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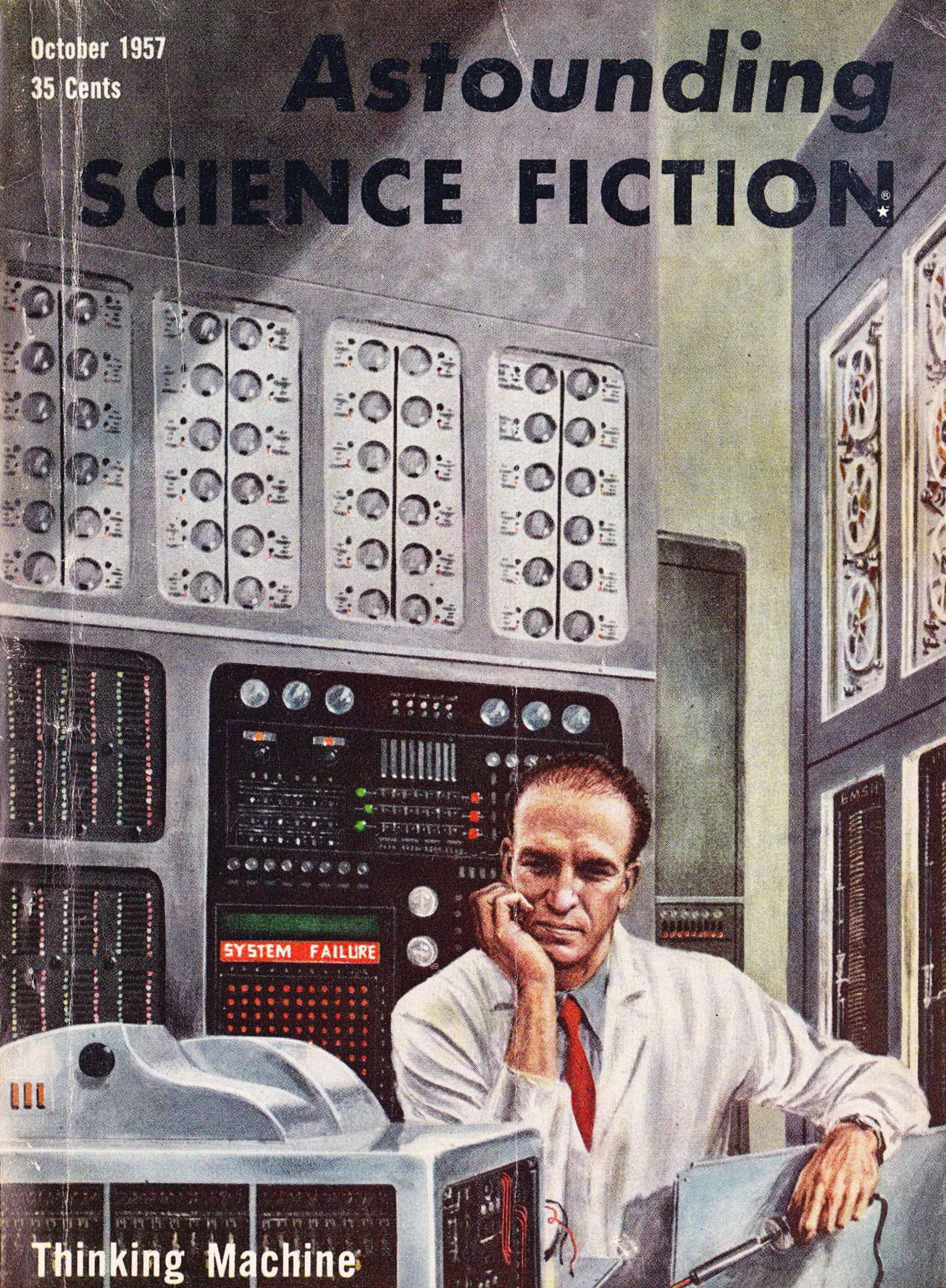

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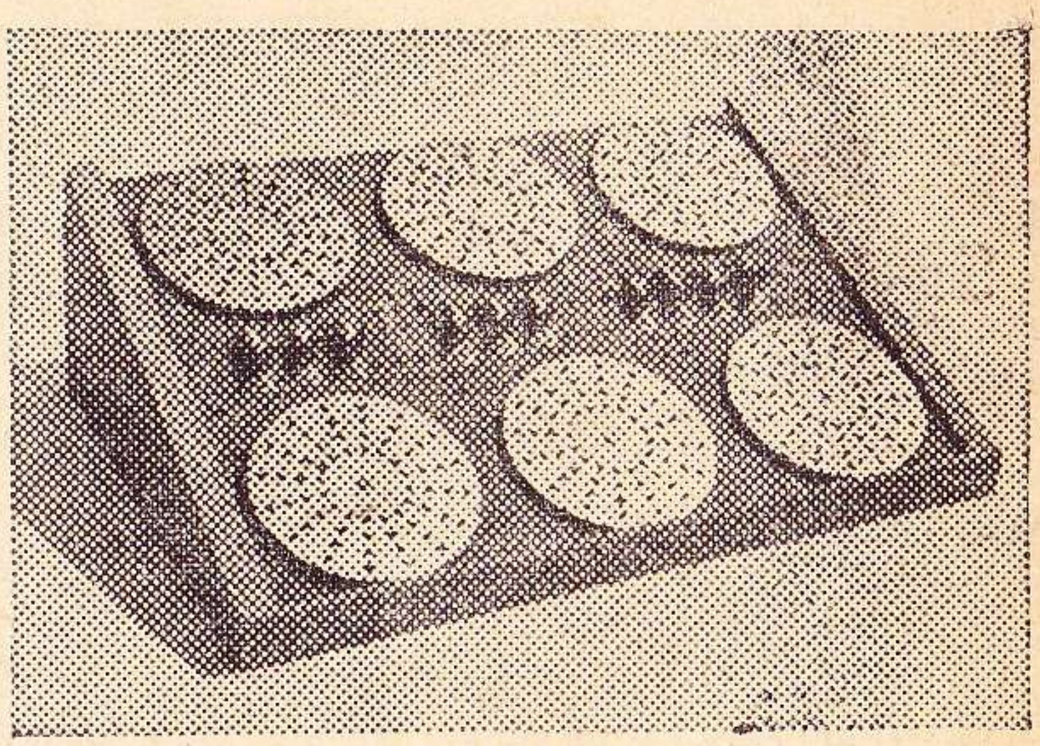

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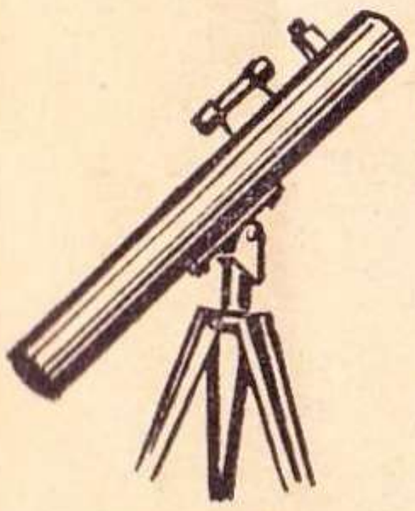

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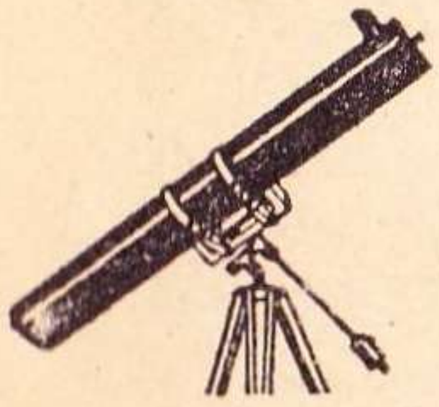

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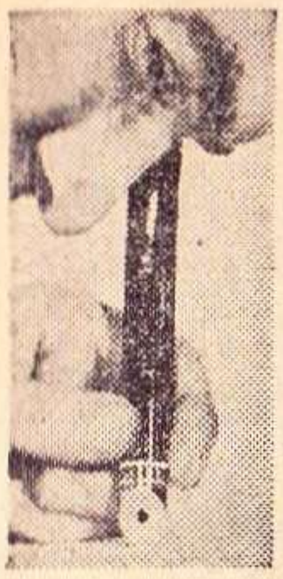

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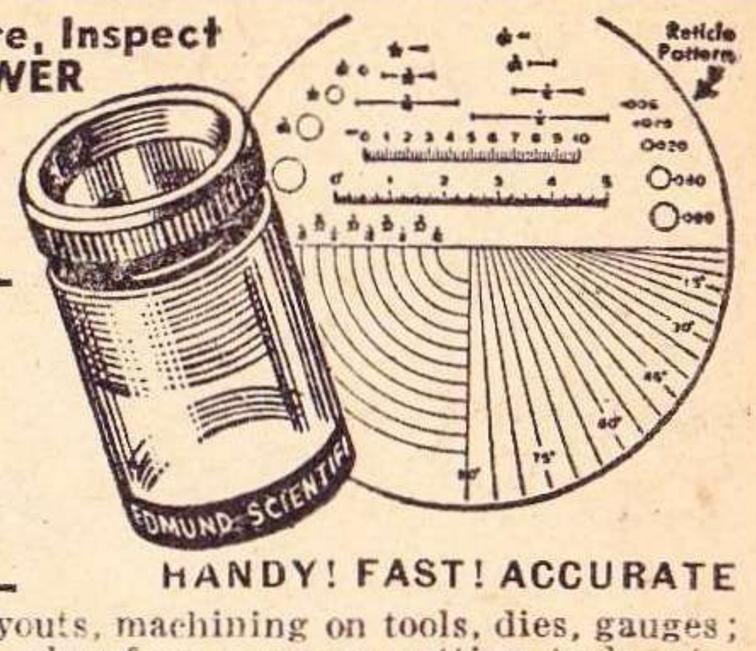

