the laboratory.

markings we'd most like to know about, I suppose the vote would be overwhelmingly in favor of the canals of Mars. It is my hunch, however, that when the true nature of the canals is finally revealed to us we are going to groan, "is *that* all they are!" I have an idea we will find that the canals are merely some natural surface feature that is impossible to interpret correctly through our shifting atmosphere at a distance of thirty-five million miles. The early

observers had the same trouble with the rings of Saturn. We will find the canals to be nothing really new. Nothing at least that we don't already know about in a general way.

But there is another planetary marking that I feel quite sure is not going to disappoint us. I doubt if it has any counterpart upon the Earth either natural or artificial. Moreover, there is no doubt about the reality of its existence as there is in the case of the canals. The ob-

ject to which I refer is the great Red Spot of Jupiter.

Interest in things Jovian has undergone a sharp upsurge recently owing to the discovery of radio waves emanating from the giant planet. Naturally the first thing to fall under suspicion was the Red Spot. But of this more later.

The first specific mention of the Red Spot in modern literature occurs in a letter written to *The Observatory* in 1878 by Professor C. W. Pritchett of Glasgow, Missouri. On July 6th he was observing Jupiter with a twelve-inch refractor*, and although it presented a splendid appearance, he noted nothing unusual upon the disk. Three days later, however, upon examining the same region he was surprised to find that a most remarkable transformation had occurred. The whole structure of the south equatorial belt had changed with the formation of an elliptic cloudlike mass, separate from the general contour of the belts. The cloud was almost perfectly oval and rose tinted. After about an hour the pangs of neuralgia forced him to retire for the night, but his fifteen-year-old son made a sketch which shows a dark marking that is unquestionably the Red Spot.

Curiously enough the Red Spot aroused little attention at the time. Changes are always occurring on

*While writing this an astronomer told me that he has used this telescope. It has an excellent lens made by Alvin Clark.

Jupiter and astronomers probably assumed that this marking would soon disappear like the others. But next year it was still there and had developed into the most conspicuous feature on the disk. Instead of being a pale rose it had blossomed into a strong brick red. Now letters from observers all over the world began pouring into astronomical publications. And from that day to this a close watch has always been kept on the Red Spot whenever Jupiter is in the sky. The members of the British Astronomical Association have been especially conscientious in this regard, going right ahead observing Jupiter despite wars and bombs and other impedimenta.

A search of the old records showed that the Red Spot, like the solar prominences and the gegenschein, had been discovered several times before. Credit for the first observation is generally accorded to Robert Hooke, who is reported to have seen it in 1664. Since Hooke claimed to have discovered practically everything worth mentioning in his time, including the law of gravitation, the wave theory of light, and the parallax of the fixed stars, one always is inclined to look askance at his numerous claims to fame. In this case, however, his title to priority seems to be fairly clear. Later the Red Spot was observed by J. D. Cassini; and there is a drawing of such a marking made in 1831 by Schwabe, who also discovered the eleven-year sunspot cycle. (Only he thought it was ten years instead.)

One naturally wonders why no one reported the Red Spot before 1878. The answer for once is easy. It was undoubtedly so dim as to escape notice unless you knew exactly what to look for. The visibility of the spot varies widely. Thus it was very conspicuous from 1878 to 1881, after which it faded and became almost invisible with revivals in 1920, 1926, and 1936-37, when it was almost as bright as in 1879. At this writing the spot is apparently quite faint. But even when the spot itself is faint or invisible, the hollow that it occupies can generally be discerned. Incidentally, the designation of "red" spot would seem to be somewhat of a misnomer. In the literature one finds it described as pink, rose, salmon, orange, ochre, and tawny—almost every color except red.

The surface of Jupiter is always changing. Nothing is stable. The atmosphere is evidently in a state of continual turmoil. As a result it is impossible to measure the positions of markings upon the disk with respect to a fixed co-ordinate system. It is really too bad that there is not at least one feature firmly attached to the solid surface of the planet. For then we could measure the period of rotation of the Red Spot relative to this feature and see how it compares with the rotation of the hidden body of the planet. But the nearest thing to a permanent feature on Jupiter is the Red Spot! The situation is somewhat the same as if the entire surface of the Earth were

covered with water and we tried to measure positions with respect to an iceberg.

But there is nothing to stop us from *defining* a system of longitude reckoning on Jupiter. We can imagine lines running from pole to pole like the meridians on the Earth. At some particular time we can designate one of these lines as the meridian of zero longitude. Then knowing the period of rotation we can calculate the position of this meridian for any time in the past or future. We can be thankful that so far nobody has detected a perceptible wobble in the Jovian axis. At least we have no trouble measuring latitudes on Jupiter.

But now a new complication arises. We don't know the period of rotation of Jupiter. The surface markings rotate at different rates, about five minutes faster in the equatorial belt than in higher latitudes. This is true also of the sun but the Jovian rotation is even more irregular. The sun rotates fastest at the equator and more slowly toward the poles, the change occurring in a regular way that is the same for both hemispheres. But there is no systematic change in rotation from equator to pole on Jupiter; and worse still, the rotation is different in opposite hemispheres. Markings on Jupiter have an extreme range in rotation period of nearly twelve minutes.

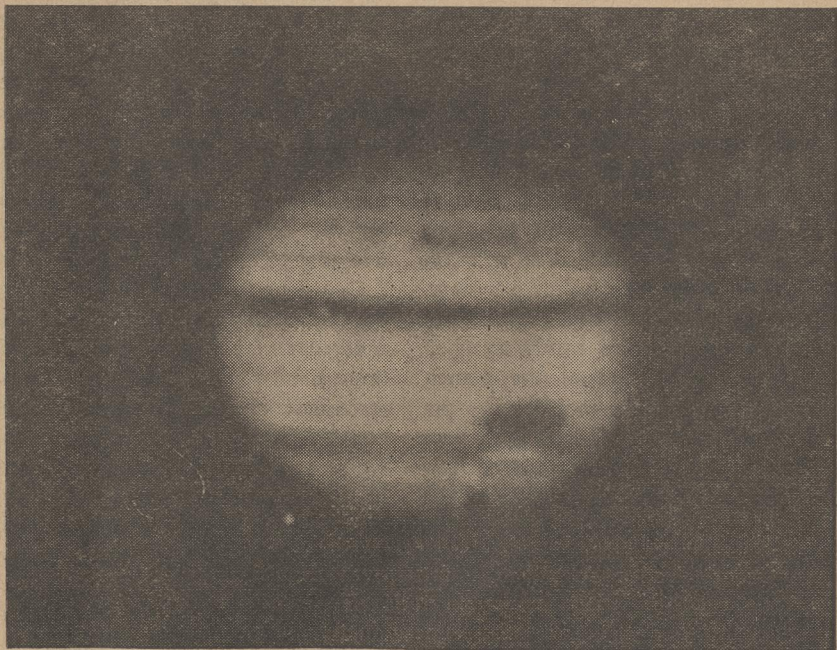
An astronomer of the last century named Marth wrestled with the

problem of Jupiter's rotation for many years. About 1890 he devised two systems of rotation for Jupiter which came to be adopted as standards and are the ones officially used today in computing ephemerides for the planet. Marth's System I is a period of 9 hours 50 minutes 30.003 seconds for the region 10 north and south of the equator. System II is a period of 9 hours 55 minutes 40.632 seconds for the rest of the planet, based principally on observations of the Red Spot.

In 1894 the Red Spot was on the prime meridian of 0° . It started drifting toward the west in the opposite direction to the rotation of the planet until by 1901 it had reached

longitude 46° , like an iceberg that had started from Greenwich and drifted halfway across the Atlantic Ocean. Then it began moving irregularly the other way until by 1910 it was back to 0° again. It continued on to the east and by 1938 had traveled a total of 933° in longitude or 2.6 times around the planet relative to System II. After which it reversed its field and according to the last official report in 1952 had moved some one hundred degrees to the west.

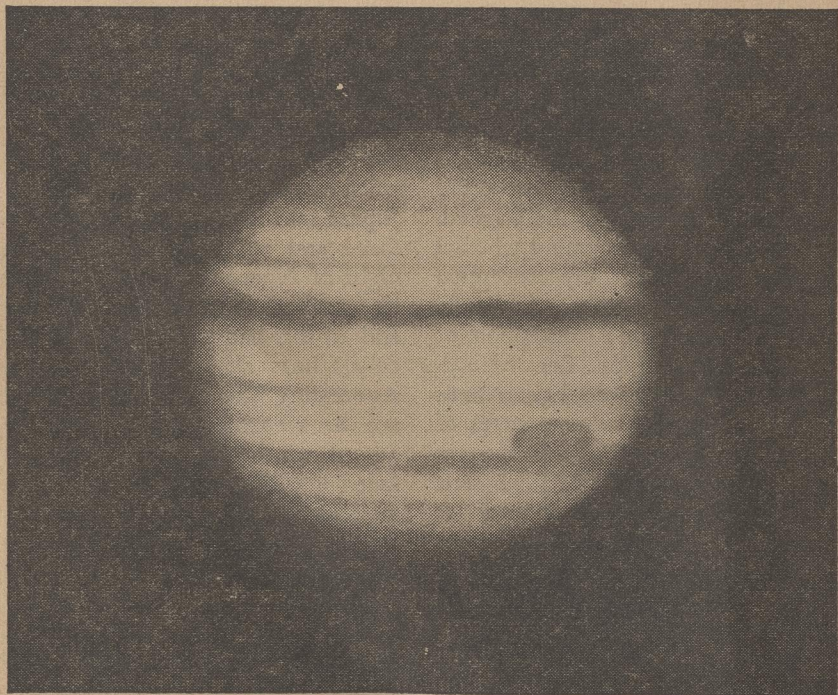
Another curious Jovian feature which we must mention is an elongated region in the same latitude as the Red Spot of 20° South called the South Tropical Disturbance



which first attracted attention in 1901. Its period of rotation is twenty seconds less than the Red Spot which causes it to gain a lap every two years. The markings interact in a peculiar way. As the Disturbance approaches the Red Spot its forward end begins to move faster as if attracted by it. The Disturbance passes the spot by flowing around it on the equatorward side. But after passing the Red Spot the following end of the Disturbance lags behind as if still attracted by it.

It is impossible to try to describe the variety of motions reported over

the years by the indefatigable Jupiter observers. Most of our knowledge of this planet comes from amateur astronomers rather than professional observers at large observatories who seldom look at the planets. In a few weeks whole belts fade out or return to great strength. Individual spots may attain velocities relative to one another of two hundred miles per hour. The amount of detail on the disk is often amazing. My photographs of Jupiter show markings apparently much finer than those on Mars at forty million miles. The tangled masses of threads and wisps on Jupiter often



remind one of the delicate tracery observed in cirrus clouds.

We can hardly form an opinion as to the nature of the Red Spot until we have some notion of the constitution of the planet as a whole. Suppose that we start at the top of the atmosphere and work down to the center. Then we will return to the surface for another look at the Red Spot.

In 1947 Chesley Bonestell did a painting of a volcanic eruption on Jupiter to illustrate an article of mine for *Air Trails*. This painting has since been reproduced in "The Conquest of Space," by Bonestell and Ley, published by Viking Press. I believe it is the only painting of conditions on Jupiter in existence. Nobody else has ever been rash enough to attempt such a scene. If we had to do it over again today, I don't know of anything that could be done to improve on the original. It is a question in my mind whether we can really form any conception of conditions on Jupiter, any more than we can form a conception of the fourth dimension. For the natural state of matter on Jupiter must correspond to the extreme states of matter found on the Earth even in the laboratory. And when we start delving into the deep interior of Jupiter we encounter matter in a state that so far has no existence except in the equations of theoretical physics.

A scant fifty years ago astronomical thought was dominated by the

idea of Jupiter as a miniature sun. The temperature of the planet was believed to be only a little below red heat—so hot that the great globe was practically self-luminous. There was nothing but the flimsiest sort of evidence to support such an idea yet it lingered on for years. The final mercy blow did not come till about 1925 when measures of the radiation from Jupiter showed the temperature of the surface to be 138°K or -221°F . Instead of being red hot the surface was at a temperature far below the freezing point of most substances.

The next question was the composition of the gases in the cloud belts. A partial answer was forthcoming about 1932 when the numerous dark bands in the spectrum were identified with ammonia (NH_3) and methane (CH_4). For twenty years afterward astronomers when asked about the atmosphere of Jupiter said it was composed of methane and ammonia. Then on the night of November 20, 1952, Jupiter occulted the star Sigma Arietis and all this had to be changed. The details have already been given in *Astounding Science Fiction* and will not be recounted here. From the rate at which the light of the star faded into the atmosphere the mean molecular weight of the gases was found to be 3.3, intermediate between the weights of H_2 (2) and He (4). A molecular weight of sixteen corresponding to a pure methane atmosphere would have given a light curve completely at variance

with the observations. It appears now that methane and ammonia are hardly more than impurities compared with the amount of hydrogen and helium present.

Despite all the progress that has been made we still don't know what causes the different colors of the belts. I had never been able to see much color on Jupiter and for a long time I was skeptical of other astronomers who claimed they could. They spoke in lyrical terms of the zones of yellow and blue, the belts of buff and fawn, and the spots and eyes of white and copper. At least that was my attitude until the night of January 28, 1955, when I picked up the image of Jupiter on a piece of ground glass at the coudé focus of the 100-inch. The disk looked as if someone had turned on a light inside a colored globe. I find I wrote in my notebook, "Always before belts appeared simply as different shades of brown and gray but this time Jupiter looks like a color photo. Central pink belt conspicuous."

E. C. Slipher of the Lowell Observatory relates that about 1937 there occurred an outbreak of the most vivid and varied coloration on Jupiter that he had ever seen in more than thirty years of observation. Cloud forms appeared first in brilliant shades of blue, yellow, and red, which gradually faded into neutral shades although the form of the markings remained unchanged. He believes that the colors originate from some peculiarities in the under-

lying material itself, rather than any reaction that occurs after the clouds reach the surface.

Rupert Wildt has suggested that the interaction between ammonia crystals floating in the atmosphere and metallic sodium would produce colored compounds whose intensity would depend upon the temperature. The chief difficulty is trying to account for the sodium. It is doubtful if there is enough free sodium in space to supply the demand, and it is hard to think of a plausible mechanism for setting the element free of its compounds on the planet. The question is still open.

It is easy to show that only a few score miles below the surface the pressure must build up until it equals the pressure in the deepest parts of the ocean. The medium would not seem like an atmosphere at all but would probably resemble some dark thick kind of soup. It was formerly believed that with increasing pressure the gases condensed to form a layer ten thousand miles thick consisting mainly of solid hydrogen with a density of 0.3. (All densities here will be given in terms of water of density 1.0.) Below the solid hydrogen was a layer of ice some seventeen thousand miles thick with an average density of 1.5. The ice layer surrounded the central metallic core nineteen thousand miles in radius with an average density of 6.

Recently W. H. Ramsey of Manchester, England, has proposed some

new models which are in better accord with current ideas on the constitution of the giant planets. In the model shown in Fig. I he assumes that eighty-four per cent of the mass of Jupiter is hydrogen with a balance of heavy elements in the central core. The model of Saturn in Fig. II is assumed to consist of seventy per cent hydrogen and thirty per cent heavy elements. These models are ideal cases constructed on the assumption that the matter at the center has an infinite density. If a moderate central density of fourteen is assumed, however, the percentage of hydrogen for Jupiter is only reduced to seventy-four per cent, and to sixty-three per cent for Saturn. Thus regardless of how the planet is built the percentage of hydrogen is restricted within rather narrow limits.