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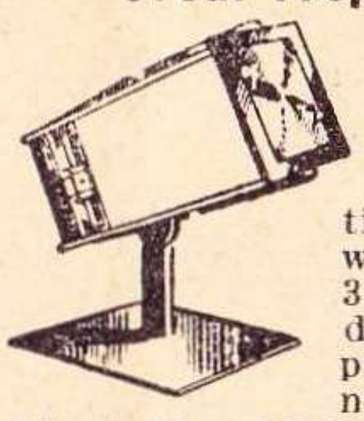

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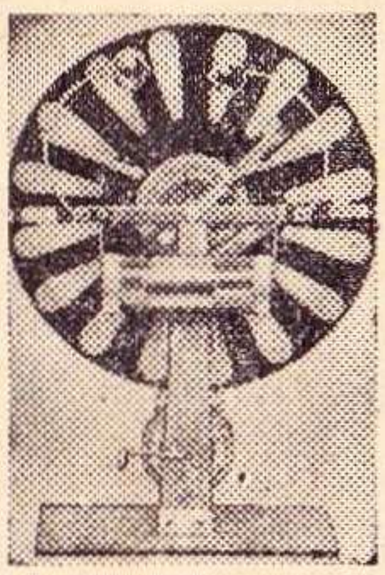

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EDITORIAL

A MATTER OF DEGREE

There has been very little study of the relationships between individuals, and the group generated by the interactions of those individuals—either at the level of purely mechanical units such as relays in a computer, or human beings in a culture. The introduction of the great electronic computers, and of ever more complex systems, and systems-of-systems, has led to a beginning of the study of systems-as-such.

The most pressing aspect of systems-problems has been the obviously high-priority one of systems failures. If we have ten thousand individual units each having a fifty per cent reliability in a one-thousand-hour run, how long can we expect the system, as a whole, to operate before failure, assuming the ten thousand units are connected in series? Answer: About six minutes.

Systems don't behave in quite as simple a way, however, when we have multiple-series-parallel connections, with crossover switching for substitution or bridging around defective units, plus feedback for internal self-checking, plus dynamic homeostasis systems, and a few of the other simpler types of arrangements the systems engineers have introduced for improved reliability. The boys in the drafting rooms are beginning to consult the biologists, and the neurologists are starting to look up from computer journals with a sudden realization of the order of, "Sooooo—so *that's* why the third ganglion of . . . hm-m-m . . ." Living organisms have been evolving solutions—purely pragmatic, but extremely competent after three to four billion years of field testing—to systems reliability problems too, of course. Negative and positive feedback systems—telemetering—servomechanisms — amplifier systems — miniaturization to make a miniaturi-

zation engineer tear his hair—it's all been there for a billion years or so.

Most of the naturally evolved systems are so darned highly evolved that human engineering can't figure out what in blazes the thing's built that way for. Usually the miniaturization technique has been carried down to a sub-molecular level, which makes it just a bit difficult for the engineer to trace out the circuits, even if he knew what the circuits were doing.

On the other extreme, the humanic fields are stopped just as completely because the structures they are studying are equally complex, and so huge that a man's-eye-view makes it as difficult to see the shape of the whole system-of-systems involved in a culture, as it is for a man to see the shape of the Earth. The tools for expressing the problem, moreover, are the inherently inadequate tools developed before the existence of the problem was recognized—language that's based on linear logic. Modern languages and thinking-systems work like a chain of links, and are inherently unsuitable for expression of a system-of-systems that works like a rope. Our formal method of discussion denies the use of analogical thinking, and refuses to consider that ten concurrent items, each having a truth-and-relevancy probability of fifty per cent, can constitute high-probability evidence. After all, logically each one of them can be shown to be too untrustworthy for consideration.

The social scientists—and in that group I include psychologists, psychotherapists, sociologists, anthropologists, linguistics specialists, and historians—are struggling with tools inadequate to their task, and struggling with the fact that the new tools can't be invented so long as the Rules of Evidence remain unmodified.

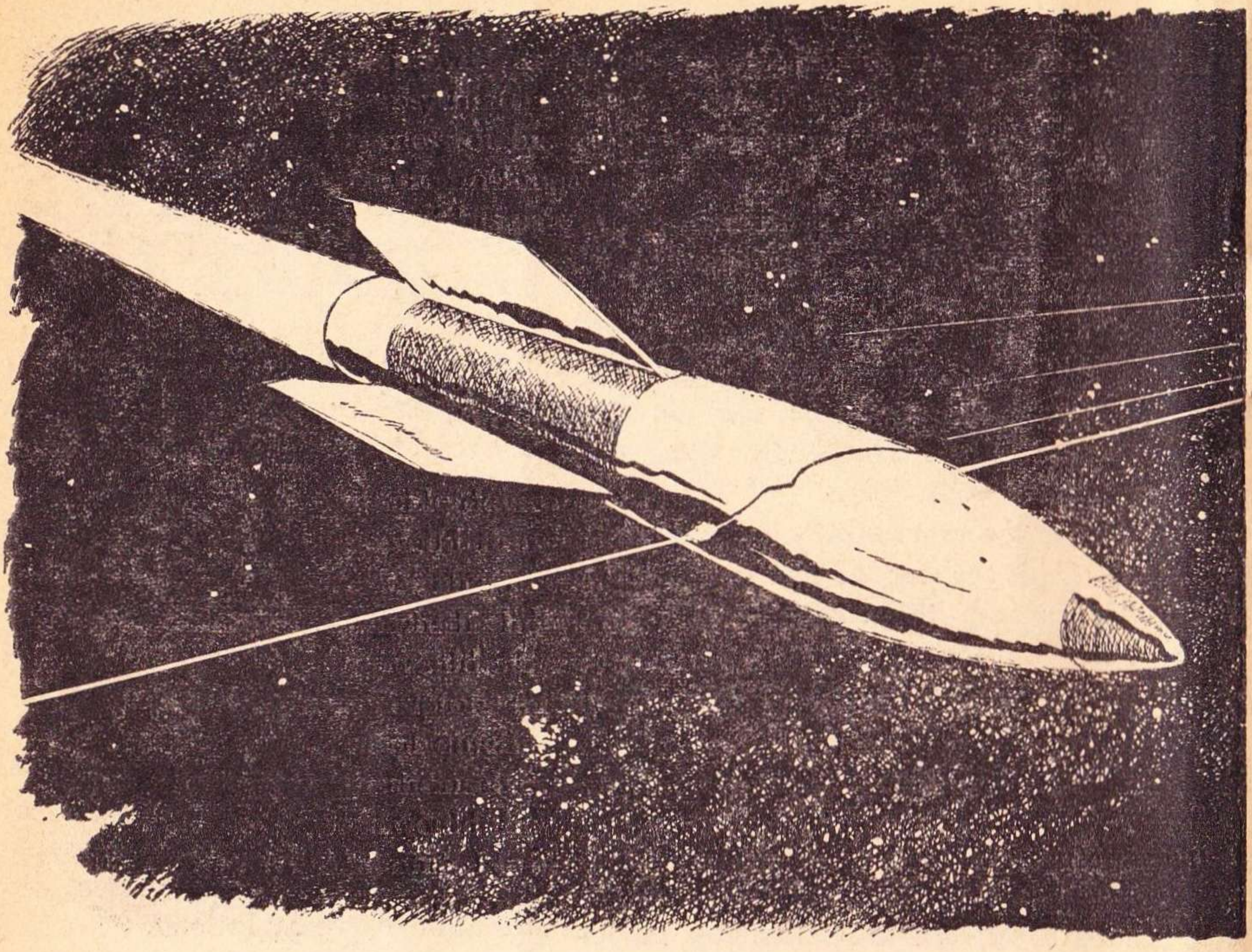
Being a science-fiction editor, I can speculate; anyone interested is invited to speculate along with me, in the full realization that no formally acceptable evidence can be educed to establish the validity of the speculations. This is reasoning by analogy, which every one knows is of no value in a truly logical discussion.

I suggest that in two populations, having a normal distribution of characteristic Alpha, such that population A has the peak of the distribution curve as little as 0.1% off the peak of that characteristic for population B, may, *as a system,* differ in *kind,* not merely in degree. That Population A, in other words, may by its interactions, produce a system of type X, while population B, in its interactions, solely because of that 0.1% difference, may produce a different *kind* of system, type Y.

If this proposition can be validated, that would imply that very minor shifts in the peak of a distribution curve could produce huge differences in the nature of the resultant culture.

The speculation is based on the following analogical reasoning: a

(*Continued on page* 160)

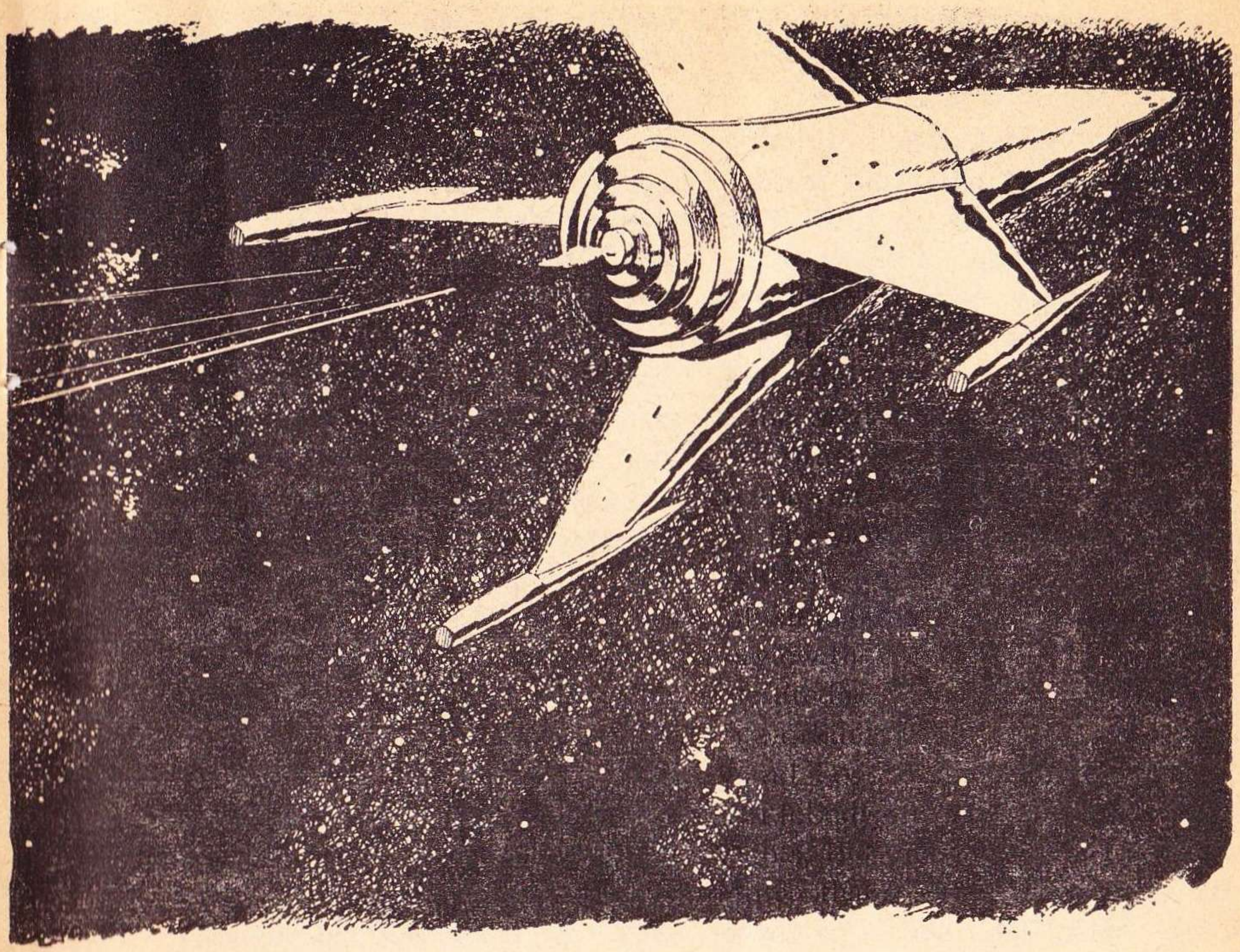


THE GRANDFATHERS' WAR

The worst kind of a fight—the kind above all others to not get in the middle of! —is a family fight. But this one was a supercolossal, interplanetary family fight!

BY MURRAY LEINSTER

Illustrated by van Dongen



I.

". . . No man can be fully efficient if he expects praise or appreciation for what he does. The uncertainty of this reward, as experienced, leads to modification of one's actions to increase its probability . . . If a man permits himself the purpose of securing admiration, he tends to make that purpose primary and the doing of his proper work secondary. This costs human lives . . ."

Manual, Interstellar Medical Service. Pp. 17-18.

The little Med ship seemed absolutely motionless when the hour-off warning whirred. Then it continued to seem motionless. The background-noise tapes went on, making the small, unrelated sounds that exist unnoticed in all the places where human beings dwell, but which have to be provided in a ship in overdrive so a man don't go ship-happy from the dead stillness. The hour-off warning was notice of a change in the shape of things.

Calhoun put aside his book—the manual of the Med Service—and yawned. He got up from his bunk to tidy ship. Murgatroyd, the *tormal,*

opened his eyes and regarded him drowsily, without uncoiling his furry tail from about his nose.

"I wish," said Calhoun critically, "that I could act with your realistic appraisal of facts, Murgatroyd! This is a case of no importance whatever, and you treat it as such, while I fume whenever I think of its futility. We are a token mission, Murgatroyd,—a politeness of the Med Service, which has to respond to hysterical summonses as well as sensible ones. Our time is thrown away!"

Murgatroyd blinked somnolently. Calhoun grinned wryly at him. The Med ship was a fifty-ton space-vessel —very small indeed, in these days— with a crew consisting exclusively of Calhoun and Murgatroyd the *tormal*. It was one of those little ships the Med Service tries to have call at every colonized planet at least once in four or five years. The idea is to make sure that all new developments in public health and individual medicine will spread as widely and as fast as can be managed. There were larger Med craft to handle dangerous situations and emergencies of novel form. But all Med ships were expected to handle everything possible, if only because space travel consumed such quantities of time.

This particular journey, for example: An emergency message had come to Sector Headquarters from the planetary government of Phaedra II. Carried on a commercial vessel in overdrive at many times the speed of light, it had taken three months to reach Headquarters. And the emergency in which it asked aid was absurd. There was, said the message, a state of war between Phaedra II and Canis III. Military action against Canis III would begin very shortly. Med Service aid for injured and ill would be needed. It was therefore requested at once.

The bare idea of war, naturally, was ridiculous. There could not be war between planets. Worlds communicated with each other by spaceships, to be sure, but the Lawlor interplanetary drive would not work save in unstressed space, and of course overdrive was equally inoperable in a planet's gravitational field. So a ship setting out for the stars had to be lifted not less than five planetary diameters from the ground before it could turn on any drive of its own. Similarly, it had to be lowered an equal distance to a landing after its drive became unusable. Space travel was practical only because there were landing grids—those huge structures of steel which used the power of a planet's ionosphere to generate the force-fields for the docking and launching of ships of space. Hence landing grids were necessary for landings. And no world would land a hostile ship upon its surface. But a landing grid could launch bombs or missiles as well as ships, and hence could defend its planet, absolutely. So there could be no attacks and there could be defense, so wars could not be fought.

"The whole thing's nonsense," said Calhoun. "We'll get there, and we've been three months on the way

and the situation is six months old and either it's all been compromised or it's long forgotten and nobody will like being reminded of it. And we've wasted our time and talents on a thankless job that doesn't exist, and couldn't! The universe has fallen on evil days, Murgatroyd! And we are the victims!"

Murgatroyd leisurely uncurled his tail from about his nose. When Calhoun talked at such length, it meant sociability. Murgatroyd got up, and stretched, and said, *"Chee!"* He waited. If Calhoun really meant to go in for conversation, Murgatroyd would join in. He adored pretending that he was a human. He and his kind imitated human actions as parrots imitated human speech. Murgatroyd frisked a little, to show his readiness for talk.

"Chee-chee-chee!" he said conversationally.

"I notice that we agree," said Calhoun. "Let's clean up."

He began those small items of housekeeping which one neglects when nothing can happen for a long time ahead. Books back in place. Files restored to order. The special-data reels Calhoun had been required to study. Calhoun made all neat and orderly against landing and possible visitors.

Presently the breakout clock indicated twenty-five minutes more in overdrive. Calhoun yawned again. As an interstellar service organization, the Med Service sometimes had to do rather foolish things. Governments run by politicians required them. Yet Med Service representatives always had to be well-informed on problems which appeared. During this journey Calhoun had been ordered to read up on the ancient insanity once called the art of war. He didn't like what he'd learned about the doings of his ancestors. He reflected that it was lucky that such things couldn't happen anymore. He yawned again.

He was strapped in the control-chair a good ten minutes before the ship was due to return to a normal state of things. He allowed himself the luxury of still another yawn. He waited.

The warning tape whirred a second time. A voice said, *"When the gong sounds, breakout will be five seconds off."* There was a heavy, rhythmic tick-tocking. It went on and on. Then the gong and a voice said: *"Five—four—three—t—"*

It did not complete the count. There was a tearing, rending noise and the spitting of an arc. There was the smell of ozone. The Med ship bucked like a plunging horse. It came out of overdrive two seconds ahead of time. The automatic, emergency-rockets roared and it plunged this way and changed course violently and plunged that, and seemed to fight desperately against something that frustrated every maneuver it tried. Calhoun's hair stood on end until he realized that the external-field indicator showed a terrific artificial force-field gripping the ship. He cut off the rockets as their jerk-

ings tried to tear him out of his chair.