The trouble before in trying to build a model of Jupiter with such a large hydrogen content was that the density always came out too low. The mean density of Jupiter is 1.35. Now if this is the average density of the whole planet then there must be regions where the density is considerably above this value. Let us start to build a planet out of hydrogen having the same mass as Jupiter and see what happens. At a depth of eighteen hundred miles below the surface, although the pressure is one hundred and forty thousand atmospheres, the density is 0.24. At three thousand miles the pressure is two hundred and eighty thousand atmospheres and the density is 0.28.

And at thirty-six hundred miles the pressure has risen to six hundred and forty thousand atmospheres but the density is only up a little to 0.33. The trouble is that solid hydrogen is only slightly compressible. It looks as if we will never be able to get the density up even as high as that of water.

But when the pressure reaches eight hundred thousand atmospheres, however, something remarkable happens. The density of the solid hydrogen suddenly jumps from 0.35 to 0.77. That is, at this critical pressure there is a discontinuity in the density.

What happens is that the hydrogen changes phase from the solid to the metallic state. And metallic hydrogen is much more compressible than the merely solid form. This change in phase is the factor in the problem that had not been taken into account before. Although metallic hydrogen has not been produced experimentally in the laboratory, it is the simplest possible solid so that its properties can be predicted with considerable assurance from wave mechanics. Calculations show that density continues to rise until at a depth of thirty-seven thousand, four hundred miles on the edge of the central core the pressure reaches ninety-three million atmospheres and the density 5.8. Slightly different models can be obtained by mixing in a little helium with the hydrogen.

The idea of a substance changing state from a solid to a metal or vice

versa is disconcerting at first. We are accustomed to thinking of chemicals as being either definitely metallic or nonmetallic and staying that way. But a few elements are known that can change state without subjecting them to extreme conditions. The best known example is tin. In its familiar white state tin shows the properties of a typical metal. But the most stable form is gray tin, which is nonmetallic and has a crystal structure similar to diamond. Gray tin is well-known to museum curators under the name of "tin disease" or "tin pest." A bit of gray tin placed on a tin ornament will soon rot it and cause the whole structure to crumble into a pile of gray powder. At low temperatures white tin transforms spontaneously into gray tin.

There is a story that Russian troops who guarded the Czar's stock of tin bullion during a severe winter in St. Petersburg were beheaded on the charge of having replaced the valuable metal with a pile of worthless ashes. It has also been supposed that the disaster of Scott's Antarctic expedition was due to the failure of the tin solder on the fuel tanks at the very low temperatures encountered.

Now that we have some notion of conditions in the atmosphere of Jupiter and the internal structure of the planet we can return to the Red Spot. The principal facts to be explained are:

1. Its great size (average dimensions 7,000 x 30,000 miles);
2. Oval shape;
3. Variable color and intensity;
4. Lifetime established from old records as at least one hundred and twenty-five years and possibly three hundred years, covering practically the entire history of the telescope; and,

5. The way in which the southern part of the South Tropical Disturbance dips equatorward in passing it.

The permanent character of the Red Spot and its obstacle to flow indicate it to be a solid. If so, it must be a floating solid to account for its wandering motion in longitude. This rules out at once any assumption that we are looking down on the top of a high plateau attached to the solid surface of the planet.

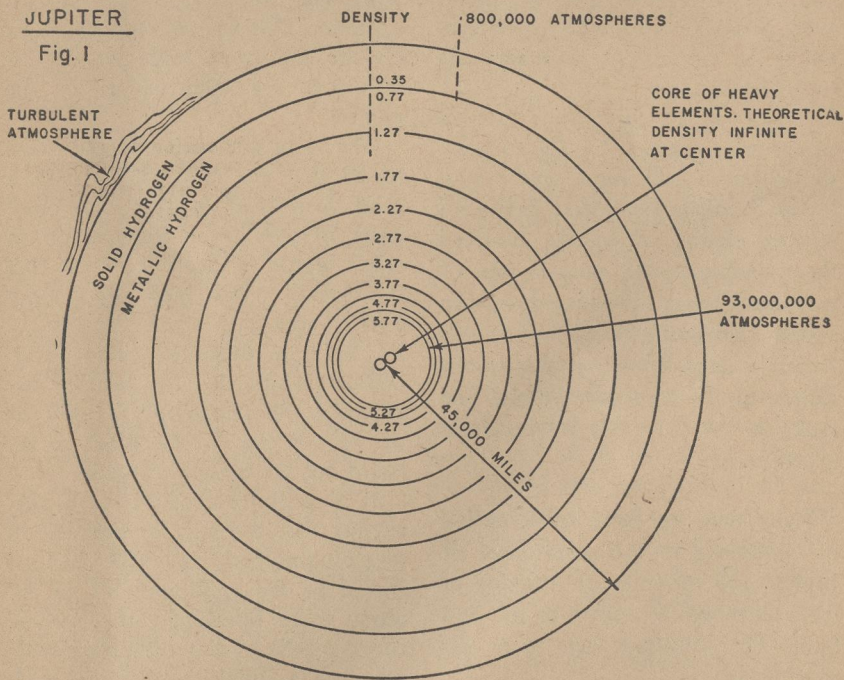
The only alternative would seem to be that we are dealing with a solid suspended in the compressed gases of the lower atmosphere; in other words, a floating island that occasionally rises into prominence only to sink back again into obscurity. Such an hypothesis has considerable possibilities for besides explaining the changing visibility of the spot it can also be made to account for its variable rotation.

It is a fundamental law of mechanics that the angular momentum of a rotating body cannot be changed except by the application of an external force. Speaking rather loosely this law tells us that a whirling body possesses a certain *quantity of rota-*

tion depending upon its mass, radius, and velocity, which remains unchanged unless some outside force—usually friction—acts upon it. The classic example is the ice skater whirling with his arms extended. (I like this one better than the boy on the piano stool with the dumbbells.) If the ice skater suddenly wraps his arms around his body, he will whirl faster. Why? Because by moving his arms in close to his body he is whirling in a circle of smaller radius. Therefore to keep his angular momentum unchanged his velocity of whirl must increase. Of course, he is continually losing angular momentum by friction with the ice so

that he will soon come to a stop unless he exerts some muscular energy.

Now consider the Red Spot whirling around on Jupiter at a certain distance from the planet's axis of rotation. Suppose for some reason the spot begins to sink so that it whirls in a circle of smaller radius. Then like the ice skater dropping his arms, the spot will have to move faster to keep its angular momentum unchanged. Conversely, upon rising in the atmosphere it will move correspondingly slower. It has been shown that a range in depth of only six miles would be enough to account for all the changes in velocity

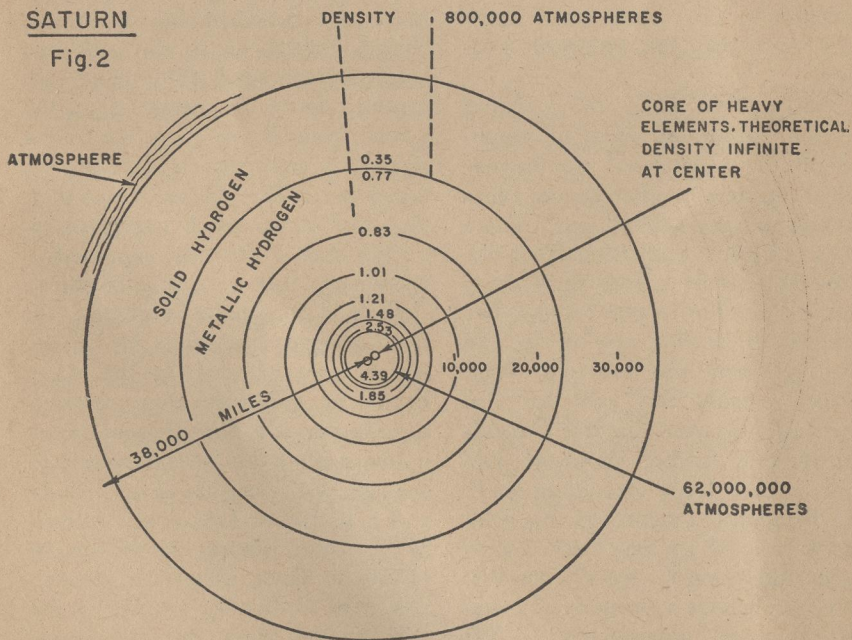


of the Red Spot that have been observed since its rotation period was first accurately determined.

This rather attractive hypothesis has been criticized on the grounds that a body immersed in a rotating fluid is acted upon by external stresses so that its angular momentum does not remain fixed. But observers who have studied the problem apparently feel that this objection is not too serious, and that the best explanation of the Red Spot is a floating island with a variable cloud cap hovering over it.

At this point we might ask, What is it that floats?

It is hard to resist the conclusion that the Red Spot consists of matter in a state entirely outside the ordinary range of our experience. For example, it has been suggested that the floating island may conceivably be one of the several solid forms of water, or other types of ice, that have been produced under great pressure in the laboratory. The reader will recall that ice melts at a lower temperature when the pressure upon it is increased. This is the cause of the icy ruts in a road even when the temperature is slightly below freezing. As a car rolls down the road the pressure of the wheels



upon the snow causes it to melt momentarily.

It can also be shown in a striking way by hanging a wire weighted at both ends over a cake of ice. The pressure of the wire melts the ice which promptly freezes behind it. In this way the wire can pass clear through the ice yet leave the cake intact. The pressure in these cases is very slight so that the melting point is only lowered by a few degrees. By increasing the pressure to two thousand atmospheres we can make ice melt at twenty degrees centigrade below its normal melting point. What happens if we continue to increase the pressure? It hardly seems reasonable to suppose that the melting point will keep on dropping indefinitely. How does water extricate itself from this awkward situation?

At -22°C when the pressure reaches twenty-two hundred atmospheres the water gives up the unequal struggle and collapses with shrinkage into another type of ice with different properties from the kind that comes out of your deep-freeze unit. For if you increase the pressure upon this type of ice the melting point also increases. With rising pressure this new ice also eventually becomes unstable and collapses with further shrinkage into still another form. According to P. W. Bridgman, a pioneer in this field, seven types of ice have been discovered called Ice-V, Ice-VI, Ice-VII, et cetera. Under a pressure of forty-five thousand atmospheres Ice-VII

may be heated to a temperature of 188°C (370°F) without melting.

Suppose the Red Spot consists of an island of Ice-VII floating in the dense highly compressed gases below the visible surface. Suppose further that on the upper surface of the island where the pressure is less the material is changing phase to Ice-VI. As the island rises and falls in the atmosphere the rate at which the ice changes from one form to another would presumably be affected. This in turn would affect the rate of evaporation of the clouds over the spot thus producing changes in its color and visibility.

The recent discovery of radio waves emanating from Jupiter serves as a startling example of our ignorance of processes going on in the Jovian atmosphere, if any such example were needed. (One has to be careful always to speak of radio *waves* from Jupiter and not radio *signals*, a term that is a little too suggestive.) This discovery was of a type that occurs much less often in science than is generally supposed—a discovery that was not anticipated.

Early in 1955 radio astronomers of the Carnegie Institution of Washington were puzzled by the short bursts of radiation they received occasionally at a frequency of twenty-two megacycles. Several objects in the sky such as the Crab Nebula and a region in Cygnus are known to be strong sources of microwave radiation. These objects, of course, stay fixed in the sky relative to the stars around them. But this source

of radio emission was moving! Thus from January 25th to March 10th it drifted to the west by four degrees, or eight times the diameter of the full moon. Investigation revealed that the disturbances were coming from the direction of Jupiter, and that they showed the same apparent motion as Jupiter. Uranus was also under suspicion for a while as the two planets were very close together early in January, 1955, but by March Uranus had moved far outside the range of the bursts.

Later observations showed conclusively that Jupiter is the source of the bursts, but their origin is still unknown at this writing. Suspicion naturally fell first upon the Red Spot but as yet no particular longitude has been identified with certainty as the source of disturbance. The cause of the bursts is wholly unknown. It has been conjectured that they arise from disturbances in the atmosphere of Jupiter similar to our thunderstorms but on a vastly larger scale.

Evidently much more research on the behavior of matter under conditions approximating those on Jupiter will be necessary before we can hope to make any headway regarding the nature of the Red Spot. Some remarks by Bridgman in this connection are well worth ponder-

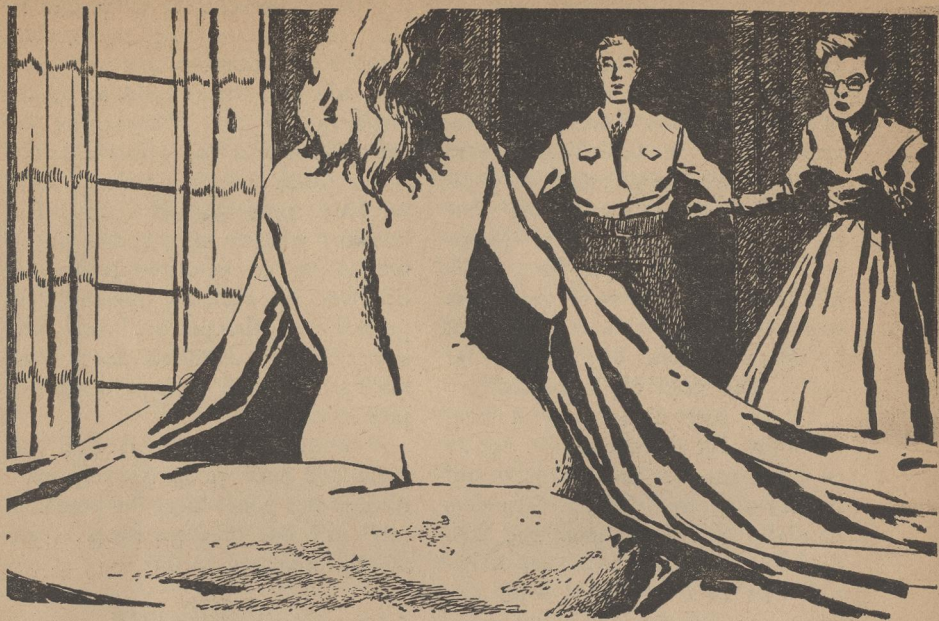
ing. He observes that as matter is subjected to increasing pressure it exhibits modifications that are quite new and that there seems to be *no tendency for the phenomenon to exhaust itself as the pressure range is increased*. In his opinion "until we have some theoretical basis for knowing what to expect, it is possible that any of the materials of daily life can, by sufficient pressure, be pushed over the potential hill into some entirely unknown form possessing new, and perhaps desirable, properties."

Is it not conceivable that in the great Red Spot we are viewing matter that has gone "over the potential hill" into one of these states as yet wholly unknown to us?