There was stillness. Calhoun rasped into the spacephone:

"What's going on? This is Med Ship *Esclipus Twenty!* This is a neutral vessel!" The term "neutral vessel" was new in Calhoun's vocabulary. He'd learned it while studying the manners and customs of war in overdrive. "Cut off those force-fields!"

Murgatroyd shrilled indignantly. Some erratic movement of the ship had flung him into Calhoun's bunk, where he'd held fast to a blanket with all four paws. Then another wild jerking threw him and the blanket together into a corner, where he fought to get clear, chattering bitterly the while.

"We're noncombatants!" snapped Calhoun—another new term.

A voice growled out of the spacephone speaker.

"Set up for light-beam communication," it said heavily. *"In the meantime keep silence."*

Calhoun snorted. But a Med ship was not an armed vessel. There were no armed vessels nowadays. Not in the normal course of events. But vessels of some sort had been on the watch for a ship coming to this particular place.

He thought of the word "blockade"—another part of his education in the outmoded art of war. Canis III was blockaded.

He searched for the ship that had him fast. Nothing. He stepped up the magnification of his vision-screens. Again nothing. The sun Canis flamed ahead and below, and there were suspiciously bright stars which by their coloring were probably planets. But the Med ship was still well beyond the habitable part of a sol-class sun's solar system.

Calhoun pulled a photocell out of its socket and waited. A new and very bright light winked into being. It wavered. He stuck the photocell to the screen, covering the brightness. He plugged in its cord to an audio amplifier. A dull humming sounded. Not quite as clearly as a spacephone voice, but clear enough, a voice said:

"If you are Med Ship Esclipus Twenty, *answer by light beam, quoting your orders."*

Calhoun was already stabbing another button, and somewhere a signal-lamp was extruding itself from its recess in the hull. He said irritably:

"I'll show my orders, but I do not put on performances of dramatic readings! This is the devil of a business! I came here on request, to be a ministering angel or a lady with a lamp, or something equally improbable. I did not come to be snatched out of overdrive, even if you have a war on. This is a Med ship!"

The slightly blurred voice said as heavily as before:

"This is a war, yes. We expected you. We wish you to take our final warning to Canis III. Follow us to our base and you will be briefed."

Calhoun said tartly:

"Suppose you tow me! When you

dragged me out of overdrive you played the devil with my power!"

Murgatroyd said, *"Chee?"* and tried to stand on his hind legs to look at the screen. Calhoun brushed him away. When acknowledgment came from the unseen other ship, and the curious cushiony drag of the towing began to be felt, he cut off the microphone to the lightbeam. Then he said severely to Murgatroyd:

"What I said was not quite true, Murgatroyd. But there is a war on. To be a neutral I have to appear impressively helpless. That is what neutrality means."

But he was far from easy in his mind. Wars between worlds were flatly impossible. The facts of space travel made them unthinkable.

Yet there seemed to be a war. Something was happening, anyhow, which was contrary to all the facts of life in modern times. And Calhoun was involved in it. It demanded that he immediately change all his opinions and all his ideas of what he might have to do. The Med Service could not take sides in a war, of course. It had no right to help one side or the other. Its unalterable function was to prevent the needless death of human beings. So it could not help one combatant to victory. On the other hand it could not merely stand by, tending the wounded, and by alleviating individual catastrophes allow their number to mount.

"This," said Calhoun, "is the devil!"

"Chee!" said Murgatroyd.

The Med ship was being towed. Calhoun had asked for it and it was being done. There should have been no way to tow him short of a physical linkage between ships. There were force-fields which could perform that function—landing grids used them constantly—but ships did not mount them—not ordinary ships, anyhow. That fact bothered Calhoun.

"Somebody's gone to a lot of trouble," he said, scowling, "as if wars were going back into fashion and somebody was getting set to fight them. Who's got us, anyhow?"

The request for Med Service aid had come from Phaedra II. But the military action—if any—had been stated to be due on Canis III. The flaming nearby sun and its family of planets was the Canis solar system. The odds were, therefore, that he'd been snatched out of overdrive by the Phaedrian fleet. He'd been expected. They'd ordered him not to use the spacephone. The local forces wouldn't care if the planet overheard. The invaders might. Unless there were two space fleets in emptiness, jockeying for position for a battle in the void. But that was preposterous. There could be no battles in unstressed space where any ship could flick into overdrive flight in the fraction of a second!

"Murgatroyd," said Calhoun querulously, "this is all wrong! I can't make head or tail or anything! And I've got a feeling that there is something considerably more wrong than I can figure out! At a guess, it's probably a Phaedrian vessel that's hooked

on to us. They didn't seem surprised when I said who I was. But—"

He checked his instrument board. He examined the screens. There were planets of the yellow sun, which now was nearly dead ahead. Calhoun saw an almost infinitely thin crescent, and knew that it was the sunward world toward which he was being towed. Actually, he didn't need a tow. He'd asked for it for no particular reason except to put whoever had stopped him in the wrong. To injure a Med ship would be improper even in war —especially in war.

His eyes went back to the external-field dial. There was a force-field gripping the ship. It was of the type used by landing grids—a type impractical for use on shipboard. A grid to generate such a force-field had to have one foot of diameter for roughly every ten miles of range. A ship to have the range of his captor would have to be as big as a planetary landing grid. And no planetary landing grid could handle it.

Then Calhoun's eyes popped open and his jaw dropped.

"Murgatroyd!" he said, appalled. "Confound them, it's true! They've found a way to fight!"

Wars had not been fought for many hundreds of years, and there was no need for them now. Calhoun had only lately been studying the records of warfare in all its aspects and consequences, and as a medical man he felt outraged. Organized slaughter did not seem a sane process for arriving at political conclusions. The whole galactic culture was based upon the happy conviction that wars could never happen again. If it was possible, they probably would. Calhoun knew humanity well enough to be sure of that.

"Chee?" said Murgatroyd inquiringly.

"You're lucky to be a *tormal!*" Calhoun told him. "You never have to feel ashamed of your kind."

The background information he had about warfare in general made him feel skeptical in advance about the information he would presently be given. It would be what used to be called propaganda, given him under the name of briefing. It would agree with him that wars in general were horrible, but it would most plausibly point out—with deep regret—that this particular war, fought by this particular side, was both admirable and justified.

"Which," said Calhoun darkly, "I wouldn't believe even if it were true!"

II.

"Information secured from others is invariably inaccurate in some fashion. A complete and reasoned statement of a series of events is almost necessarily trimmed and distorted and edited, or it would not appear reasonable and complete. Truly factual accounts of any series of happenings will, if honest, contain inconsistent or irrational elements. Reality is far too complex to be reduced to simple statements without much suppression of fact . . ."

Manual, Interstellar Medical Service. P. 25.

He was able to verify his guess

about the means by which interstellar war became practical, when the Med ship was landed. Normally, a landing grid was a gigantic, squat structure of steel girders, half a mile high and a full mile in diameter. It rested upon bedrock, was cemented into unbreakable union with the substance of its planet, and tapped the ionosphere for power. When the Med ship reached the abysmal darkness of the nearest planet's shadow, there were long, long pauses in which it hung apparently motionless in space. There were occasional vast swingings, as if something reached out and made sure where it was. And Calhoun made use of his nearest-object indicator and observed that something very huge fumbled about and presently became stationary in emptiness, and then moved swiftly and assuredly down into the blackness which was the planet's night-side. When it and the planetary surface were one, the Med ship began its swift descent in the grip of landing grid-type forcefields.

It landed in the center of a grid—but not a typical grid. This was more monstrous in size than any spaceport boasted. It was not squat, either, but as tall as it was wide. As the ship descended, he saw lights in a control-system cell, midway to the ground. It was amazing but obvious. The Med ship's captors had built a landing grid which was itself a spaceship. It was a grid which could cross the void between stars. It could wage offensive war.

"It's infernally simple," Calhoun told Murgatroyd, distastefully. "The regular landing grid hooks onto something in space and pulls it to the ground. This thing hooks onto something on the ground and pushes itself out into space. It'll travel by Lawlor or overdrive, and when it gets somewhere it can lock onto any part of another world and pull itself down to that and stay anchored to it. Then it can land the fleet that traveled with it. It's partly a floating dry dock and partly a landing craft, and actually it's both. It's a ready-made spaceport anywhere it chooses to land. Which means that it's the deadliest weapon in the past thousand years!"

Murgatroyd climbed on his lap and blinked wisely at the screens. They showed the surroundings of the now-grounded Med ship, standing on its tail. There were innumerable stars overhead. All about, there was the whiteness of snow. But there were lights. Ships at rest lay upon the icy ground.

"I suspect," growled Calhoun, "that I could make a dash on emergency rockets and get behind the horizon before they could catch me. But this is just a regular military base!"

He considered his recent studies of historic wars, of battles and massacres and looting and rapine. Even modern, civilized men would revert very swiftly to savagery once they had fought a battle. Enormities unthinkable at other times would occur promptly if men went back to barbarity. Such things might already be

present in the minds of the crews of these spaceships.

"You and I, Murgatroyd," said Calhoun, "may be the only wholly rational men on this planet. And you aren't a man."

"Chee!" shrilled Murgatroyd. He seemed glad of it.

"But we have to survey the situation before we attempt anything noble and useless," Calhoun observed. "But still—what's that?"