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THE END

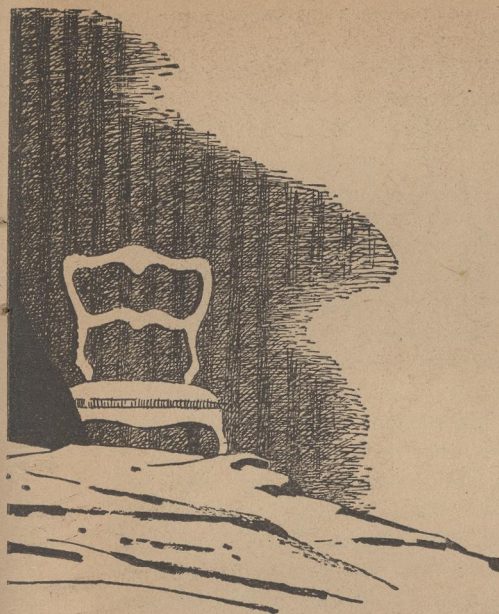


A LITTLE THING FOR THE HOUSE

*They say everyone wants security. Any-
one want a nice, secure, padded cell . . . ?*

BY F. L. WALLACE

Illustrated by van Dongen



Most people didn't know what he was talking about. Those that did thought it was illegal and closed the door in his face. Fred Holloway wiped his forehead and went on to the next house, glancing at the name. It was the Woodruff residence. He knocked on the door and a woman answered.

"Scissors sharpened," he said. "Leaky faucets fixed, household gadgets repaired. Guaranteed to be better than new."

"What's a scissor?" she asked.

"I don't know, but I can sharpen it." He hadn't shaved this morning. It made him look older.

"I'd let you sharpen it if I had one," she said. "It must be something old—and I like antiques."

She was the first prospect in hours. It was nice to know that there were still some left. "I can make one for you," he said. "I've got books at home and I can find out what it is. If you give me an order, I can deliver it in a few days." He dropped his eyes. He shouldn't have said that. He always talked too fast. He reached down for the brief case. "Sorry I bothered you," he said. "I'd better leave."

"Don't," she said. "There's no harm in talking about these things, is there?"

He clung to the brief case that was not what it seemed. "No harm talking," he repeated.

"Why don't you come in? The woman across the street is watching us. She's been looking out the window since you started down the street."

He turned, peering through the vine covered patio. The gossip across the street couldn't see through the leaves but he could. She wouldn't know whether he went in or not. He nodded and set the brief case inside and closed the door behind him. He was safe from prying eyes. "Now, what did you have in mind?"

It was cool and dim inside and the woman was on the light side of middle age, handsome and motherly. She looked at him steadily, biting her lip. "I'm having trouble with my kitchen," she said.

It was an outright untruth. Nobody had trouble with a kitchen. The important thing was that she thought she did. "I can fix it so it's really efficient."

She turned away. "I'm not interested in efficiency."

It was getting better. "What are you interested in?"

"I read," she said.

"So do I," he said. "Since I was little. 'Machinery's Handbook' and 'Audel's Wiring Guide' and the twenty-four volumes of 'Ingenious Mechanisms and Most Important Inventions of the Past Four Hundred Years.'" He paused. She was impressed but wavering. Careful now. "What do you read?" he asked.

She blushed. "Cook books."

He whistled. "Old ones?"

"Most of them."

"You must serve wonderful food."

Flattery.

"It's not as good as you'd think. There's trouble with the translation."

"Aren't the cook books in English?"

"They are. But what does a machine know about: 'Season to taste?' Or how much is 'a pinch of salt?'"

He nodded. "That's a problem, especially with anything that's not standard menu. I think I can fix up the scanning drum."

"I don't want that," she said. "I don't want improvements. I want to fry things or bake bread or make meatloaf. I want to do it myself, not punch a button and have it done for me."

It was as simple as that; he had

her. "You want me to turn off the kitchen altogether?"

"That's right. From now on I'll do the cooking."

He shook his head. "That's no good. It's dangerous if somebody investigates. Anyway there are times you don't want to cook. You want coffee and you don't care who makes it."

"You can't do it for me?"

"I didn't say that. But we should cover up. Let's look at it." He took up the brief case and followed her to the kitchen. It was big and looked like what it was supposed to be, a further indication of her character. There was a stove, refrigerator, table, and storage space. Quaint, old fashioned—the real thing. As real as it could be in this age. Holloway laid the brief case on the table and opened it.

"Tools," exclaimed the woman.

"All sorts of little tools."

"I made most of them myself. You can't work without good tools." He got busy and in a short time had removed most of the wall panels and some on the stove and other mechanisms. He traced the circuits intently, making sure he understood the purpose of each. The woman, he had learned her name was Madge Woodruff, stood by helplessly.

"Goodness," she said. "A nightmare of machines to make sure I have a cup of coffee."

"That and several thousand other things. You've got the most complicated family-size food center built. It handles as many items as

a restaurant and it's installed in a much smaller space."

"I know," she said. "I kept adding to the specifications but it's still not what I want. Thanks for trying to help me."

He smiled faintly. "Don't worry. It's complicated but I'll fix it."

"I'm not sure I can run that machinery."

"Leave that part to me. All you'll have to do is cook. I'll install a series of switches that will give you complete control."

He replaced the panels. It was a relief to have the kitchen normal. It would be dangerous if someone walked in on that disorder. He snapped the brief case on the tools and sat on the table. "How soon do you want it?"

"I don't know. As soon as I can get it."

He thought for a moment. "How's the playboy?"

"Playboy?"

"Hobby counselor, Recreational Therapist."

"Oh. I didn't realize he was called all those things," she said. "He's old, due for retirement next year. You won't have any trouble from him."

"Good." He went on questioning her about the habits of her family. After subtracting a reasonable amount for uncertainty and interruptions he gave an estimate. "It will take at least a week. Not more than two weeks."

"That long?"

"That long. You've got to re-

member the machine isn't doing this for you."

"I'm not complaining. But it does seem like a lot to ask someone I don't know."

"Don't worry, you'll know me before it's over. I can't keep coming back every day. I'll have to live here until it's done."

She could see that it was necessary. They discussed the arrangements and when it was settled he took his tools and left. He had been in the house not longer than half an hour.

He couldn't tell whether the woman across the street was still watching. In case she was he went patiently down the street, knocking at every house and being refused. At the corner he tucked the brief case under his arm and walked away. In front of him was a district relay station. It was a white building, tall and square, the sides curved inwardly. He stood and looked at it with emotionless distrust. It was a smaller replica of the Civic Machine.

And Civic, though it provided him with all the necessities, was a personal nemesis. Because of it, it was illegal to work.

This had begun long ago in quiet ways in factories. Automatic machines replaced man after man. At first this was solved by giving each worker more machines to tend. But gradually machines were made independent of supervision. And then machines were built which would

run entire factories and later whole groups of factories.

One other development was necessary and it came: commercially successful atomic power. Factories could run for centuries without human intervention. Well, almost. Parts did wear out. Certain products were no longer in demand and people wanted something else; it had to be supplied. New machines were designed and built. But the designers of these machines were good and they had a vast technology to depend on. They built mechanical minds to take over their own jobs. And the machine did their work better than they could.

Now it was possible to combine all of these elements and the possibility never exists long before it is tried. Entire cities were constructed which supplied all the needs of the inhabitants. Nobody had to work. Total leisure was the result.

In the center of each city, partly because of the symbolic value and partly because it was more efficient there, was the Civic Machine. It regulated the productive processes and initiated new ones. But it was soon learned that the vast central machine could predict and control only elements like itself—other machines. Human interference threw it out of kilter and made it difficult to satisfy all the needs of the populace. The next step was obvious.

Before it had been unnecessary to work. Now it was made illegal to do so—and there were means to enforce this decision.

No human could tolerate inactivity and this was provided for. Arts were properly outside the province of any machine. Total leisure allowed anyone who wished to do so the freedom to create artistically. Painting, dancing, writing—all these flourished. So did athletic competition, and so did most of the abstract sciences. The Civic Machine could perform computations far faster than any human—but it couldn't invent a new mathematics. This was left to anyone who wished to investigate.

Mostly it was a happy time. Never in history was there so much freedom, so little to fear. But it was not a complete success. There were still some people who didn't know what they wanted to do.

Fred Holloway was one of those people, though it was not from indecision. He had always known what he wanted to do, what he had to be. He couldn't help anything about it: he was a mechanic.

He scowled as he crossed in front of the district station that relayed signals from Civic. He went to the nearest transportation belt and doubled back and forth across the city several times, making sure that no one followed him. Later he went to his apartment and sat in solitude, clasping his hands.

He had a job.

All he had to avoid was the Stopper.

He timed his arrival for mid-morning. Sunlight was shining

through the vines as the door opened. Madge Woodruff gazed at him with sleepy blankness. "Are you looking for someone?" she asked.

He frowned. "Have you changed your mind so soon?"

She laughed nervously. "I didn't recognize you. The light's different, I guess."

"I'm not anxious to be recognized. I take precautions when I look for work." Very few precautions: a wrinkled suit and a slouching posture, a day without shaving. The rest was expression. It was easy to have a fugitive expression when in fact he was one.

"It's effective. You don't seem like the same person."

He wasn't. Yesterday he had been a hunted creature, fearful of shadows and loud noises. The situation hadn't changed except that today he had a job and he didn't let it bother him. He grunted and shoved his way inside.

Madge took the brief case and promptly set it down. It was heavy.

"These are tools. My personal belongings are being sent over this afternoon." He listened; there wasn't a sound. "Is everyone gone?"

Madge smiled. "George is in the stock market. He's rigid about being the first one in the office."

"Stock market? He won't give us any trouble. What about Alicia?"

"She has a painting class that's studying the effects of early morning light. She's gone before I get up."

"Did you actually see her leave?"

"No, but she always does."

"People don't always do anything, especially Alicia if you've described her accurately. See if she's home."

Her eyes widened. "She's my daughter, Mr. Holloway. Surely it isn't that serious?"

"Fred. We're supposed to be friends," he said. "See if she's in her room."

Madge went to the wall and screened in her daughter's room. A tousled head was on the pillow. "Alicia, you've missed your painting class," she said.

An eye opened sleepily and then she sat up. There was a brief display of nakedness until Alicia saw Holloway. She covered herself languidly, glancing at him with frank curiosity though she spoke to her mother. "A three-minute egg please and a glass of juice. Dial it up to me."

"But dear, you've missed the class."

"I've dropped painting. It's dancing now." Alicia let the covers slip. "Will you turn that thing off or are you forcing me to make a show of myself? Never mind breakfast. I'll come down."

Madge hastily screened off as the girl stood up. "That's for your benefit," she said. "I'm sorry, she's an exhibitionist."

"Don't worry," he said. "She's safe."

"I didn't mean that, I meant—"

"Sure, I know," he said. "I'll go to my room until she leaves."

"It won't do any good," said Madge. "She's coming down to see

you. You might as well stay and let her look you over." She moved the tools out of sight behind a door.

He followed her into the kitchen. "I'll have a cup of coffee," he said. He was still having coffee when Alicia came down. She was a slender girl, almost thin. A pert face rather than pretty, but her vitality made up for a lot. "Hullo. Mother didn't tell me about you."

"I couldn't. You didn't come home until I was in bed. This is Fred Holloway. He's going to stay with us for a while. I knew his mother."

Alicia draped herself on the table, swinging her legs. "Not bad," she said in swift appraisal. "What do you do?"

"I make things," he said. "People put them in their house."

"Like?"

"Like wire mobiles."

"Are they good?"

"No. I have no talent."

"I know. I used to paint. But what's the use. I could just as well be color blind. That's why I'm taking up dancing." She slid off the table and raised her dress. "I don't expect to be good at it but it will develop my legs."

"Nice legs," he said.

"Just nice," she said. "They've got to be long creamy petals."

"I'd rather see legs," he said.

"Why don't you like women with petals?"

"Elementary reasons," he said.

"Seems to me you should take up something else."

"This season the accent is on legs." Alicia yawned in his face. "I've got to run."

"But you haven't had breakfast."

"I'll get it after class." She turned and hurried away. "Bye," she called back as the front door slammed.

He smiled at Madge. "I didn't mean to be unflattering. She's attractive. But I did want her to leave."

"You scared her away, but not for the reason you think. She might have taken your comments as a challenge." Madge sighed. "You don't know her. She left because you said you weren't famous."

"I'm not. I don't have any talent for the arts."

"I know," said Madge. "I could never do anything either."

"Except cook—and you're going to." He tossed down the coffee and brought the tools in from the next room. He took off his jacket and rolled up his sleeves and began removing the panels to study the mechanisms at length. When he had the main features memorized he made a symbolic sketch. He looked up to discover he had Madge's rapt, if uncomprehending, attention.

"You're good," she said.

"I am. I can beat the machine in some things." He wondered if he really could. He shook his head and stood up.

"This is a job for you. Order a dinner for six, an elaborate one."

"Can we eat that much? Most of it will have to be thrown out."

He scowled at her. "Does it matter what we throw out?" He felt strongly about things she had never thought about.

She ordered the dinner. He followed the relays as they clicked on and off. He scribbled furiously, turning his attention to the food as it traveled through the stations. The table lengthened automatically as the food arrived. He had a fair idea of how the kitchen functioned. But that was not enough.

Again and again he had her re-order until the table was full and could extend no farther. He knew everything he needed to as he jotted down the final note. "Get rid of it," he said, jerking his head.

She looked distressed as she began disposing of the food. He wondered whether she regretted calling him in. Silently he helped her and when the job was done he took out his notes, studying them intently. Then he tore them into shreds and tossed them into the disposal slot. He replaced all the panels except one and turned to her.

"You have a choice," he said. "You can watch what I do or you can see that no one comes in."

"Which would you rather?"

"It would be nice if you saw how it goes together." He frowned. "But it would be disastrous if someone walked in on this."

"Then I'll go up front. I can give you a few minutes' warning."

"That's all I need. Does anyone come in at the back?"

"No one except the family, and

then only if they're puttering in the yard, which they never do during the week."

"Lock it," he said.

She locked the rear door and then went to the front to keep watch. She seemed glad to get away. She wasn't used to his intensity. Few people had it. She herself liked to cook but it was a mild desire, originating more out of dissatisfaction with herself than out of real need.

That's why he worked harder the first day. It took hours to install the first switch. One switch, and there were many more to go. But once one was in nobody was going to stop him.

Late in the afternoon he put the loose panel in place and went in search of Madge Woodruff. She was looking out the window at the street. "Done for the day," he said cheerfully.

"I was hoping you'd hurry. Is it safe to make dinner?"

"As usual. No one will know the difference." But he knew, and she did. That made them equally guilty. He went to his room. The thought made it easier for him to rest.

It was evening when he came down. The floor glowed faintly ahead of and behind him as he walked through the hall. Probably Madge's idea. There were times he tended to underestimate how smart she was.

She must have heard his footsteps because she was waiting at the bottom of the stairs. "We're going to



have dinner later than usual," she said. "George called and said he would be detained at the office. I hope you don't mind."

Her voice wasn't loud nor was there anything wrong with what she said. It was the tenseness that gave him warning. "Meanwhile we have company," she said. "Isn't that nice?"

"Very nice," he said. There was only one kind of company that would arouse this anxiety. He'd handle the old guy.

"Imagine," said Madge, grasping his arm. "Our former Recreational Therapist retired. We were very fond of him but I know we're going to like his replacement even better."

If this was a coincidence, it was a pretty strong one. Holloway was wondering about it as they went in. The new counselor was about his own age, an inch shorter and several

pounds heavier. "Edward Dixon, this is the Fred Holloway I've been telling you about."