He stared at a screen which showed lights on the ground moving toward the Med ship. They were carried by men on foot, walking on the snow. As they grew nearer it appeared that there were also weapons in the group. They were curious, ugly instruments—like sporting rifles save that their bores were impossibly large. They would be— Calhoun searched his new store of information. They would be launchers of miniature rockets, capable of firing small missiles with shaped charges which could wreck the Med ship easily.

Thirty yards off, they separated to surround the ship. A single man advanced.

"I'm going to let him in, Murgatroyd," observed Calhoun. "In war time, a man is expected to be polite to anybody with a weapon capable of blowing him up. It's one of the laws of war."

He opened both the inner and outer lock doors. The glow from inside the ship shone out on white, untrodden snow. Calhoun stood in the opening, observing that as his breath went out of the outer opening it turned to white mist.

"My name is Calhoun," he said curtly to the single dark figure still approaching. "Interstellar Medical Service. A neutral, a noncombatant, and at the moment very much annoyed by what has happened!"

A gray-bearded man with grim eyes advanced into the light from the opened port. He nodded.

"My name is Walker," he said, as curtly. "I suppose I'm the leader of this military expedition. At least, my son is the leader of the . . . ah . . . the enemy, which makes me the logical man to direct the attack upon them."

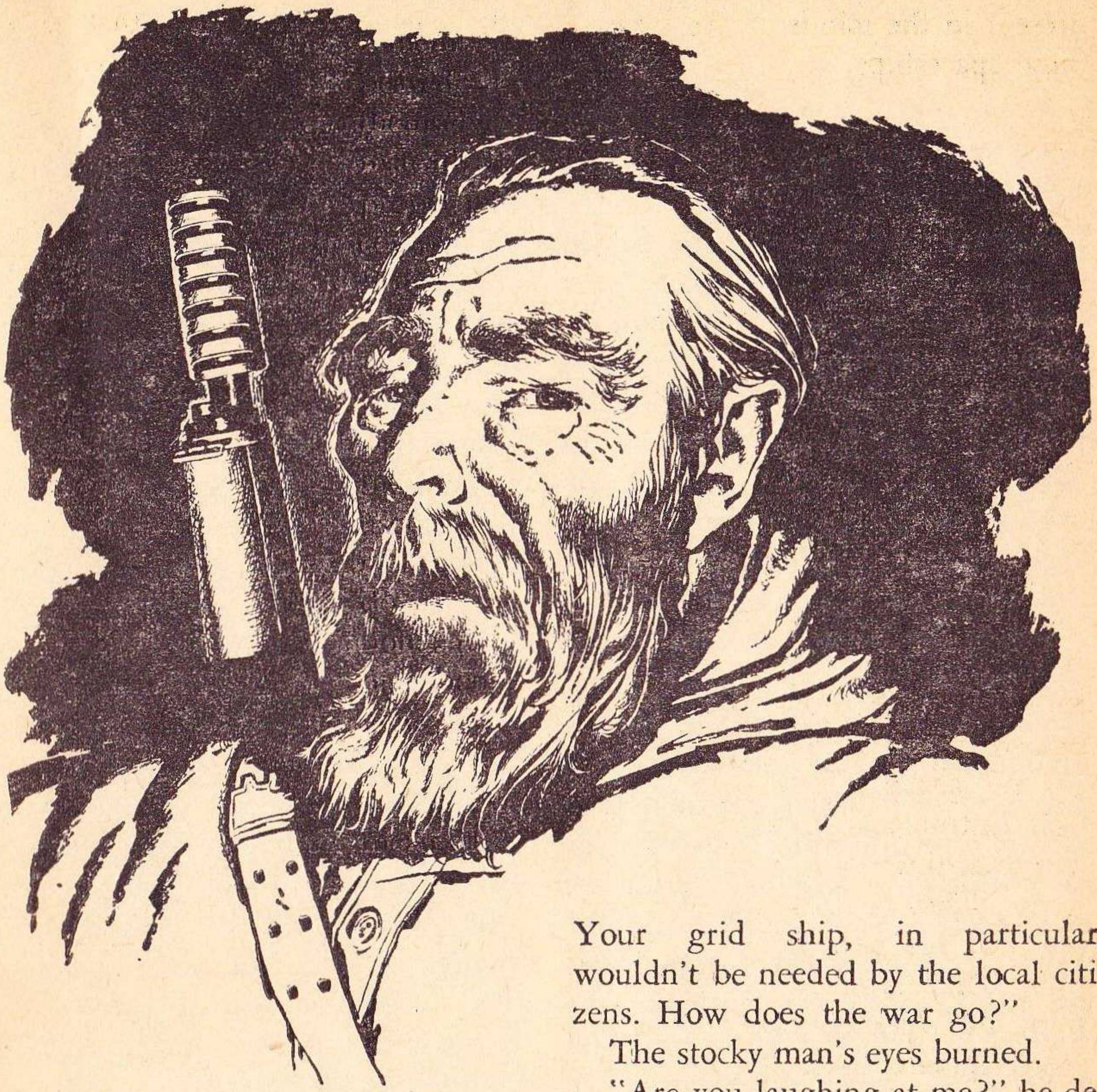
Calhoun did not quite believe his ears, but he pricked them up. A father and son on opposite sides would hardly have been trusted by either faction, as warfare used to be conducted. And certainly their relationship would hardly be a special qualification for leadership at any time.

He made a gesture of invitation, and the gray-bearded man climbed the ladder to the port. Somehow he did not lose the least trace of dignity in climbing. He stepped solidly into the air lock and on into the cabin of the ship.

"If I may, I'll close the lock-doors," said Calhoun, "if your men won't misinterpret the action. It's cold outside."

The sturdy, bearded man shrugged his cape-clad shoulders.

"They'll blast your ship if you try



to take off," he said. "They're in the mood to blast something!"

With the same air of massive confidence, he moved to a seat. Murgatroyd regarded him suspiciously. He ignored the little animal.

"Well?" he said impatiently.

"I'm Med Service," said Calhoun. "I can prove it. I should be neutral in whatever is happening. But I was asked for by the planetary government of Phaedra. I think it likely that your ships come from Phaedra. Your grid ship, in particular, wouldn't be needed by the local citizens. How does the war go?"

The stocky man's eyes burned.

"Are you laughing at me?" he demanded.

"I've been three months in overdrive," Calhoun reminded him. "I haven't heard anything to laugh at in longer than that. No."

"The . . . our enemy," said Walker bitterly, "consider that they have won the war! But you may be able to make them realize that they have not, and they cannot. We have been foolishly patient, but we can't risk forbearance any longer. We mean to carry through to victory even if we arrive at cutting our own throats for

a victory celebration! And that is not unlikely!"

Calhoun raised his eyebrows. But he nodded. His studies had told him that a war psychology was a highly emotional one.

"Our home planet Phaedra has to be evacuated," said Walker, very grimly indeed. "There are signs of instability in our sun. Five years since, we sent our older children to Canis III to build a world for all of us to move to. Our sun could burst at any time. It is certain to flare up some time—and soon! We sent our children because the place of danger was at home. We urged them to work feverishly. We sent the young women as well as the men at the beginning, so that if our planet did crisp and melt when our sun went off, there would still be children of our children to live on. When we dared—when they could feed and shelter them—we sent younger boys and girls to safety, overburdening the new colony with mouths to feed, but at the least staying ourselves where the danger was! Later we sent even the small children, as the signs of an imminent cataclysm became more threatening."

Calhoun nodded again. There were not many novas in the galaxy in any one year, even among the millions of billions of stars it held. But there had been at least one colony which had had to be shifted because of evidence of solar instability. The job in that case was not complete when the flare-up came. The evacuation of a world, though, would never be an easy task. The population had to be moved light-years of distance. Space-travel takes time, even at thirty times the speed of light. Where the time of disaster—the deadline for removal—could not be known exactly, the course adopted by Phaedra was logical. Young men and women were best sent off first. They could make new homes for themselves and for others to follow them. They could work harder and longer for the purpose than any other age-group—and they would best assure the permanent survival of somebody! The new colony would have to be a place of frantic, unresting labor, of feverish round-the-clock endeavor, because the time-scale for working was necessarily unknown but was extremely unlikely to be enough. When they could be burdened further, younger boys and girls would be shipped—old enough to help but not to pioneer. They could be sent to safety in a partly-built colony. Later smaller children could be sent, needing care from their older contemporaries. Only at long last would the adults leave their world for the new. They would stay where the danger was until all younger ones were secure.

"But now," said Walker thickly, "our children have made their world and now they refuse to receive their parents and grandparents! They have a world of young people only, under no authority but their own. They say that we lied to them about the coming flare of Phaedra's sun: that we enslaved them and made them use

their youth to build a new world we now demand to take over! They are willing for Phaedra's sun to burst and kill the rest of us, so they can live as they please without a care for us!"

Calhoun said nothing. It is a part of medical training to recognize that information obtained from others is never wholly accurate. Conceding the facts, he would still be getting from Walker only one interpretation of them. There is an instinct in the young to become independent of adults, and an instinct in adults to be protective past all reason. There is, in one sense, always a war between the generations on all planets, not only Phaedra and Canis III. It is a conflict between instincts which themselves are necessary—and perhaps the conflict as such is necessary for some purpose of the race.