They shook hands and the counselor sat down. The light was at his back, shining directly on the chair he expected Holloway to take. Holloway crossed to the other side and when the counselor turned the light was in his eyes. Dixon settled himself comfortably, seeming not to notice.

"Actually this is more a social visit than professional," he said. "Old Mikolan was a good counselor and I've got to keep up his standards."

"That's not what you told me," said Madge. "You've left out the thrilling part. You said you were on the trail of someone who must be maladjusted."

Dixon laughed easily. "Theoretically I am but there's not much chance I'll find him. This sort of

person leaves his own district for activity such as this." He turned blandly to Holloway. "Isn't that right?"

"I don't know. I never paid much attention." Now he could see why the old man had retired. Mikolan didn't think he could handle this case. Even so Holloway didn't have much to fear. This counselor was young and eager, but he didn't have experience.

"It's obvious he's not going to operate where he'll be recognized," said the counselor. He felt in his jacket and brought out several sheets of drawing paper. "We have descriptions of him, unfortunately too many." He smiled ruefully at what he held, glancing at Holloway. "About your general build," he summarized. "Somewhat shorter and ten years older. Altogether an unhappy person."

He extended the sketches for Holloway to examine. Three people had drawn him from memory. The visual accuracy was not great. All had erred on most of his features. The eyes were a particularly poor representation, haunted burning eyes. It wasn't like him. "Lucky there were some artists who saw him," he said, handing back the sketches.

"Not artists. Let's say they draw," said Dixon. "They had cameras. I don't see why one of them didn't use it. They're carrying their artistry a little too far."

"Careful," said Holloway. "I sense an implied criticism of our leisurely way of life."

"There is," said the counselor cheerfully. "Too many people do things they shouldn't. This man for instance."

"What did he do?"

"Didn't I tell you?" Dixon smiled at him.

"You didn't." The counselor must think he was stupid.

"As long as you're under my jurisdiction I'll have to bring you up to date," said the counselor, shifting away from the light.

It was not particularly subtle but maybe the counselor thought he didn't have to be. Holloway smiled to himself. Let him think that.

"Not much to it," went on the counselor. "The story I pieced together is that this man went around asking for work like a tinker."

"A what?"

"An old-time fixit man. He used words he probably didn't know the meaning of. Maybe he read them somewhere. Anyway, he's competing with machines that are far better than he is. With his ability he should be a scientist."

"Like you?"

The counselor flushed. "I'm not a scientist. I perform a social service no machine can."

"I thought you worked from psychometric charts."

"I do. But the charts are prepared by machines and indicate aptitude only in a general way. Recreational therapy helps the individual but he must be willing to adjust."

"There should be no great trouble

with that. You always have the Stopper to back you up."

"The Stopper is an admission of failure. We use it only as a last resort."

"What a dreary subject," interrupted Madge nervously. "Can't we find something else to talk about?"

Fortunately for her peace of mind there was a diversion. Quick footsteps sounded outside and the door opened and Alicia came in. She slowed her headlong rush when she saw the two men, particularly the strange man. Her sight was excellent. Almost instantly she spotted the insignia in Dixon's lapel which told what his profession was.

"At last we've got a new hobby counselor," she said. "Mother, have you told him about me?"

She didn't notice Dixon wince as she called him a hobby counselor, but Holloway did. The man took himself seriously. It was something to remember. There might be a use for it.

"Not yet. We've been talking about other things."

"How can anything be more important than me? To me at least."

The counselor smiled at her enthusiasm. "You are a perfect example of the artistic temperament."

"The temperament, but not the ability." She looked at him with interest. "I'm going to do something sensible. I'm going to marry men."

"I should hope so."

"Not a man. Men. Many of them."

"Why so many? Are you insatiable?"

She sighed and slid into a chair close to him. "Mikolan was old and didn't understand. I was hoping you would."

"What is there to understand? Marrying incessantly isn't a hobby."

Holloway grinned; the counselor certainly believed in the official attitude. Everything could be cured by the proper recreation.

"There must be something I can do well," she said. "It's the wrong century for courtesans."

The counselor smiled paternally. "That's not it. What you really want is to influence men."

"True, but can you think of a better way of doing it than by being a courtesan?"

"That's a novel ambition," said the counselor uncomfortably. "But it's just as well you live now instead of centuries ago. You wouldn't be happy in the role you think you want."

"You mean I couldn't be a courtesan, I don't have the equipment?" Alicia looked down at herself, wriggling her hard young body. "Maybe I'm not voluptuous or pretty. Maybe I'm only cute. But I can make men forget that while they're in my arms."

"Don't be vulgar," said Madge. "You hardly know these people."

"I'll know the counselor better," said Alicia. She glided out of the chair and into the counselor's arms. She kissed him with slow deliberate passion.

"Alicia," said Madge.

"It's a test," said Holloway. "She'll win it." There were certain drawbacks to it if she did.

"There," said Alicia, bounding up happily. "Do you think I can be?"

"I never doubted it," said the counselor. His face was flushed but not with embarrassment. "I merely wanted to convince you that your ambition is misplaced."

"You'll never convince me by arguing," said Alicia, going to the stairs. "Excuse me while I change."

Conversation languished after she left. The counselor found it difficult to get back on the subject and Holloway didn't help him. The threat was still there but he didn't want to think about it. He preferred to hold it off as long as he could.

Before long there were other footsteps. Madge recognized who it was and got up and went to the door. "You poor dear," she murmured in the distance. "You look so tired."

"I am tired," grumbled the man in the foyer. "Fighting off disaster all day."

"There aren't many people with your knowledge of the market," said Madge.

"Nor my luck," said George gloomily. "Lost everything. Not a cent to my name."

"It doesn't matter," she consoled. "Money will buy nothing except stocks and bonds."

"That's all," he said bitterly. "My life, my whole life, and you say it doesn't matter." He stamped into

the room, stopping when he saw the two men.

"George, this is—"

"I see who he is," said George. "Do you think I could miss the insignia?" He squared his heavy shoulders and planted himself in front of the counselor. "Young man, if Civic doesn't do something about the market I'm going to lose faith."

"That's a dangerous attitude, sir."

"I don't care what it is," said George, wrinkling his black brows. "I had the market cornered. As soon as I gave the order to buy, Civic started selling. Wiped me out in five hours. That's twice in the last three weeks I've made and lost fortunes."

The counselor was careful not to smile. The market was a vestige of a way of life that had long since passed out of existence. It was kept for the unimaginative type of misfit. "That's the thrill of the ga . . . business, sir. If it was easy to do, there would be no merit in doing it."

"I don't know," said George heavily. "I just don't." He forced a grim smile to his lips. "I'll start again in the morning. I'll start at the bottom but by noon I'll be somewhere. Mark my words." He nodded to both of them and stalked away.

"That's the spirit," said the counselor. It was getting late but he made no move to leave.

Madge twisted her fingers and hesitated. Hospitality won out. "Won't you stay for dinner?" she asked.

"I've got to get after this person," said the counselor. "I really ought to go."

But he glanced toward the stairs and Holloway knew he wasn't going. Alicia had convinced him. She was too convincing. Holloway turned away. She was proving to be a handicap.

Madge came to his room early in the morning. "Just a moment," he called in answer to her knock. He put on a robe and let her in. She sat down and looked out the window. There were lines on her face he hadn't noticed yesterday.

"I'm sorry," she said.

"You didn't waken me. I was getting up."

"You know I didn't mean that. I'm sorry about the counselor."

"It's not your fault."

"I know. But it's too bad he found you here the very next day after he got the report. He's suspicious."

"He'd be a fool if he wasn't. I don't like them but I never thought counselors were stupid."

Madge sighed and for the first time turned away from the window. "I'm glad you see it. I was afraid you'd be a fanatic."

He sat on the bed and leaned back. He had thought about it at length through the night. Thought about it and gone to sleep—as evidently she had been unable to. He was more used to the idea of the Stopper.

The Stopper was a simple mechanism that had made prisons obsolete

and reduced the need for institutions for the mentally unbalanced to the vanishing point. The fact that the society had few tensions was one factor—but even so the Stopper played a part, and would continue to do so. It was a small machine based on the principle of the encephalograph, but it was even simpler than the ordinary instrument. It was simpler because it had to react to only a few of the basic impulses.

Behavior comes in patterns. An act of consequence is associated with emotions proportional to it. The killer about to shoot down his victim is aware of what he is doing. The person whose desires are destructive has a characteristic emotional state before he destroys. It was this impulse which the Stopper identified before the event could happen.

The entire mechanism was surgically inserted into the body in such a way as to be connected with the mental processes without disturbing them. In the beginning it was set to identify three impulses though at first two of these impulses were not usually present. The identification mechanism was the most complicated part of the Stopper. The rest of it was merely a tiny atomic battery that could produce an appreciable electric current and apply it directly to the base of the spinal cord.

Shock. It was not much different from the early forms of electrotherapy. But in this instance the corrective unit was carried around in the body until there was need for

it. The would-be-killer reaching for a weapon was stopped before he could grasp it. If, upon recovering from paralysis he tried again, the shock was repeated. Before long an unbreakable conditioned reflex was set up that absolutely prohibited the undesirable action. It was used only as a last resort and then only after ample warning—but it could be set for any impulse. It could, for instance, stop a mechanic from picking up a wrench.

This was why the Stopper was always set to block three impulses—the original one—and murder and suicide. The Stopper was infallible, but it had certain side effects.

Holloway smiled at Madge. The threat of the Stopper was almost as potent as the thing itself. And as long as it was it didn't make much difference whether he had it in him or not. He could not allow it to influence him at all.

"Unfortunately, I am a fanatic," he said. "There's not much either of us can do about it."

Relief faded from her face. "But I thought you said—"

"I did. The counselor's suspicious. But he can't prove anything. He doesn't even know what to look for."

"He does. He knows you're a mechanic."

"But he doesn't know what I'm doing here. Do you have a history?"

She shook her head miserably. "No. I've been dissatisfied but it's never resulted in anything definite."

"See? He suspects me. Not you."

"But he does. He knows I was

the only one home. The woman across the street told him." She lowered her eyes. "Won't that make you stop?"

"It won't. I've already done enough to incriminate both of us. You'll get off with a warning if we're found out."

"But why do you have to do it now? Why not wait until he's no longer suspicious?"

"He won't forget about it. If I come back in six years, he'll be after me."

Madge was looking out the window again. "Can't you do the work for yourself? You have a kitchen you can change."

"I do, but it's not the same. I wouldn't use it. An artist might paint a picture and not care whether anyone saw it. With me it must be *used* by someone who wants it."

"I won't go near it," she said. "I won't have anything to do with the kitchen."

"You'll use it," he said. And so she would. But for the present she was an unwilling ally. He'd have to do something about it.

There was a noise down the hall. "Mother," came the faint call. Madge smiled wanly and got up. "I have a meeting most of the day," she said. "Should I cancel it?"

"By no means," he said. "Stick to your routine. You have nothing to hide."

He waited until Madge and Alicia left, though not together. He made a brief but thorough inspection of

the house. At the rear, near the kitchen, was a studio-workshop. It was well equipped but haphazardly. George's probably; but he was in the market and never had time actually to use it. It would do nicely for Holloway.

He brought his own tools and worked for a short time in the studio. When everything was arranged to his satisfaction he took a small kit and went into the kitchen. This time he took off a different panel.

He had meant to do it systematically, working through in an orderly fashion. Now he couldn't; he had to skip about. He needed results—fast. He worked on methodically, checking the time. He finished ahead of his estimate, ran a test on it to make sure it would work, and replaced the panel. It was earlier than he had finished yesterday but there was nothing he could complete in the short time left. He was expecting a visitor.

He tidied up and took the tools back to the studio and was eating when the entrance carillon sounded, filling the house with door-music. He let it sound off twice and went leisurely to the front. "Alicia's not at home," he said as he opened the door.

The counselor grinned. "She's nice, but I didn't come to see her."

"Madge isn't home either."

"Let's not pretend. You know who I want to see." He came in.

"Do you mind if I finish eating?"

The counselor shrugged and ac-

companied him to the kitchen, sitting on the other side of the table. "I thought you'd like to know I've investigated you."

"Why didn't you ask me? I can tell you more than is in the files."

"I hate to see you do this, Holloway."

"Don't look. Run along and play with Alicia. She'll play."

"I intend to do that, too. Meanwhile I'm watching you."

"Ever occur to you the fault's in your duty, not my inclination?"

"It's occurred to me. The answer is no. You don't have to work."

"Have to? You mean—am allowed to."

"Have it your way—allowed to. You can be anything you want, artist, scientist, musician. There are more of them, and some are very good, than any age ever dreamed of."

"Hurrah for them," said Holloway. "I mean it. I've read history. I know they led a marginal existence in the past. This is their world and I'm glad for them. Only thing is—I'm not one of them."

"You could be. There's nothing to prevent you from being a scientist."

"Except me—everything I am. I can't sit down and think things out and tell the machine what experiments to run. I've got to have things in my hands."

"You merely think you're not capable of the abstract approach. If you want to try, I'll help you reorient your thinking."

"It's too late. My great grandfather used to set me on his knee and tell me how he ran the fixit shop and when business was bad he'd get in his car and go looking for odd jobs. He was a remarkable man in his way. Lived a hundred and three on his own and then geriatrics came along and added another sixty."

"I *thought* you were the man but this cinches it," said the counselor. "Why did you give me this information?"

"It's in the record. Sooner or later you'd run across it," he said. "But you're wrong. Sure, I know about fixits—but I'm not the man who came down the street the other day."

"No? Then what are you doing here? What are you making?"

Holloway smiled. "Little things for the house. Want to see one of them?" He got up and led the way to the studio. He paused in front of a bench. He'd done a nice job of mussing it up so that it looked used. "My masterpiece," he said sardonically.

The counselor blinked at it. "You didn't make this here," he said.

"Not altogether. I put the finishing touches on it this morning."

"It's not pretty Holloway. You're no artist. You're not even trying to be one. It's not purposely ugly, that might be art. It's senselessly hideous."

"Yeah, but you haven't seen it run." Holloway snapped on the ventilator and as the air currents stirred the mobile whipped into motion, dipping and whirling dizzily. The

counselor wrinkled his forehead in distaste.

"Turn it off. I've seen enough. No one in his right mind would have that in his house."

"I'm not good at making things pretty," said Holloway with mock humility. "But my creations certainly can move."

"I don't know why you go on like this. It can't be much fun. Take my advice and drop what you're doing. I don't know what you're doing yet, but I'll find out if you keep on. Let me help you before it's too late."

"What can you do, read percentages off a chart? Tell me to take up another hobby?" Holloway grinned. "Has it occurred to you the machine doesn't allow you to be much of a therapist?"

"I've thought of it. There isn't much need for therapy, except in certain cases."

"And I'm that certain case. Maybe. One of these days I might wind up with the Stopper skewered into me. Not this time though. I'm clean. I told you what I'm doing, making things for the house."

The counselor grunted and went back to the kitchen and resumed interrogation. Holloway was less cooperative than before and he learned nothing. Soon Alicia came home and that put an end to his questions. Holloway left them as soon as he could. Maybe the counselor would exchange one kind of pursuit for another. Maybe.

He wasn't counting on it.

The next few days passed. There were interruptions but he got through them. Twice Alicia came home unexpectedly and he had to scramble to get the kitchen in working order. The counselor kept dropping over in the afternoon and staying until late at night. Ostensibly he came to see Alicia and actually it was his main purpose. But he was on the lookout for anything else he could see.

Dixon's attention flattered Alicia. She would have preferred someone who was famous but she didn't know many people who were and those that she did weren't seriously attracted to her. A counselor was important though his chances for fame were slender. As she said more than once, it could be a beginning.

This made it at once easier and more difficult for Holloway. Alicia was capricious. She would never marry anyone who tried to find her mother guilty. The counselor was aware of this and didn't apply the pressure to Madge he might have. He saved it for Holloway, who didn't mind. The mechanic was used to it.

But he had to counteract the effect of constant surveillance. He called Madge in at the earliest opportunity. Only part of the kitchen was finished but that part was self-contained. There were some things she could do with it.

He went over the controls carefully, making sure she understood. "It's complicated," she said. "I won't be able to remember."

"You will," he said. "Think of what you're doing and say it. It's as easy as that."

"I'm afraid to use it," she said. "The counselor is always around."

"I've taken care of that," he said. It was imperative she use it, get the feel. "If you have to leave the room, just say so. The mechanism will then take over and complete the preparation automatically. Just be sure no one is around when you start. And don't be afraid someone will accidentally stumble on the secret. You're the only one who can operate it." He might have added that he could—but he didn't intend to use it—and most of all he didn't want to take away the pride of ownership.

He stood by while she tried it out. She didn't make any discernible errors but the first product was not edible. He shook his head while she beamed at him. "Throw it away and try again. There's an art to this."

"Do you think I really would throw it away?" she said. Then she tasted what she had baked and decided it was a good idea.

He went to the front and watched while she baked and threw away and baked again until she was satisfied. He didn't know if what she was making was good, but he did know what he had built was. She was with him solidly. Neither of them were going to make that slip the counselor must be waiting for.

He saw Alicia coming and called Madge. It took her scarcely a moment to conceal what she had been

doing. Now she would be less apprehensive. Pleased with the progress, Holloway went to his room before Alicia reached the house. Where she was the counselor was apt to be not far behind.

But actually the counselor didn't come over until evening. They were all there, including George who was having some success in his make-believe market. As a consequence he was affable and communicative, freely fortelling what would happen when he captured the market. Holloway wondered what he would do if he realized the elusive ambition—collapse probably. But it would never occur; there were many like George and the Civic Machine would never allow them to destroy their plaything.

The mobile Holloway had made was in a dark corner, wired tight so it couldn't rotate. It was an alibi, but it certainly didn't add an esthetic touch to the room.

"Mother," said Alicia through the conversation. "Can't we be hospitable and offer our guests something?"

"Everyone I see has a glass," said Madge amiably.

"Food, not drink," said Alicia. "I'm famished."

"All right, I'll get you something," said Madge.

"Sit still. You don't have any idea what I want."

"I don't believe you do either," said Madge.

But it was Alicia who went to the kitchen. Presently she came out,



sending the serving cart ahead of her. "Where did you get these?" exclaimed Alicia as she nibbled on a small confection.

Madge beamed with quiet pride she didn't dare display. "A new recipe," she murmured.

"Make them often," said Alicia. "Here. You must try them."

The counselor looked at his glass. "Alcohol and pastry don't mix. Do you mind if I don't?"

"I do mind," said Alicia. "They're not pretty but the taste is wonderful. You must have some."

Ruefully the counselor set down his glass. "All right. But I must have coffee."

She has him, or he has her, thought Holloway. Maybe they both had each other. Somehow the summarization failed to be completely satisfactory. He was disturbed and didn't know why.

The counselor balanced the cup with one hand and ate a small confection. "It's good," he said in surprise.

"Thank you," said Madge. "I pride myself on my cooking and baking." It might have been all right if she hadn't said that.

The counselor took another small confection and looked at it carefully. He turned to Holloway and smiled. It was a quiet knowing expression. "Won't you have some?" he asked politely. He was too polite.

"No thanks," muttered Holloway. The counselor knows, he thought blankly. He knows I've been working in the kitchen. He can even tell what

part of it. Betrayed by trifles, by a cooky. He half expected the counselor to get up and ask Madge and himself to come along.

But the counselor didn't. The smile faded as he sat there. Holloway could guess what went on in his mind. The counselor's triumph included Alicia's mother—and he didn't know how to make it easier on her. He must have known it would be so from the beginning—but it was different to run directly into it with Alicia chattering gayly at his side. The counselor now had a new problem—how to separate Madge's guilt from Holloway's.

And so Holloway still had freedom. He excused himself and went to his room. The counselor didn't seem to notice that he left.

The Stopper was hours away.

And yet it wasn't inevitable. He couldn't leave the city. He'd be traced and sent back. The counselor could work this out slowly, knowing that there was no escape.

He still had a few days. Was there anything he could do—anything at all? Holloway sat on the bed and pondered. There was nothing. If there had been a way out of the situation he would have thought of it long ago.

The Civic Machine was too powerful. It fed and clothed and housed the people in the city and there were only a few it failed to satisfy. He was not an artist or a scientist with real contributions to make. He was not even a market speculator who

could pretend he was an asset in controlling the production of goods within the community and regulating the flow of commerce to other cities.

He was a mechanic, totally useless since the machine repaired itself and redesigned itself to meet future needs. Mechanic against machine—and the machine was intelligent.

There was only one possibility—slight but real. In the center of the city was the Civic Machine, the great building which housed the largest computers and memory banks. It would do no good to get inside the main machine, there were repair units which patrolled the entire building. Their prime purpose was repair and alteration, but some of them were quite large and against a single man or even an armed group they would be very effective. They would simply roll over the opposition.

This was also true of the underground factories and the numerous district stations. All of them had repair units inside capable of crushing an invasion. But there was one single weakness he could exploit. He didn't know whether he could find it in time—but it was there.

He went to the screen and dialed Service. In a short time a map of the city was ejected from the chute. He spread it out on the bed. He had never realized how big the city was. Transportation was so swift he had never wondered at distance. So much the better that it was big. The larger anything was the more impera-

tive it became to break it down in sections.

He looked at the city. Practically, the map was a blueprint of a machine. He knew machines. He looked at it and knew how it was put together. And he had a good idea how to take it apart.

The city began in the center with the vast Civic Machine. On the map the central building resembled a large four-pointed star. The sides were steeply curved so that the corners came together sharply. Radiating from these points was a straight line of district stations, staggered as the distance from the center increased.

The design was apparent. Civic controlled the outlying parts through the corners. The complex of machinery was compartmentalized as any reasonable consideration would have suggested in the first place. If there were three other men like him, they could shut down the city by seizing the corners.

But there was only himself. He wasn't going to get any help and he didn't have much time. Nevertheless he was convinced it was possible to change Civic's directives. Tomorrow he would see.

Madge greeted him cheerfully when he came down. "Wasn't it a success last night? I'm so happy."

"Nice party," he said.

"Not that. We've had other gatherings as friendly. I mean my first real attempt at baking."

"Yeah," he said.

"The counselor kept marveling at

the cookies. Alicia ate more than she should and even George tasted them. I put them away yesterday afternoon and didn't think Alicia would find them, but I'm glad she did. I kept wanting to tell people I made them."

"You didn't have to do that," he said.

"Of course I wouldn't but it was a temptation." She looked at him. "What's the matter? Don't you feel well?"

"Huh? Sure, I feel swell. I was thinking what to do next."

"I can't wait till it's all done. One of these days I'll make a roast."

"Yeah," he said. "I can't do anything until I get some special material."

"I hope it won't take long."

"It won't be long," he said. "Better get caught up on your baking."

"Oh I will," she said.

He ate and went across town to his apartment. He emptied the brief case and filled it with other equipment, stuffing what it wouldn't hold in his pockets. His pockets bulged but not noticeably and anyway no one would stop in except the counselor and Holloway didn't expect to see him.

It was good equipment, tiny and extremely sensitive, more suited for a scientist than the wire sculptor he pretended to be. Some he had been able to order, the rest he had made himself. The latter, as far as he knew, was not duplicated elsewhere on earth.

After that he went to the Civic building. It loomed up, so large

that from nearby the walls hardly seemed curved. On the ground floor and for several stories up there were offices for speculators, perhaps several layers deep. But Holloway felt sure that a cross section would reveal that the core of the building was occupied solidly by the Civic Machine.

He was not interested in the offices nor even the machine directly. He went down to the first basement. Again there was the outer protective zone, rest rooms and various public facilities. The second basement was more of the same, though public facilities were fewer—and he couldn't get down into the third basement.

It was a good indication that that was where he had to go.

There was a stairway down, but it was closed off by a heavy steel gate with a good mechanical lock. He leaned against the wall and pretended to be waiting for someone while he studied it. Civic seemed to have assumed that the prohibition of mechanics had wiped out all mechanical sense and therefore elaborate precautions need not be taken. It was a good lock but not that good. When no one was looking Holloway inserted a probe, twisted it, and the gate opened.

The third basement hadn't been built for human convenience. The main corridor was wide and low and there were small passageways branching off which were even lower and extremely narrow. Holloway ignored the details and went on, trusting his

orientation to tell him when he was near the objective. Abruptly the corridor slanted off in an improbable direction and he had to retrace his steps.

A repair machine scurried by and he froze against the wall. It scanned him with a single eye and hurried on. Humans weren't expected down here and the recognition factor hadn't been built into it. This was a piece of luck.

He examined the wall of the passageway at length before he found what he was looking for. It was an alloy door, practically flush with the wall, almost invisible. It was not at the exact corner of the building, but it was near enough to bear out his supposition. He took out tools and went over the door inch by inch. The instrument didn't reveal anything except that the door was very thick. The diamond scratch test indicated that it was very hard. He was on the right track. The door protected something important.

Other instruments enabled him to locate the locking mechanism. Repeated tests determined that it was electronically controlled. Twice during this time a repair machine scurried by and though there might be no need for it he squeezed into adjacent corridors until the danger passed.

Next he cracked the electronic impulse that unlocked it. This took hours but it was finally accomplished. The door swung open. He was lucky—it could have been much more difficult. Civic didn't realize it

was vulnerable at this point, that there was anything to protect against except mechanical damage. Otherwise he'd never have gotten in.

But he was in and he could see it was the place. Above him was at least forty feet of concrete and steel and more than that below and on either side. At the rear of the vault the door opened on a communication conduit. Running a city in its entirety, even a quarter of a city, required untold millions of signals per second. The communication conduit had to be big to handle it. It was some six feet in diameter where it curved into the solid concrete and steel at the back of the vault.

He examined the door from the inside, tracing the lock mechanism with instruments. The principle was common, but it was very well made. It would stand up against almost anything that could be directed against it. This made it harder to change but in the end it would save him.

When he learned what he could he closed the door, leaving most of his tools inside. He reversed the electronic signal; it was locked until he came back—or Civic sent a machine down to inspect it. The latter couldn't occur often, perhaps once in ten years. He wasn't taking much of a chance.

He went back the way he came. The gate between the third and second basement was harder to open from this side but he thrust his

arm through the bars and probed it blind.

The second basement was deserted. He hurried on. He could get out even if the building was closed, but he didn't want to attract attention. He was relieved when he saw someone in the first basement. He wouldn't be the only one leaving at this hour.

Purposely he brushed close to the man, a huge burly fellow with massive shoulders. As he got nearer he saw the man's eyes were red-rimmed and blinking. He looked again and veered away. The man's hands were clenched convulsively.

At no time was he in danger but just the same Holloway was glad he hadn't come closer. The man was Stopped, probably because he was predisposed to physical violence. It was revealed in his straining body. Violence—but the Stopper stopped it.

Holloway had never objected to the device as long as nothing better was available. But he didn't want it for himself. This man was a grim reminder of what might happen to him. He shook his head and went on.

There were still some people on the street floor. He mingled with them and went out.

That night he excused himself early and went to his room. He dialled Service for a number of small instruments and as soon as they arrived took them apart, altering them as he went along. When he got sleepy he dozed off for a few hours.

The next morning he waited until he was sure George had gone to the office. He went down and ate lightly, parrying Madge's questions. He took the device he was working on and completed it shortly before noon. It was small but important.

He examined it minutely for defects. Mechanically there were none. He didn't have time to test it for theoretical imperfections but before he was out of danger it would be tested. It had to stand up.

He loaded up again, stretching the brief case to the limit, shoving in everything his pockets would hold. He went to the Civic building and down to the third basement. He went to work on the lock and soon had it apart. He replaced the original actuating mechanism with what he had made. It didn't take long. He emptied his pockets and the brief case inside the compartment.

He closed the door and tried the lock. He could hear the faint hum as the molecular bond between door and wall was completed. It was locked—but it was his lock now.

After this he went back and forth between Civic and his own apartment several times. He couldn't carry much each time, but he made several trips. In the end he brought everything he thought he would need. He was ready. He was as ready as he would ever be.

He went back to the Woodruff residence and up to his room. He took off his jacket but that was all. He had been working steadily for

the better part of two days. He fell on the bed in exhaustion.

The first thing he saw was the counselor. Holloway rolled over. On the other side of the bed were Madge and Alicia. He'd been too busy to take this possibility into account. He should have prepared for this, too. He had known well enough that the counselor couldn't take forever to make up his mind.

"We've talked things over and it's straightened out," said the counselor. "It's tough—but it's got to be done."

"It will be better for everyone," said Madge. "I told him. We couldn't go on like this."

"Better for you," he snarled. "You might have thought about me before you started talking." He sat up and the counselor dropped his hand in his pocket and shook his head warningly.

"We'll have another chance," said Madge. "We'll have to go to therapy for a while. But that's all. We'll be all right."

"Yeah," he said. "You will. It's my third time."

Madge blinked bewilderedly at the counselor. "You didn't tell me that. You didn't say he was ready for the Stopper."

"There was no need to. I'm protecting you from misplaced loyalty." He brought the paragon out of his pocket. Holloway had been certain he had it. Counselors, and only they, were allowed to carry weapons. But

they seldom did. In this case it was a mistake to display it.

"You should have told her everything," said Alicia. "You really should. My mother's capable of making her own decisions. All of our family are."

"Don't listen to him," said the counselor. "He'd like to make you think he has a chance. He doesn't. I'm merely making certain he doesn't get hurt."

"But he believes he has a chance," said Alicia. "I know mother wants him to have a chance as long as that is what he believes." She came around the side of the bed.

"Alicia," said the counselor.

"I don't think much of a man who points a gun at me. I know I can never marry a man who conceals vital information from my mother. I will never speak to anyone who paralyzes a helpless man to make sure he doesn't escape." Alicia put her hand on the gun and looked at the counselor. She was young and certain and she had principles.

"He can't get far," she said. "Think of him, years and years with the Stopper. And if you can't think of him, think of us. I don't want him standing outside my house, looking at me every time I come out—staring because he can't do anything else."

She took the gun away from the counselor and aimed it at him. "On the other hand, I will shoot."

"You shouldn't do this," said the counselor.

Alicia shrugged. "Maybe not. But

you've got a strong constitution and can stand it. I'm delicate."

Holloway swung his feet off the bed and grinned at her. "Thanks, cutie. You won't regret it."

"No special thanks, and I already do regret it. Better get going before my sense of what's right gives out."