"They grew tired of the effort building the colony required," said Walker, his eyes burning as before. "So they decided to doubt its need! They sent some of their number back to Phaedra to verify our observations of the sun's behavior. Our observations! It happened that they came at a time when the disturbances in the sun were temporarily quiet. So our children decided that we were overtimid; that there was no danger to us; that we demanded too much! They refused to build more shelters and to clear and plant more land. They even refused to land more ships from Phaedra, lest we burden them with more mouths to feed! They declared for rest; for ease! They declared themselves independent of us! They disowned us! Sharper than a serpent's tooth . . ."

". . . Is an ungrateful child," said Calhoun. "So I've heard. So you declared war."

"We did!" raged Walker. "We are men! Haven't we wives to protect? We'll fight even our children for the safety of their mothers! And we have grandchildren—on Canis III! What's happened and is happening there . . . what they're doing—" He seemed to strangle on his fury. "Our children are lost to us. They've disowned us. They'd destroy us and our wives, and they destroy themselves, and they will destroy our grandchildren— We fight!"

Murgatroyd climbed into Calhoun's lap and cuddled close against him. *Tormals* are peaceful little animals. The fury and the bitterness in Walker's tone upset Murgatroyd. He took refuge from anger in closeness to Calhoun.

"So the war's between you and your children and grandchildren," observed Calhoun. "As a Med ship man—what's happened to date? How has the fighting gone? What's the state of things right now?"

"We've accomplished nothing," rasped Walker. "We've been too softhearted! We don't want to kill them —not even after what they've done! But they are willing to kill us! Only a week ago we sent a cruiser in to broadcast propaganda. We considered that there must be some decency left even in our children! No ship can use any drive close to a planet, of

course. We sent the cruiser in on a course to form a parabolic semiorbit, riding momentum down close to atmosphere above Canopolis, where it would broadcast on standard communication frequencies and go on out to clear space again. But they used the landing grid to strew its path with rocks and boulders. It smashed into them. Its hull was punctured in fifty places! Every man died!"

Calhoun did not change expression. This was an interview to learn the facts of a situation in which the Med Service had been asked to act. It was not an occasion in which to be horrified. He said:

"What did you expect of the Med Service when you asked for its help?"

"We thought," said Walker, very bitterly indeed, "that we would have prisoners. We prepared hospital ships to tend our children who might be hurt. We wanted every possible aid in that. No matter what our children have done—"

"Yet you have no prisoners?" asked Calhoun.

He didn't grasp this affair yet. It was too far out of the ordinary for quick judgment. Any war, in modern times, would have seemed strange enough. But a full-scale war between parents and children on a planetary scale was a little too much to grasp in all its implications in a hurry.

"We've one prisoner," said Walker scornfully. "We caught him because we hoped to do something with him. We failed. You'll take him back. We don't want him! Before you go, you will be told our plans for fighting; for the destruction, if we must, of our own children! But it is better for us to destroy them than to let them destroy our grandchildren as they are doing!"

This accusation about grandchildren did not seem conceivably true. Calhoun, however, did not question it. He said reflectively:

"You're going about this affair in a queer fashion, whether as a war or an exercise in parental discipline. Sending word of your plans to one's supposed enemy, for instance—"

Walker stood up. His cheek twitched.

"At any instant now, Phaedra's sun may go! It may have done so since we heard. And our wives—our children's mothers—are on Phaedra. If our children have murdered them by refusing them refuge, then we will have nothing left but the right—"

There was a pounding on the air-lock door.

"I'm through," rasped Walker. He went to the lock and opened the doors. "This Med man," he said to those outside, "will come and see what we've made ready. Then he'll take our prisoner back to Canis. He'll report what he knows. It may do some good."

He stepped out of the air lock, flinging a command to Calhoun to follow.

Calhoun grunted to himself. He opened a cabinet and donned heavy winter garments. Murgatroyd said

"Chee!" in alarm when it appeared that Calhoun was going to leave him. Calhoun snapped his fingers and Murgatroyd leaped up into his arms. Calhoun tucked him under his coat and followed Walker down into the snow.

This, undoubtedly, was the next planet out from the colonized Canis III. It would be Canis IV, and a very small excess of carbon dioxide in its atmosphere would keep it warmer—by the greenhouse effect—than its distance from the local sun would otherwise imply. The snow was winter snow only. This was not too cold a base for military operations against the planet next inward toward the sun.

Walker strode ahead toward the rows of spaceship hulls about the singularly spidery grip ship. It occured to Calhoun that astrogating such a ship would be very much like handling an oversized, open-ended wastebasket. A monstrous overdrive field would be needed, and keeping its metal above brittle-point on any really long space voyage would be difficult indeed. But it was here. It had undoubtedly lifted itself from Phaedra. It had landed itself here, and should be able to land on Canis and then let down after itself the war fleet now clustered about its base. But Calhoun tried to take comfort in the difficulty of traveling really long distances, up in the tens or twenties of light-years, with such a creation. Possibly, just possibly, warfare would still be limited to relatively nearby worlds—

"We thought," rumbled Walker, "that we might excavate shelters here, so we could bring the rest of Phaedra's population here to wait out the war—so they'd be safe if Phaedra's sun blew. But we couldn't feed them all. So we have to blast a reception for ourselves on the world our children have made!"

They came to a ship which was larger than any except the grid ship. Nearby half its hull had been opened and a gigantic tent set up against it. It was a huge machine shop. A spaceship inside was evidently the cruiser of which Walker had spoken. Calhoun could see where ragged old holes had been made in its hull. Men of middle age or older worked upon it with a somehow dogged air. But Walker pointed to another object, almost half the size of the Med ship. Men worked on that, too. It was a missile, not man-carrying, with relatively enormous fuel-capacity for drive-rockets.

"Look that over," commanded Walker. "That's a rocket-missile, a robot fighting machine that we'll start from space with plenty of rocket-fuel for maneuvering. It will fight and dodge its way down into the middle of the grid at Canopolis —which our children refuse to use to land their parents. In three days from now we use this to blast that grid and as much of Canopolis as may go with it from the blast of a megaton bomb. Then our grid ship will land and our fleet will follow it down, and we'll be aground on Canis with blast-rifles and flame and

more bombs, to fight for our rightful foothold on our children's world!

When our fighting men are landed, our ships will begin to bring in our wives from Phaedra—if they are still alive—while we fight to make them safe. We'll fight our children as if they were wild beasts—the way they've treated us! We begin this fight in just three days, when that missile is ready and tested. If they kill us—so much the better! But we'll make them do their murder with their hands, with their guns, with the weapons they'd doubtless made. But they shall not murder us by disowning us! And if we have to kill them to save our grandchildren—we begin to do so in just three days! Take them that message!"

Calhoun said:

"I'm afraid they won't believe me."

"They'll learn they must!" growled Walker. Then he said abruptly: "What repairs does your ship need? We'll bring it here and repair it, and then you'll take our prisoner and carry him and your message back to his own kind—our children!"

The irony and the fury and the frustration in his tone as he said, "children," made Murgatroyd wriggle, underneath Calhoun's coat.

"I find," said Calhoun, "that all I need is power. You drained my overdrive charge when you snatched my ship out of overdrive. I've extra Duhanne cells, but one overdrive charge is a lot of power to lose."

"You'll get it back," growled Walker. "Then take the prisoner and our warning to Canis. Get them to surrender if you can."

Calhoun considered. Under his coat, Murgatroyd said *"Chee! Chee!"* in a tone of some indignation.

"Thinking of the way of my own father with me," said Calhoun wryly, "and accepting your story itself as quite true—how the devil can I make your children believe that this time you aren't bluffing? Haven't you bluffed before?"

"We've threatened," said Walker, his eyes blazing. "Yes. And we were too soft-hearted to carry out our threats. We've tried everything short of force. But the time has come when we have to be ruthless! We have our wives to consider."

"Whom," observed Calhoun, "I suspect you didn't dare have with you because they wouldn't let you actually fight, no matter what your sons and daughters did."

"But they're not here now!" raged Walker. "And nothing will stop us!"

Calhoun nodded. In view of the situation as a whole, he almost believed it of the fathers of the colonists on Canis III. But he wouldn't have believed it of his own father, regardless, and he did not think the young people of Canis would believe it of theirs. Yet there was nothing else for them to do.

It looked like he'd traveled three months in overdrive and painstakingly studied much distressing information about the ancestors of modern men, only to arrive at and witness the most heart-rending conflict in human history.

III.

"The fact that one statement agrees with another statement does not mean that both must be true. Too close an agreement may be proof that both statements are false. Conversely, conflicting statements may tend to prove each other's verity, if the conflict is in their interpretations of the facts they narrate . . ."

Manual, Interstellar Medical Service. P. 43.

They brought the prisoner a bare hour later. Sturdy, grizzled men had strung a line to the Med ship's power bank, and there was that small humming sound which nobody quite understands as power flowed into the Duhanne cells. The power men regarded the inside of the ship without curiosity, as if too much absorbed in private bitterness to be interested in anything else. When they had gone, a small guard brought the prisoner. Calhoun noted the expression on the faces of these men, too. They hated their prisoner. But their faces showed the deep and wrenching bitterness a man does feel when his children have abandoned him for companions he considers worthless or worse. A man hates those companions corrosively, and these men hated their prisoner. But they could not help knowing that he, also, had abandoned some other father whose feelings were like their own. So there was frustration even in their fury.