He got into his jacket, making sure that all the small tools were in the pockets. He went to the door, beckoning Alicia to come along. The counselor watched helplessly. "Don't hold him long," he whispered. "Ten minutes will do. Try to keep him from calling the police. If he loses track of me, tell him I'll be at Civic Center."

Her eyes widened. "You sure that's where you want to go?"

"That's my choice. Don't worry. If I lose, if I get the Stopper, I won't haunt either you or your mother."

"That's what I wanted," she said in relief. "He doesn't know what it means."

"Good girl." He brushed his lips lightly against her cheek and went down the stairs. It was dark when he left the house. Down the street he passed George coming home, but the latter didn't recognize him and Holloway didn't speak. He hurried to the nearest transportation belt. He wanted the counselor to follow him, but not too closely. The plan didn't absolutely depend on it but it would be better if he didn't have to wait to be discovered.

He transferred to the fastest belt and rode toward Civic. His main concern now were the police robots.

They were seldom used and it might take time to activate them even if the counselor did call in. He didn't see any as he neared his destination.

There were lights in some of the offices. There was no reason for any of the speculators to be there at this hour, but they didn't seem to know when to quit. For once Holloway appreciated them. The street floor was open and he wouldn't attract attention.

He went in—and spotted a police robot. It was a ponderous tank model, more suitable for repelling an invasion than for apprehending a single, unarmed man. Holloway went past it but, though it turned an eye on him, it didn't stop him. He got by on steady nerves.

The first basement was also open—again no undue attention on him. He hadn't told anyone *where* in Civic Center he was going. They were probably expecting him to go up.

The gate at the second basement was closed and it took Holloway a few minutes to open it. He was sweating. Now that Civic was on the alert for him this would do it. It would have tracers on every mechanism it could reach, and it would now know where he was. Everything had to be done fast after this.

As soon as it was unlatched he started running toward the gate at the third basement. He had trouble there, too. Not much, but his fingers were clumsy with haste and he had trouble with the probe. He heard a

shout behind him. The counselor was catching up, and he wouldn't be alone. He twisted the probe and got through, down into the third basement. A small machine skittered at him but it was very small and he kicked it away and ran on. He could hear the police robot rumbling down the stairs. In the other direction a large machine was approaching.

But they were too late. They were all too late. He put his face close to the door and it opened. He swung it shut behind him.

He was safe for a while. He fumbled in the darkness for a hand light and snapped it on. Everything was as he had left it. Outside the police robot must have arrived, and the counselor, and perhaps Alicia. But he couldn't hear them. He couldn't hear anything until equip-

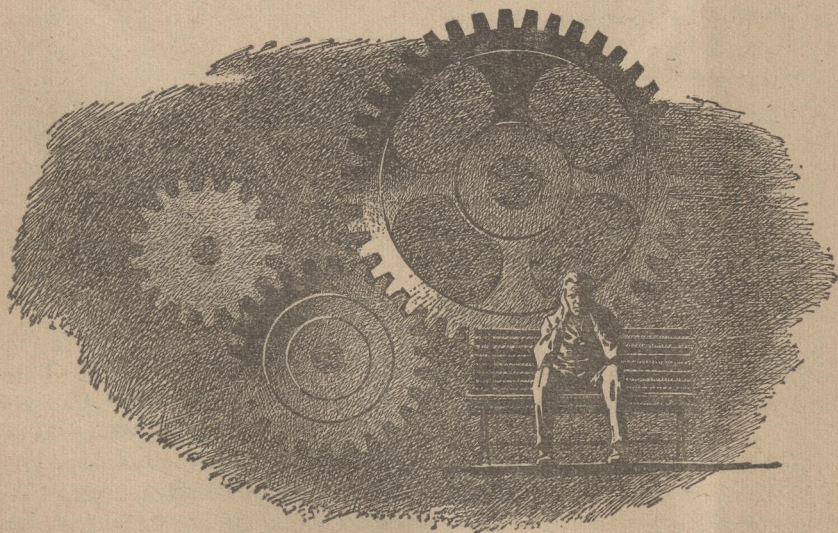
ment was brought up that would punch sound through the enormously thick door.

He didn't have to wait long. Previously Civic may have been unconcerned but now that it knew where he was activity speeded up. It was well aware what was behind the door. The counselor's voice came through, thin but discernible. A contact mike had been plastered on the outside. "I don't know what you're trying to do Holloway but it won't get you anywhere. Come out and make it easier on yourself."

"You mean I don't get the Stopper?"

"Not immediately, even though it's usual. You'll be given a thorough examination. There may be something else we can do for you."

As a concession it was hardly



tempting. "No thanks. Come in and get me."

"Don't think we can't. We'll be in as soon as the machine that tends this part of the building gets here. We are not going to use force unless we have to."

The counselor honestly believed he was speaking for himself. The machine always preferred to deal with recalcitrants through other humans. It made the display of power less obvious. Before he was through he'd change things a little. "Better plan on using force," he said. That was for the benefit of the police robot. Through it his answers would be passed on to Civic. While he waited he began assembling the equipment.

A few minutes passed. "Holloway," called the counselor.

"Yeah."

"The machine tells me you've changed the code. Clever, but it's not enough. What you've changed Civic can decipher."

"Theoretically it can, but I'm betting it won't." Later they'd see what he meant by that.

There was a pause. The counselor was trying not to let concern show in his voice. "It may take time, but we'll get through. Will you be alive when we do? How long will your air last?"

"As long as yours out there. I brought a reconditioner along."

Thereafter there was silence as the mike snapped off. Activity outside didn't cease but they were concealing

from him what was happening. He worked on the reconditioner until he got it together. He turned on the tiny atomic motor and the stale air freshened almost at once. He had water too, enough to last this out.

He heard the mike hum. "Holloway, we're getting impatient," called the counselor.

"So am I," he said. "Let's speed things up. Maybe it will help you to know you'll never find the electronic code. I've changed it to a sonic lock."

The counselor's voice wavered. "Sonic or not doesn't matter. I've been instructed to tell you we can burn the door down."

"Who are you getting instructions from?" There was no answer. Holloway expected none. He laughed. "Go ahead, burn it. It's thermasteel."

"It is. But it can be melted."

"Sure. But I'll be dead before it's soft enough to break through."

"That won't save you. Civic does not take human life but emergencies have been foreseen. It is empowered to do so for the general welfare. I think this covers the situation. You are a dangerous man."

"Damn right I'm dangerous," said Holloway. "Let it get a little hot in here and see what I do."

The counselor was cut off before he could answer and Holloway grinned. That meant there was a crowd outside and Civic didn't want him to give out information. But he'd got the idea out and now it couldn't be suppressed. Few were in sympathy

with him—but the news would travel fast.

There was a new voice, crisp and metallic, one of the bigger police robots. He was one step nearer authority. "Inadvertently you let something slip," it said. "We'd have discovered it in time but it helps to know that the lock is sonically operated. Come out and save yourself an hour of anxiety."

"You think I let that slip?" said Holloway. "I wanted to show you there are still a few things you don't know about me. Let me tell you more about that lock. It's handmade, smoother than any mass produced part ever turned out. It's tight. You can't jam it open with noise interference. You've got to say exactly the right words or it won't move. If I had wanted to make it really tough on you, I'd have tuned it to my voice. But I didn't want to give you a problem you couldn't solve."

"Is there any other information you wish to divulge?" Civic knew the mathematics of what it was up against.

"Sure. There is no time lapse with the mechanism except that due to the inertia of the parts. I've tested it out at one complete message of three words in one second."

"It takes three words to open it?"

"It does. It will respond in slightly less than one second to those three words. See if you can find them. I'll come out if you do."

"Those words will be found. You have been psychometrically tested many times. In addition every book

you've looked at is listed. Your limitations are known better than you think."

Holloway smiled. There was an enormous amount of information about him on file—but it wasn't enough. The machine knew his vocabulary was about fifty thousand words—but which fifty thousand? It could establish a core of about thirty to forty thousand words but after that it was in trouble. The remainder would have to be selected from a greater English list of some six hundred thousand words. And when the different verb forms were added in, and the plurals of nouns, the actual sum of words that he knew or might know mounted impressively.

At the least the machine would be forced to assign him a possible vocabulary of some two hundred thousand. Civic would have to consider any possible three-word combination out of two hundred thousand words. That was 8×10^{15} combinations. At one per second in one day the machine could run through 86,400 combinations. At this rate it would take a few million years to exhaust the possibilities, quite a few million.

Civic would attack the problem systematically. It would immediately dispatch machines capable of speaking three words a second. It would set up other machines to make certain there would be no repetition.

And it wouldn't use trial and error alone. In the beginning it would try to determine what he was

most likely to say. It would feed in these answers first. It knew a lot about him, but not everything. That was the point. It had bothered to learn about him, or anyone, merely that which would help it foretell in a general way how he would fit in the society. And he didn't fit in.

Holloway turned out the light. The floor was hard but he didn't mind. He was safe behind the simple mathematics of the problem.

Vibration penetrated the vault. Holloway blinked as he recognized the source; three words a second were being shouted at contact range outside the door. Inside it was discernible only as a faint vibration.

He glanced at his watch. Eight hours had passed. The machine had gone through less than thirty thousand combinations. This should be convincing.

He swallowed a small sip of water. There wasn't much left and he had to conserve. Neither was there any food. He'd forgotten that. But Civic wouldn't know this.

He yawned and snapped on the light and looked over the rest of the equipment. It was nearly ready to go. An adjustment here and there and it would never be any readier. He wheeled a small machine toward the communication conduit, setting it at right angles to and some distance from the huge alloy tube. He adjusted the machine to a light charge and a duration of one microsecond. He yawned again and pressed the switch.

"That is sabotage," said a voice through the door. It was not the counselor nor the police robot though undoubtedly it was speaking through the robot. There was no mistaking it. This was Civic, remote and mysterious. Now he could do business.

"I had to attract your attention."

"You could have spoken. I've been listening as you moved about."

Holloway smiled. It had been listening since the police robot arrived—but it hadn't said anything until now. "Good. Maybe you're willing to discuss terms."

"There are no terms. You are subject to the same laws as everyone else. I can do only things I am assigned to do."

"I wasn't talking about laws—but I think I can change the way you react to my suggestions." Holloway went to the machine and made other adjustments. Again he pressed the switch. This time interference with the signals passing through the conduit lasted longer.

He could picture what was happening. In one quarter of the city doors would not open or were flung back and forth wildly. Steam spouted indiscriminately out of hot and cold faucets, or no water would flow at all. Meals were prepared in record time and were then hurled smoking out into kitchens. Elsewhere in underground factories assembly lines ran backward, hopelessly snarling production. Transportation belts spurted jerkily and then came to a halt. At that time the switch cut off the interference.

"Stop the sabotage," said Civic through the door. "Stop it or I will stop you."

"You can, but I don't think you will," said Holloway. "You'll have to sacrifice too much—a quarter of the city to be exact. Are you convinced I can put that much out of commission before you break in?"

There was no answer. Civic had to protect everybody, but it couldn't. "Think it over," said Holloway. "Do you want to evacuate this part of the city, move people into the sections I can't touch? You can, but there will be overcrowding and confusion—people will begin to wonder if a machine *is* efficient, whether it can protect and provide for them."

"The basic pattern of the city can't be changed. Laws are Laws."

"I don't suggest you change any law. Reclassify. Ask the counselors. They'll agree that a reclassification is overdue." He had found the one weak part of the Civic Machine. It would never be left with so little protection again, but right now he had it.

There was a pause while Civic checked the suggestion. "This is an answer to the dilemma. But I can't permit it. You will not fit in any production line."

"Who wants to? No decent mechanic will do that kind of work if he can avoid it. But I can alter things already made. I can make things that are too insignificant to set up assembly lines for, one of a kind mechanisms that no one will ever want again."

"It *can* be done," admitted Civic.

"One other thing," said Holloway. "A cook should also be reclassified."

"A cook?"

"Surely, if the cooking is done primarily for taste, not nutrition." It was not an altruistic gesture. Among other reasons he had to have a group of people who would want his services. "Check that with the counselors if you don't agree. But don't take long. I've been pushed around enough. I'm going to do some shoving on my own unless I get results." He grinned at that. The counselor Civic could reach easiest was outside and he'd be willing to agree with anything that would square him with Alicia.

He wondered whether the machine would ever speak again, but it did. "Reclassification of mechanics and cooks has been made. They are both artists. What is the code that opens the door?"

"See how easy reclassification is when you get started?" he said, moving toward the door. Civic wouldn't retract now. The only emotion it had was efficiency and it was always more efficient to leave the *status quo* as it was in any instant. And in this instant he was a citizen in good standing. He bent near the lock and whispered the words.

The door swung open and the police robot allowed him to leave, blocking the entrance as soon as he was out.

A small figure catapulted from the crowd into his arms. She felt warm and emotional. "You did it," she said

when she stopped kissing him. "You did it by yourself." He looked down and saw it was Alicia. She was very nice, but she was not the person he thought it was.

"Wait for me," she said, gazing up earnestly at him. "I've promised to marry the counselor. But that will be over in a year and then I'll marry you."

Someone else was elbowing her way through the crowd, squirming and fighting to get to him. "He will not marry you, now or next year or ever. He was spoken for long before you saw him."

It was wonderful patient Anne, who had always known he had to do what he had to do. She had allowed him to go on his stubborn way, hoping that there would be something left for her to claim when he got through. And he was through—or just beginning. He disengaged himself from Alicia's embrace and went to meet Anne.

He thought the women had gone to the kitchen but he couldn't hear them. They might be outside looking at flowers or upstairs discussing things. The counselor looked at the mobile in the corner and grinned at him. He seemed to have difficulty with the expression. "Maybe I should have helped you," he said.

"How could you?" said Holloway. "It's your job to protect the *status quo*. I was the one who was hurt by it. It was up to me to do the changing." He, too, glanced at the mobile.

"I no longer have to make things like that."

"That's something gained," said the counselor wryly.

Holloway chuckled. "I think there's more than that. I've helped others, too."

"Madge?"

"Partly. But the biggest thing is the precedent for change. It will spread from city to city. There are others who are hurt who don't seem to realize it yet."

"I can't see anything that's out of line," said the counselor.

"What about your field? Seems to me there's too great a reliance on tests and charts, putting someone where he belongs on a graph. Often you lose sight of the real person." Holloway grinned. "What can you do about a woman who's determined to have a different husband every year?"

"She'll get over that nonsense," said the counselor, looking around to make sure no one overheard. "She'll get over it if I have to break every law in therapy."

That's what he thought now, but wait until it came to breaking them. Holloway could see the idea take hold but nevertheless the counselor seemed uncomfortable with it. Maybe that was why he changed the subject as he heard the women coming in the front.

The counselor cleared his throat. "I understand why it was so difficult—but just what was the verbal code the machine couldn't discover?"

"It was a favorite expression of

my great grandfather," said Holloway. "I heard him say it often, but I never read it anywhere. Maybe that's because I was always looking in the wrong kind of books. At any rate it seemed perfect for what I wanted." He had staked his future on three words, three simple words. For eight hours it had baffled a mind that was far faster than any human's.

"Is it a childhood expression?"

"I told you I never heard the story

that went with it, if there was a story. All I know is that my great grandfather used it when he showed me how to work a tough problem he'd assigned me." Holloway gave the mobile a twirl and watched the counselor blink. "Here it is, and remember it's got to be said exactly right. This was the code: 'Open, says me.' "

"I can see that any machine would have trouble with that," said the counselor.