The prisoner came lightly up the ladder into the Med ship. He was a very young man, with a singularly fair complexion and a carriage at once challengingly jaunty and defiant. Calhoun estimated his age as seven years less than his own, and immediately considered him irritatingly callow and immature because of it.

"You're my jailer, eh?" said the prisoner brightly, as he entered the Med ship's cabin. "Or is this some new trick? They say they're sending me back. I doubt it!"

"It's true enough," said Calhoun. "Will you dog the air-lock door, please? Do that and we'll take off."

The young man looked at him brightly. He grinned.

"No," he said happily. "I won't."

Calhoun felt ignoble rage. There had been no great purpose in his request. There could be none in the refusal. So he took the prisoner by the collar and walked him into the air lock.

"We are going to be lifted soon," he said gently. "If the outer door isn't dogged, the air will escape from the lock. When it does, you will die. I can't save you, because if the outer door isn't dogged, all the air in the ship will go if I should try to help you. Therefore I advise you to dog the door."

He closed the inner door. He looked sick. Murgatroyd looked alarmedly at him.

"If I have to deal with that kind," Calhoun told the *tormal,* "I have to have some evidence that I mean what I say. If I don't, they'll be classing me with their fathers!"

The Med ship stirred. Calhoun glanced at the external-field dial. The mobile landing grid was locking its force-field on. The little ship lifted.

It went up and up and up. Calhoun looked sicker. The air in the lock was thinning swiftly. Two miles high. Three—

There were frantic metallic clankings. The indicator said that the outer door was dogged tight. Calhoun opened the inner door. The young man stumbled in, shockingly white and gasping for breath.

"Thanks," said Calhoun curtly.

He strapped himself in the control-chair. The vision-screens showed half the universe pure darkness and the rest a blaze of many-colored specks of light. They showed new stars appearing at the edge of the monstrous blackness. The Med ship was rising ever more swiftly. Presently the black area was not half the universe. It was a third. Then a fifth. A tenth. It was a disk of pure darkness in a glory of a myriad distant sun.

The external-field indicator dropped abruptly to zero. The Med ship was afloat in clear space. Calhoun tried the Lawlor drive, tentatively. It worked. The Med ship swung in a vast curved course out of the dark planet's shadow. There was the sun Canis, flaming in space. Calhoun made brisk observations, set a new course, and the ship sped on with an unfelt acceleration. This was, of course, the Lawlor propulsion system, used for distances which were mere millions of miles.

When the ship was entirely on automatic control, Calhoun swung around to his unwilling companion. Murgatroyd was regarding the youthful stranger with intense curiosity. He looked at Calhoun with some apprehension.

"My name's Calhoun," Calhoun told him. "I'm Med Service. That's Murgatroyd. He's a *tormal*. Who are you and how did you get captured?"

The prisoner went instantly into a pose of jaunty defiance.

"My name is Fredericks," he said blandly. "What happens next?"

"I'm headed for Canis III," said Calhoun. "In part to land you. In part to try to do something about this war. How'd you get captured?"

"They made a raid," said young Fredericks scornfully. "They landed a rocket out in open country. We thought it was another propaganda bomb, like they've landed before—telling us we were scoundrels and such bilge. I went to see if there was anything in it good for a laugh. But it was bigger than usual. I didn't know, but men had landed in it. They jumped me. Two of them. Piled me in the rocket and it took off. Then we were picked up and brought where you landed. They tried to mind-launder me!" He laughed derisively. "Showing me science stuff proving Phaedra's sun was going to blow and cook the old home planet. Lecturing me that we were all fools on Canis, undutiful sons and so on. Saying that to kill our parents wouldn't pay."

"Would it?" asked Calhoun. "Pay, that is?"

Fredericks grinned in a superior manner.

"You're pulling more of it, huh?

I don't know science, but I know they've been lying to us! Look! They sent the first gang to Canis five years ago. Didn't send equipment with them, no more than they had to. Packed the ships full of people. They were twenty years old and so on. They had to sweat! Had to sweat out ores and make equipment and try to build shelters and plant food. There were more of them arriving all the time—shipped away from Phaedra with starvation rations so more of them could be shipped. All young people, remember! They had to sweat to keep from starving, with all the new ones coming all the time. Everybody had to pitch in the minute they got there. You never heard that, did you?"

"Yes," said Calhoun.

"They worked plenty!" said Fredericks scornfully. "Good little girls and boys! When they got nearly caught up, and figured that maybe in another month they could breathe easy, why then the old folks on Phaedra began to ship younger kids. Me among 'em! I was fifteen, and we hit Canis like a flood. There wasn't shelter, or food, or clothes to spare, but they had to feed us. So we had to help by working. And I worked! I built houses and graded streets and wrestled pipe for plumbing and sewage—the older boys were making it—and I planted ground and I chopped trees. No loafing! No fun! They piled us on Canis so fast it was root hog or die. And we rooted! Then just when we began to think that we could begin to take a breather they started dumping little kids on us! Ten-year-olds and nine-year-olds to be fed and watched. Seven-year-olds to have their noses wiped! No fun, no rest—"

He made an angry, spitting noise.

"Did they tell you that," he demanded.

"Yes," agreed Calhoun. "I heard that and more."

"All the time," raged Fredericks sullenly, "they were yelling at us that the sun back home was swelling. It was wabbling. It was throbbing like it was going to burst any minute! They kept us scared that any second the ships'd stop coming because there wasn't any more Phaedra. And we were good little boys and girls and we worked like hell. We tried to build what the kids they sent us needed, and they kept sending younger and younger kids. We got to the crack-up point. We couldn't keep it up! Night, day, every day, no fun, no loafing, nothing to do but work till you dropped, and then get up and work till you dropped again."

He stopped. Calhoun said:

"So you stopped believing it could be that urgent. You sent some messengers back to check and see. And Phaedra's sun looked perfectly normal, to them. There was no visible danger. The older people showed their scientific records, and your messengers didn't believe them. They decided they were faked. They were tired. All of you were tired. Young people need fun. You weren't having it. So when your messengers

came back and said the emergency was a lie—you believed them. You believed the older people were simply dumping all their burdens on you, by lies."

"We knew it!" rasped Fredericks. "So we quit! We'd done our stuff! We were going to take time out and do some living! We were away back on having fun! We were away back on rest! We were away back just on shooting the breeze! We were behind on everything! We'd been slaves, following blueprints, digging holes and filling them up again." He stopped. "When they said all the old folks were going to move in on us, that was the finish! We're human! We've got a right to live like humans! When it came to building more houses and planting more land so more people—and old people at that—could move in to take over bossing us some more, we'd had it! We hadn't gotten anything out of the job for ourselves. If the old folks moved in, we never would! They didn't mind working us to death! To hell with them!"

"The reaction," said Calhoun, "was normal. But if one assumption was mistaken, it could still be wrong."

"What could be wrong?" demanded Fredericks angrily.

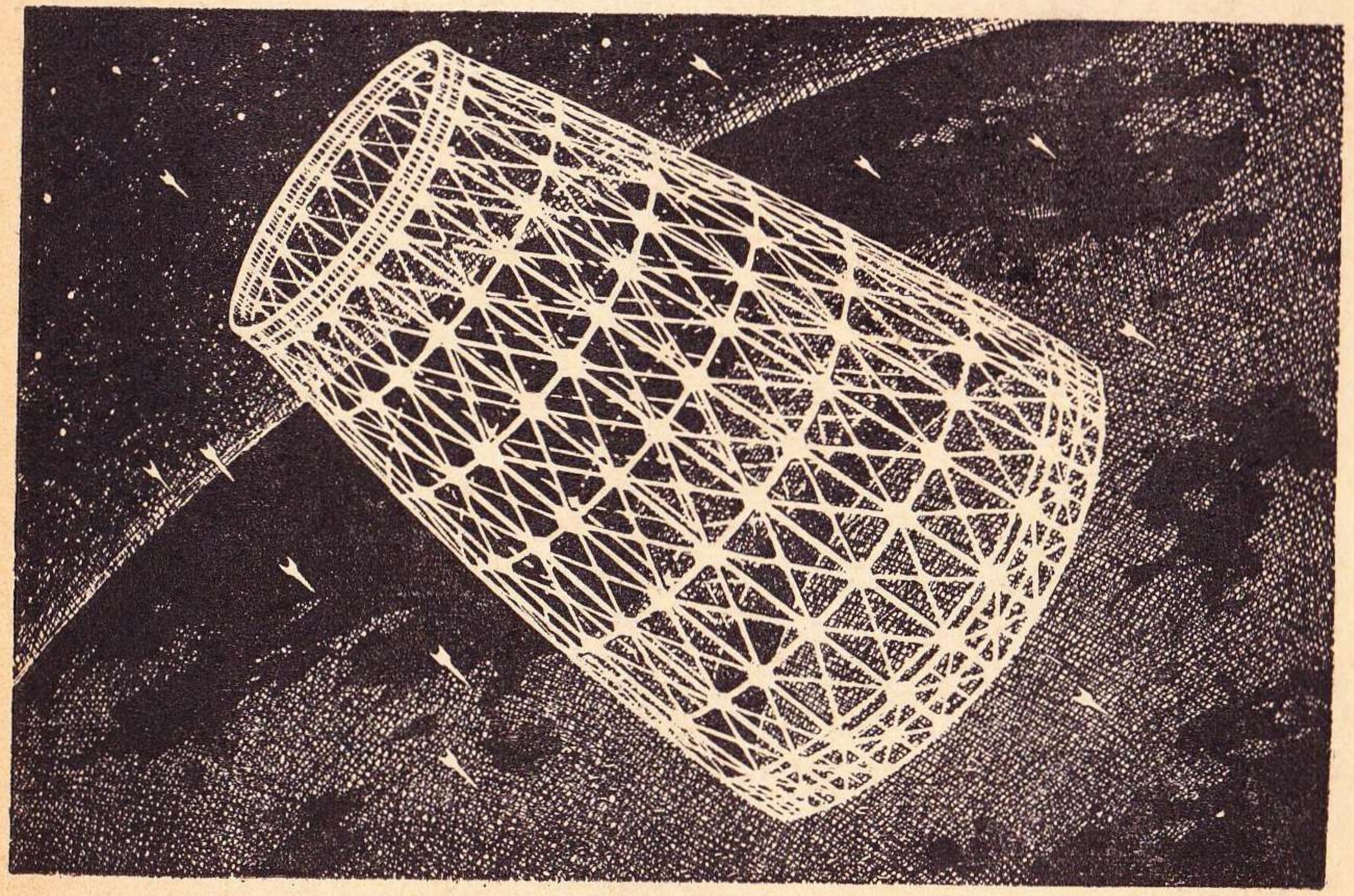
"The assumption that they lied," said Calhoun. "Maybe Phaedra's sun is getting ready to flare. Maybe your messengers were mistaken. Maybe you were told the truth."