THE END

HOW TO FRUSTRATE A LOGICIAN

1. No fact can be proven; it can only be demonstrated. But a demonstration is not proof, since it cannot be shown that the same thing will happen next time.
2. A proposition can be proven in logic, but this does not establish its validity in the real world, since a theory may be logically sound, but invalid.
3. This means that propositions which are not true—not valid in reality—can be proven true.
4. But it has also been proven that there are true propositions that cannot be proven true.
5. Therefore, I do not have to accept either your demonstrations or your logic, and I know you're wrong, even if I can't prove it, because there are true propositions that can't be proven true.
6. Nyah! So there!

The above sequence is believed to have originated with Xantippe, Socrates' wife, and to have been the real reason for his accepting the hemlock. Her original presentation of the argument is believed to have been considerably more discursive, but it has not been preserved in its full form.

But don't laugh boys; the blasted thing is perfectly sound logic!



THE REFERENCE LIBRARY

BY P. SCHUYLER MILLER

THEY'RE MOVING IN —

The chief literary pretensions of the science-fiction-fantasy field center around the fact that it is a literature of extraordinarily free—though not necessarily uninhibited—extrapolation, whose practitioners are free to build worlds and prove societies of their own construction. By and large this is done for purposes of entertainment and a publisher's check, but with so much elbowroom there have been ample opportunities for serious satire and social criticism on many different levels.

In the first quarter of this century,

and before, the method of fantasy was known and accepted by writers, readers and critics. It was the era of Machen and De La Mare, Dunsany and Cabell and Chesterton, very nearly the last giants of the untrammelled imagination. It was also the era which on a level of less subtlety produced Burroughs, Cummings, Merritt and John Taine, whose best books sold as well in hard covers at then-current prices as did most other popular fiction. Out of this atmosphere of acceptance came the first magazines, *Thrill Book*, *Weird Tales*, and finally *Amazing Stories*, dedicated to bringing imaginative fiction to

the mass reader. The Munsey magazines and a few others had for years leavened their popular-fiction content with "different" stories of one kind or another. Very few people, until Hugo Gernsback began to emphasize the distinction, cared much whether these stories dealt with the impossible or the possible, with sheer fantasy or "science fiction."

Then Literature developed a bad case of the shakes where the imagination was concerned. Fiction ceased to be playful and became deadly earnest. Dreiser, Fitzgerald, Hemingway and others of their school gave us a literature of brutal realism. Social criticism became blunt, direct and literal, and in consequence there was no place in "serious" writing for the oblique absurdity, the deft thrust, or the affectionately swung shillalagh of invented fiction. H. G. Wells turned heavy and stolid even in his predictions of the future, and his science fiction was discarded by public libraries as of no interest.

But, as we all know, the "trashy" popular magazines not only clung to the old freedom but built on it a skilful, ingenious, often thoughtful fiction of the unbounded imagination. If it observed certain taboos which were all the more evident because the fashionable novelists of the day were wallowing in the sordid side of society, it was because almost the only medium open to writers of this kind of fantasy were the magazines, and because no self-respecting Victorian-survival mother was going to let her teen-age son buy magazines that spec-

ulated on the future of sexual practices or the probable purposes of women on long space voyages. She remembered her own flapper days, and maybe the War, but now she belonged to the older generation . . .

In spite of the critics and the fluctuating fashions in Literature, science fiction took nourishment and grew into and out of its adolescence. It grew up. And now it begins to look as if Literature is beginning to rediscover its own imagination and move back into the roomy old mansion it abandoned so hurriedly a generation ago.

I have tried, in this department, to locate these books when I could find them and to make some kind of report on them. Often this meant stumbling across them in a library, or waiting for someone with second sight, like Anthony Boucher, to spot them first. It's made somewhat more difficult by the fact that the publishers do not want these books to carry the SF label, and on the whole seem a little embarrassed at the idea of their being reviewed by a science-fiction magazine.

Setting aside, for the moment, the host of "after the Atomic War" stories, the bulk of this slowly reappearing literary SF has concerned itself with imagining a society of a little or a long way ahead. You had Taylor Caldwell's "The Devil's Advocate" in 1952; during the past year you had Lin Yutang's unbelievably dull and clumsy "Looking Beyond"; and so notable a personage as Bertrand Russell used both this and open

fantasy for his rather heavy-handed short stories in "Satan in the Suburbs" (1953) and "Nightmares of Eminent Persons" (1955).

One or two books—Willy Johns' sometimes successful but oftener inept "The Fabulous Journey of Hieronymous Meeker" in 1954, for example—used the gimmick which was probably old with Lucian and Plato, of setting up their distorted societies on another planet. Francis Bellamy's "Atta" drew on the almost outmoded device of the little-man-among-giant-insects—which, of course, had all-too-human frailties. Henry Myers' "O King, Live For Ever" (1953) dealt with some of the same consequences of immortality that less ambitious science-fiction writers had explored more smoothly, and "Vercors"—Jean Bruller—took up the "lost race" theme with a subtlety and significance that the other books I have mentioned seemed to lack, in his "You Shall Know Them" (1953), in which he asks the very embarrassing question: "What is Man?"

Rather unexpectedly, to me at least, science-fiction themes have been used in at least three religious novels in the last two years. The least successful, Louis de Wohl's "The Second Conquest," works out a theological morality play on a completely unrealistic Mars with more dogma and less finesse than C. S. Lewis did in his now classic "Out of the Silent Planet." Gore Vidal's "Messiah" showed us the alarming rise of a religious

opportunist, and could well have served as the unwritten prelude to Robert Heinlein's "Revolt in 2100." The most moving—if the hardest for me, as a Protestant, to appreciate—was Riley Hughes' "The Hills Were Liars" (1955), which showed a Catholic Church beaten back to the bare rudiments of Roman times, following a Communist domination of the world, yet cherishing the embers which would enable it to rebuild a Faith and a society on the same principles as the old.

Most of these I have noted here before, but in the last month I have been reading some others that reinforce what begins to look like a trend. Among them is a Civil Defense morality by Martin Caidin—"Wolds in Space" et al—which does every bit as forcefully and much more directly and subtly what Philip Wylie tried to do in "Tomorrow." Caidin's book, "The Long Night"—Dodd, Mead & Co., N.Y. 1956. 242 pp. \$3.00, simply follows in detail what happens to an upstate New York City, somewhere in the Binghamton area, during the "long night" after an atomic bomb goes off high above its downtown business district. This isn't the Good-Town-Bad-Town, black-vs-white treatment that made Wylie's book downright ridiculous most of the time, nor is it the intensely personal thing that Judith Merrill made of her "Shadow on the Hearth," still the best of this kind. Nobody emerges as a character, and

indeed this may be intentional, for one of the decisions the Civil Defense authorities must make is to abandon some fifty thousand people in the center of Harrington to the firestorm that would otherwise destroy their entire rescue organization and doom hundreds of thousands more. In war and disaster, the book says, men and women must become mere statistics if they are to be manipulated efficiently and scientifically. The "wild" factor that breaks away from the formula can destroy everything.

John G. Schneider's "The Golden Kazoo" is science fiction only in the strict sense that the events it describes won't happen for four years yet, until the 1960 presidential campaign. Almost its only gadget is the Royal Presentation Model Wrist Timemachine—wrist watch, timer, stop watch, perpetual calendar, wrist alarm and traffic counter—which Advertising Executive Blade Reade uses to good effect as his agency masterminds the 1960 Republican campaign (after—it says here—a hurly-burly of un-directed Madison Avenue geniuses have loused up the 1956 campaign and let the Democrats back into the White House). What you have is a satire on advertising—Rinehart & Co., N.Y. & Toronto. 1956. 246 pp. \$3.50—which is just barely projected into the future. That it uses the future at all, seems to me to be an indication that its author has recognized the added freedom the device gives him. Shepherd Mead's "The Big Ball of Wax," you'll remember, was a much

more gadgety extrapolation of advertising, almost but not quite as extreme as the Pohl-Kornbluth "Space Merchants."

The completists will find much more to confuse them in Nigel Dennis' "Cards of Identity"—Vanguard Press, N.Y. 1955. 379 pp. \$3.75. This is a book whose closest parallel—in mood, at least—is Chesterton's equally perplexing "The Man Who Was Thursday." It is a kind of fantasy of ideas, liberally larded with double meaning, symbolism, and philosophical double-talk, which may fall into the science-fiction category simply because there is nothing of the supernatural involved, and because its ostensible theme is the manipulation of personalities.

These things are, in this case, merely window-dressing which enable the author to comment satirically on the malleability of identities in our increasingly regimented society. His mechanism is a meeting, in an English country house, of the Identity Club. This bizarre organization is dedicated to the postulate that identities can be made and remade more or less at will. By way of demonstration, as the book opens, we watch the host for the coming conference deftly staffing his manor by converting a neighboring parasite into a butler, his sister into a housekeeper, a local doctor into the gardener, his nurse into a gardener's helper, and a nondescript village woman into an even more nondescript charwoman. This much is overt, although the process is not particularly clear: gadgets and gimmicks have no

place in such a book. The rest is made up of reports by members of the club—hypothetical identity transformations, actually, rather than real ones. Each satirizes one of the confusions in identity which characterize our times: the delving for security in the past until one becomes lost in the past . . . the plight of the individual whose sexual identity has become hopelessly confused until he/she no longer knows whether to behave as a man/woman or a woman/man . . . the professional ex-Communist who has become a member of a religious order composed entirely of professional ex-Communists, and whose discipline has a strong flavor of Moscow . . . and finally a pseudo-Shakespearean comedy of identities.

"Cards of Identity" has been a great success in England. It may be a critical success here, though the very Englishness of many of its private jokes blunts the edge of the satire for us. Nevertheless, the fact that such a book can again be a success—as Chesterton's was in its day, thirty-odd years ago or more—shows that novelists are relearning the lesson of imagination that science fiction has had pretty well to itself for thirty years. We have also learned a discipline of the freed imagination, which hasn't penetrated to some of these new practitioners, but an imagination is a difficult thing to handle when you've been used to being a tape recorder . . .

No wonder they're beginning to move in on us!

LORD OF THE FLIES, by William Golding. Coward-McCann, New York. 1955. \$3.50

This will be in the dealers' lists, as borderline science fiction at least, because it is a story of the future. A plane load of English schoolboys—including an entire choir—are dropped on a tropical island, refugees from the atomic blasting of their homes. There is fruit, there are fish, and there are pigs: they can stay alive. Alone, abandoned, they begin to build their own new society.

The book is a macabre revelation of the realism and ruthlessness of children in a world where they can be themselves. What Jessamyn West played around in her disappointing "Little Men," William Golding—a schoolmaster who has seen boys at their best and worst—states subtly and harrowingly. The boys try to organize a kind of club for survival and rescue; they set a signal fire and nearly destroy the forest; they grow jealous, envious, terrified of unseen monsters; they launch a savage revolution against the boredom of order, create themselves a monster-god of the flies from an impaled pig's head. And with a little turn, a flash of perspective, the author adds the crowning horror of the situation in his last few paragraphs.

No gadgets, a situation that's been used over and over and that has no necessary tie with the future: maybe you won't be interested. But it's an unusual, unusually written book that you should try.

THE RETURN OF THE KING, by
J. R. R. Tolkien. Houghton Mif-
flin Co., Boston. 1956. 416 pp.
\$5.00

If I weren't dragging this trilogy into "The Reference Library" by brute force, because it is a masterpiece of fantasy which won't be forgotten for a long time, I'd probably be giving over the whole introductory section this month to a learned discussion of the 1,500-page work as a whole—as have the *New York Times Book Review*, *Saturday Review*, *New Republic*, and many more.

To refresh your memory, the author, an English philologist, actually began his epic of the Third Age of Middle Earth a good many years ago with a book nominally for children, "The Hobbit." This promptly became more a discovery of adults than an enthusiasm of children, and now Tolkien has expanded and developed his world of heroism, beauty and magic on an adult level, tying one small incident of the first book into a story of a questing company and a great war of Good against Evil.

I haven't tried reading straight through the three volumes of "The Lord of the Rings," as the trilogy is called. I don't know whether the hundred pages of appendices at the end of the final volume should be studied first or last. I do know there should be more maps of the fabulous country through which our adven-

turers traveled, and there may be in later editions.

Having come to the end, however, I can state some personal prejudices about the work. The first of the three volumes, "The Fellowship of the Ring," was pure wonder and delight in almost every page and chapter. But when, at its end, the Fellowship broke up and its several members went their own ways, to accomplish their destinies according to their particular talents and fates, some of the magic of Middle Earth was lost for me. There was a wonderful battle in "The Two Towers," and there were the ageless Ents, and other strangeness, and in this final volume we have the last, inevitable showdown between the dark forces of Sauron and those of the allied good, before the walls of Minas Tirith. But there is a disappointing quality of anticlimax to the final ease with which Frodo and Samwise win through to destroy the Ring of Power. Sauron himself never appears—and how can we believe in a villain we never know?

These seeming flaws, I am sure, have their reasons. One is the integrity of Tolkien's characterization. The hobbits are unheroic little creatures, doing what they must: it would have been out of character for them to hew their way through walls of monsters or confront Sauron—as they alone could have done, since only they ever penetrated his dark realm. The theme or lesson of the entire work has been the growing

poison of the Ring, which grants power to its users but drains them of much more than it gives, so that some of the early vigor has been going out of our folks as their journey nears its end. Yet I can't help wishing that the high level of the first book could have been maintained, integrity or no. If it had, I'd be starting right through the series again.



ARK OF VENUS, by Clyde B. Clason.
Alfred A. Knopf, New York.
1955. 181 pp. \$2.00

This is a teen-ager on about the level of some of the best of the Winston series—which haven't been reaching me now for some time. It's not up to the Heinlein or Norton standard, but it's a good starter.

Tal Roberts, eighteen, goes to Alaska to help his father launch an eleventh Venus rocket in the wake of the ten which have vanished without a trace. The anti-rocket forces are strong, and in the ensuing violence Tal becomes one of the *Ark of Venus* crew and a co-pilot of one of its little scout ships. They solve the mystery of the "wall" around Venus, struggle against the oxygenless desert, paradoxically find life and intelligence in a race of talking, snake-worshiping monkeys. It's good, fast-moving adventure all along the line.

THE BOY WHO DISCOVERED THE EARTH, by Henry Gregor Felsen.
Charles Scribner's Sons, New York. 1955. 140 pp. Ill. \$2.25

A wholly unnecessary cuteness spoils this book for six- to nine-year-olds as science fiction—and this from the publisher of Robert Heinlein's superb teen-age novels. The theme is ideal, too: boy from a flying saucer visits Earth, meets and chums with a boy, wants to swap places with him and enjoy the wonders of the new planet all his life—then in the end decides home's best. If the author had played it straight, this would have my top recommendation for its age level. Instead TexSon's home world of Feor is flat, and you're in danger of falling off the edge; the Feorians know Mars—for its Mars-burgers—and the Moon, but have never heard of Earth or even visited the "universe" it's in; space is full of "exploding stars." Too bad.



EXPLORING THE MOON, by Roy A. Gallant and Lowell Hess. Garden City Books, Garden City, N. Y.
1955. 63 pp. Ill. \$2.00

Here's a fine big picture-book for the youngsters which isn't quite on a par with the Jack Coggins-Fletcher Pratt books but makes a worthy companion to them. Lowell Hess, the artist, has dramatized the lunar landscape and the theories of lunar origins in a series of violent, colorful paintings which haven't quite the

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Coggins or Bonestell photographic realism, but do have an eye-catching quality of their own. Both the Darwin and Weizsäcker theories are illustrated clearly as is Baldwin's idea of meteoric origin for the lunar craters. The title of the book applies to only one chapter, and there isn't a spacesuit or rocket anywhere. Since the author has written space-travel articles for *Boy's Life* he may be saving that aspect for another book.



THE CITY AND THE STARS, by Arthur C. Clarke. Harcourt, Brace & Co., New York. 1956. 310 pp. \$3.75.

This is the poetic—as distinguished from the documentary—Clarke, completely rewriting his 1948 magazine classic, "Against the Fall of Night," which in turn was expanded into the 1953 Gnome Press book and Perma PB.

The author considers that only about a quarter of the present book has been taken over from the earlier version. This may be literally true, but the entire theme and plot skeleton are the same. What Clarke has done is expand and enrich his picture of the great, self-sufficient, self-renewing city at the end of Time, Diaspar—Paradis?—whose one rebel, Alvin, breaks through into the past in order to find a way to his people's once-glorious Empire among the stars. First the pastoral, variegated community of Lys at the end of Diaspar's forgotten subway system . . .

then the ravished fortress of Shal-mirane, with its weird guardians . . . finally the voyage to the abandoned worlds of the Seven Suns, and the discovery of the child-monster Vanamonde.

It's as though the older book were a thin abridgement of this new one, with the same bare outline and some of the color, but—to completely garble the metaphor—unorchestrated. You either like this kind of Clarke or you like his "Prelude to Space" approach—and I understand he'll have a book on the Great Barrier Reef of Australia out by the time you see this, just to underline his versatility. He handles both equally well.



THE DRAGON IN THE SEA, by Frank Herbert. Doubleday & Co., Garden City, N.Y. 1956. 192 pp. \$2.95.

When I tell you that this is the book version of "Under Pressure," one of the best serials this magazine has published in a long time, I suppose I need say no more.

The mission on which Ensign John Ramsey, BurPsych, is sent as undercover electronics officer on the atomic submarine, *Fenian Ram*, is packed with every element of physical suspense and danger: a hidden spy, sabotage, hunting by the enemy wolf pack, runaway radiation. As a spy story, an adventure story, a chase story it's a terrific job. But Ramsey's real mission is to get at the psychological pressures which make the men

of the subs crack up mentally—and which have welded together the three members of Commander Harvey Sparrow's crew into the strongest unit in the undersea fleet. And on this level too the suspense mounts, and the final revelation carries a sound evaluation of the pressures of our own times.

This is certainly going to be one of the top books of 1956.



MARTIANS, GO HOME, by Fredric Brown. E. P. Dutton & Co., New York. 1955. 189 pp. \$2.75.

I would never have believed that Fredric Brown could blow up his delightfully comic novelette, a highlight of last-year's ASF honor-roll, into a full-length book—but he's done it. I expected to find it running thin, the gimmick playing out, the interest lagging—but I went through it at one sitting. You will too.

He's done it by enlarging on the character and problems of Luke Devereaux, California science-fiction writer who was shocked into a paranoid condition in which he no longer believed that Earth was infested with little green Martians. That made him the one comfortable man in a world driven nuts by the interplanetary pests who were: "abusive, aggravating, annoying, brash, brutal, cantankerous, caustic, churlish, detestable . . . knavish killjoys (and) leering, loathsome, malevolent, malignant . . . waspish, xenophobic, yapping, and zealous in making themselves obnoxious." They

were everywhere, nosing into everybody's business, nebbishly reporting everything they saw and heard to the world at large. And in the end Luke—or it may have been the Moparobi witch doctor, Bugassi, or the Chicago janitor, Hiram Pberdorffer, with his anti-extraterrestrial subatomic super-vibrator with the outboard power plant and the tambourine diaphragm.

It's bigger and better than ever, but why didn't Dutton have the good sense to use Kelly Freas' original ASF cover for the jacket, instead of the infantile monstrosity they have?



CITIZEN IN SPACE, by Robert Sheckley. Ballantine Books, N.Y. 1956. 200 pp. \$2.00; paper 35¢.

The twelve mixed fantasy and science-fiction tales in this second book of Sheckley short stories aren't quite up to those in "Untouched by Human Hands," singly or as a whole. Most of them originally appeared in *Galaxy*, and the opening story, "The Mountain Without a Name," appears to be written for the book. It details some of the headaches encountered by a planet-landscaping contractor.

There are really only two simon-pure fantasies: "The Accountant," in which a youngster who is failing sadly in his Theoretical and Applied Wizardry comes through with flying colors, and "Something for Nothing," in which a machine grants wishes. Maybe you can rationalize that one into SF too. But there's a

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powerful element of fantasy, whimsy, whimsy and what-the-hell in all of the stories—a pinch of Bradbury, perhaps, but with more meat in the stew.

In "Hunting Problem," for example, a gang of extraterrestrial Boy Scouts set out to catch and skin a Mirash—which turns out to be suspiciously like a human being. "A Thief in Time" tangles paradox with paradox. "The Luckiest Man in the World" is a short-short portrait of an egomaniac. "Hands Off" sets up a pleasant situation in which human and nonhuman explorers on a far world try to steal each others' ships: I think it's my favorite. But then there's "A Ticket to Tranai," in which a bored young man gets to Paradise and sets out to reform it, and there's "Skulking Permit," a broad burlesque of the rural community trying to comply with bureaucratic directives, and there's "Citizen in Space," which came from *Playboy* and is an even broader burlesque of certain tendencies not too hard to find about us. "Ask a Foolish Question" is another very short one built around a philosophical dilemma.

And I overlooked one other fantasy, "The Battle," in which the final Armageddon between Good and Evil is fought out along strictly up-to-date lines, with an alarming and unexpected result.

Shekley and Matheson seem to be carrying on the wry and pawkish Bradbury-Collier approach and at the same time telling stories. Good for them!

SCIENCE FICTION ADVENTURES IN MUTATION, edited by Groff Conklin. Vanguard Press, Inc., New York, 1955. 316 pp. \$3.75.

I don't think Groff Conklin, Judith Merrill or Andre Norton has ever turned out a poor anthology. In fact, I don't think they can, as the twenty stories in this collection demonstrate. They aren't *the* twenty best stories of mutation and mutants, because one of the house-rules Mr. Conklin has adopted is that he uses only stories not previously anthologized. For one of them, Dr. Miles J. Breuer's "The Hungry Guinea Pig," he's gone clear back to 1930. The British magazines are represented as well as the Americans: this magazine contributed Emmett McDowell's "Veiled Island" (1946), a rather weird story of Venusian evolution that reminds you of Edgar Rice Burroughs' neglected "Land That Time Forgot," and Alan Nourse's "Family Resemblance," a grand double-take spoof. There's a brand new S. Fowler Wright vignette, "The Better Choice," that is pure fantasy.

Mutant men predominate, of course: James Blish's "Battle of the Unborn," Fredric Brown's "Keep Out," Theodore Cogswell's startling "Limiting Factor," a Kuttner yarn about the Hogbens, "Cold War"—can it be true that he only did four in this series?—which is one of the best, "Veiled Island," Kris Neville's frightening "Experiment Station" with its deadly sting in the tail, Margaret St. Clair's even more disturbing

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both crimes. But it's the picture of the London of the mad George III and his playboy heir, of Sheridan and the Drury Lane theater, of filth and duels and boxing and every other facet of that strange era, that makes the book fascinating. Time travel is merely a gimmick, and the mystery is below Carr's own standard; it's really a historical novel with modern characters. Hence the price. Rent it, or watch for a PB.



ALIEN FROM ARCTURUS, by Gordon R. Dickson.

ATOM CURTAIN, by Nick Boddie Williams. Ace Books, Inc., New York. 1956. 150 + 168 pp. 35¢.

It's no world-beater, but I liked both halves of this back-to-back Ace Double Novel. Dickson's yarn is another of the "Is Man Worthy?" stories, with Earth given a deadline for development of an interstellar drive and various interests trying to block any move to upset a profitable situation. Johnny Parent gets himself involved with a seemingly dilettante tycoon, his red-headed secretary, a Venusian underground organization, assorted cultists, and a delightful Alien named Panjarmeeeklotutmrp—"Peep" for short—who is a visitor from Jusileminopratiup. There's plenty of fun and stuff before Johnny whisks 'em all to Arcturus for the showdown.

"Atom Curtain" hasn't the same carefree spirit and lacks Peep and pep. After WW III, the Americas

have dug themselves a hole and pulled it in over them, so that the rest of the world is cut off outside an "Atom Curtain" of radioactivity. (Why doesn't it saturate Europe and Asia with fall-out? Dunno—it's peculiar stuff.) Emmett O'Hara of the International Patrol gets inside the Curtain—and out again—with a very strange story of a race regressing to the apes, trained by an immortal in underground Washington. Spectacular, but not much more.

REPRINT ROUNDUP

STAR SHINE, by Fredric Brown, Bantam Books, N.Y. 1956. 138 pp. 25¢.

PB edition of "Angels and Space-suits." Short-short spacers intact.

SNOW FURY, by Richard Holden. Perma Books, N.Y. 1956. 194 pp. 25¢.

Mystery about snow that consumed.

TOMORROW! by Philip Wylie, Popular Library, N.Y. 1956. 288 pp. 35¢.

Bad Town is destroyed because it scoffed at Civil Defense; Good Town spared.

THE SCIENCE BOOK OF SPACE TRAVEL, by Harold Leland Goodwin. Pocket Books, Inc., N.Y. 1956. 213 pp. 35¢.

With most of the Coggins illustrations.

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(Continued from page 5)

All right; there's a simple analogy to that type of situation. I have at home a camera with a film in it; six of the twelve frames have been exposed. Are there, or are there not, images on that film?

The answer is the logically impossible one, "No; there are," or "Yes; there aren't." It is the interesting case of a *specific ambiguity*; there is no "maybe" about this situation. I know with high assurance that there are six latent images, and six blank areas capable of accepting latent images. But I also know with high probability (say 0.999999 or so) that there are no images. Now a latent image *is not* an image; it won't ever become an image, either. If that film is left alone, undisturbed, in about ten to twenty years there won't even be a latent image.

That film can be examined under infrared light, and it can be demonstrated conclusively that there is no image present. And there isn't, because by "image" we mean a deposit of metallic silver in a meaningful pattern.

But if that film is treated in a

suitable developer solution, the chemical energy available in the developer can be used to reduce the silver halide salt to metallic silver—but that energy is *not* available, is *not* usable, unless there is a pre-existent condition of the silver halide crystal known as a "latent image."

Development is useless alone; it cannot produce metallic silver in significant amounts. (Unless deliberate chemical fogging is induced.)

Exposure is useless alone; it cannot produce significant metallic silver deposits either.

Then which is most important, exposure or development?

Well . . . proper developers can make much more delicate shadings, far more detailed information appear, in the finished negative. But you can't develop any image whatever in an unexposed film. Of course, if you overdevelop the negative, chemical fogging sets in, the negative turns gray all over, whether it was exposed or not, and if the negative is moved in a constantly repeated manner during development, it will probably show swirl marks where the developer solution flowed in a

sort of eddy pattern across it. A sort of a kind of image will show up—but it will have nothing to do with the real world outside the dark-room.

A collection of films can be made to show great regularity of pattern, however, if they are all vigorously overdeveloped, so that all original pattern of exposure is drowned out in chemical fog, and the developer is caused to swirl over them in such a way as to leave eddy marks. This will have the interesting result that no matter what the original exposure was, all the negatives show excellent uniformity of pattern.

The Nurture advocates can show something as evidence of the power of educational development. I'm not sure just what it is they're showing, however. Maybe it's swirl marks from overdevelopment?

And it's certainly true that Nature alone doesn't produce any significant results. If a normal human child is brought up by deaf mutes, he never learns to talk. Of course, he does become remarkably adept at sign language, but that's not *talking* . . . or is it? The latent potential to communicate by symbols hasn't been expressed in the usual vocal manner, so evidently Nature has nothing to do with the matter.

One final item: a mind must be able to generate a concept, an abstraction, before it can label it with a word. But suppose we have an individual who can generate a concept for which there is no word in any language? He will, evidently, be

forced to think without words with respect to that concept—and no matter how cogent and valid his thinking, he cannot communicate it to any other individual. He must first communicate the concept without a word! The word can be established only *after* the concept has been communicated.

Now if there is a variation in the ability to generate abstractions, as human individuals vary in physical strength, and in all other measurable characteristics, there will then be some human individuals who cannot be taught this new word, and some who can. The ones who cannot be taught will "know" that the word is nonsense, because there is no referent for the word. Since the actual referent for any word is a concept, and that concept exists solely at the subjective level—if a man says "There is no referent for that word!" he is unarguably correct. For him, in his subjective world, there is no concept to which he can attach that word.

For most of the two billion or so human individuals on the planet today there is no referent for the term "curved space." "Space" is emptiness—the concept of nothing-present. It's a negation term, like "drought" or "poverty." It's an absence-of. And obviously if there is nothing there, then there is nothing to be curved. So "curved space" is nonsense by definition; it has no referent.

Go ahead, you Relativists! Point to it!

THE EDITOR.

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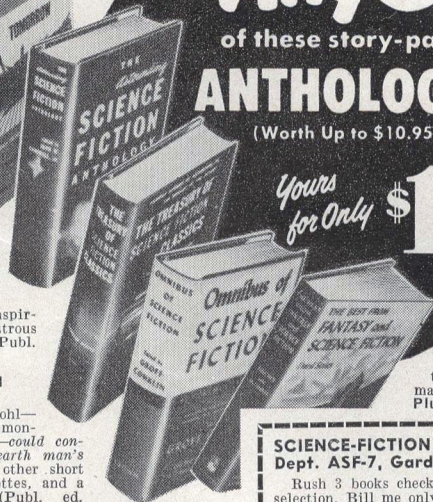
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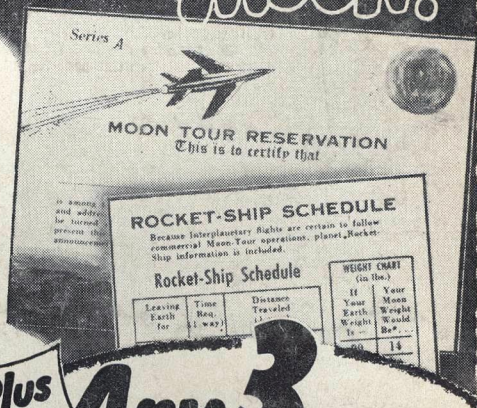
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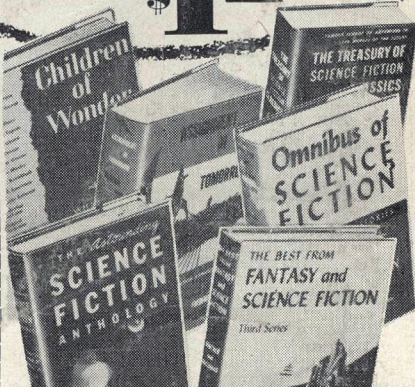
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