Fredericks spat. Calhoun said:

"Will you clean that up, please?"

Fredericks gaped at him.

"Mop," said Calhoun. He gestured.



Fredericks sneered. Calhoun waited. Murgatroyd said agitatedly:

"Chee! Chee! Chee!"

Calhoun did not move. After a long time, Fredericks took the mop and pushed it negligently over the place he'd spat on.

"Thanks," said Calhoun.

He turned back to the control board. He checked his course and referred to the half-century-old Survey report on the Canis solar system. He scowled. Presently he said over his shoulder:

"How has the resting worked? Does everybody feel better?"

"Enough better," said Fredericks ominously, "so we're going to keep things the way they are! The old folks sent in a ship for a landing and we took the landing grid and dumped rocks where it'd run into them. We're going to set up little grids all over, so we can fling bombs up—we make good bombs—if they try to land anywhere besides Canopolis. And if they do make a landing, they'll wish they hadn't! All they've dared so far is drop printed stuff calling us names and saying we've got to do what they say!"

Calhoun had the inner planet, Canis III, firmly in the center of his forward screen. He said negligently:

"How about the little kids? Most of you have quit work, you say—"

"There's not much work," bragged Fredericks. "We had to make stuff automatic as we built it, so we could all keep on making more things and not lose hands tending stuff we'd made. We got the designs from home. We do all right without working much!"

Calhoun reflected. If it were possible for any society to exist without private property, it would be this society, composed exclusively of the young. They do not want money as such. They want what it buys—now. There would be no capitalists in a world populated only by the younger generation from Phaedra. It would be an interesting sort of society, but thought for the future would be markedly lacking.

"But," said Calhoun, "what about the small children? The ones who need to be taken care of? You haven't got anything automatic to take care of them?"

"Pretty near!" Fredericks boasted. "Some of the girls like tending kids. Homely girls, mostly. But there's too many little ones. So we hooked up a psych circuit with multiple outlets for them. Some of the girls play with a couple of the kids, and that keeps the others satisfied. There was somebody studying pre-psych on Phaedra, and he was sent off with the rest to dig holes and build houses. He fixed up that trick so the girl he liked would be willing to take time off from tending kids. There's plenty of good technicians on Canis III! We can make out!"

There were evidently some very good technicians. But Calhoun began to feel sick. A psych circuit, of course, was not in itself a harmful device. It was a part of individual psychiatric equipment — not Med

Service work—and its value was proved. In clinical use it permitted a psychiatrist to share the consciousness of his patient during interviews. He no longer had painfully to interpret his patient's thought-processes by what he said. He could observe the thought-processes themselves. He could trace the blocks, the mental sore spots, the ugly, not-human urges which can become obsessions.

Yes. A psych circuit was an admirable device in itself. But it was not a good thing to use for baby-tending.

There would be a great room in which hundreds of small children would sit raptly with psych-circuit receptors on their heads. They would sit quietly—very quietly—giggling to themselves, or murmuring. They would be having a very wonderful time. Nearby there would be a smaller room in which one or two other children played. There would be older girls to help these few children actually play. With what they considered adult attention every second, and with deep affection for their self-appointed nurses—why the children who actually played would have the very perfection of childhood pleasure. And their experience would be shared by—would simultaneously be known and felt by—would be the conscious and complete experience of each of the hundreds of other children tuned in on it by psych circuit. Each would feel every thrill and sensation of those who truly thrilled and experienced.

But the children so kept happy would not be kept exercised, nor stimulated to act, or think, or react for themselves. The effect of psych-circuit child-care would be that of drugs for keeping children from needing attention. The merely receiving children would lose all initiative, all purpose, all energy. They would come to wait for somebody else to play for them. And the death rate among them would be high and the health rate among those who lived would be low, and the injury to their personalities would be permanent if they played by proxy long enough.

And there was another uglier thought. In a society such as must exist on Canis III, there would be adolescents and post-adolescents who could secure incredible, fascinating pleasures for themselves—once they realized what could be done with a psych circuit.

Calhoun said evenly:

"In thirty minutes or so you can call Canopolis on space phone. I'd like you to call ahead. Will there be anybody on duty at the grid?"

Fredericks said negligently:

"There's usually somebody hanging out there. It makes a good club. But they're always hoping the old folks will try something. If they do—there's the grid to take care of them!"

"We're landing with or without help," said Calhoun. "But if you don't call ahead and convince somebody that one of their own is returning from the wars, they might take care of us with the landing grid."

Fredericks kept his jaunty air.

"What'll I say about you?"

"This is a Med ship," said Calhoun with precision. "According to the Interstellar Treaty Organization agreement, every planet's population can determine its government. Every planet is necessarily independent. I have nothing to do with who runs things, or who they trade or communicate with. I have nothing to do with anything but public health. But they'll have heard about Med ships. You had, hadn't you?"

"Y-yes," agreed Fredericks. "When I went to school. Before I was shipped off to here."

"Right," said Calhoun. "So you can figure out what to say."

He turned back to the control board, watching the steadily swelling gibbous disk of the planet as the Med ship drew near. Presently he reached out and cut the drive. He switched on the spacephone.

"Go ahead," he said dryly. "Talk us down or into trouble, just as you please."

IV.

"Experience directs that any assurance, at any time, that there is nothing wrong or that everything is all right, be regarded with suspicion. Certainly doctors often encounter patients who are ignorant of the nature of their trouble and its cause, and in addition have had their symptoms appear so slowly and so gradually that they were never noticed and still are not realized . . ."

Manual, Interstellar Medical Service. P. 68

It was a very singular society on Canis III. After long and markedly irrelevant argument by spacephone, the Med ship went down to ground in the grip of the Canopolis landing grid. This was managed with a deftness amounting to artistry. Whoever handled the controls did so with that impassioned perfection with which a young man can handle a mechanism he understands and worships. But it did not follow that so accomplished an operator would think beyond the perfection of performance. He came out and grinned proudly at the Med ship when it rested, light as a feather, on the clear, grassy space in the center of the city's landing grid. He was a gangling seventeen or eighteen.

A gang—not a guard—of similar age came swaggering to interview the two in the landed spacecraft. Fredericks named where he'd been working and what he'd been doing and how he'd been taken prisoner. Nobody bothered to check his statements. But his age was almost a guarantee that he belonged on Canis. When he began his experiences as a prisoner among their enemies, all pretense of suspicion dropped away. The gang at the spaceport interjected questions, and whooped at some of his answers, and slapped each other and themselves ecstatically when he related some of the things he'd said and done in enemy hands, and talked loudly and boastfully of what they would do if the old folks tried to carry out their threats. But Calhoun observed no real preparations beyond the perfect working condition of the grid itself. Still, that ought to defend the planet adequately — except against such a mobile spaceport as he'd been captured by, himself.

When they turned to him for added reasons to despise the older generation, Calhoun said coldly:

"If you ask me, they can take over any time they're willing to kill a few of you to clear the way. Certainly if the way you're running this particular job is a sample!"

They bristled. And Calhoun marveled at the tribal organization which had sprung up among them. What Fredericks had said in the ship began to fit neatly into place with what once had been pure anthropological theory. He'd had to learn it because a medical man must know more than diseases. He must also know the humans who have them. Oddments of culture-instinct theory popped into his memory and applied exactly to what he was discovering. The theory says that the tribal cultures from which even the most civilized social organisms stem—were not human inventions. The fundamental facts of human society exist because human instinct directs them, in exact parallel to the basic design of the social lives of ants and bees. It seemed to Calhoun that he was seeing, direct, the operation of pure instinct in the divisions of function in the society he had encountered.

Here, where a guard must be mounted against enemies, he found young warriors. They took the task because it was their instinct. It was an hereditary impulse for young men of their age to act as youthful warriors at a post of danger. There was nothing more important to them than prestige among their fellows. They did not want wisdom, or security, or families, or possessions. The instinct of their age-group directed them as specifically as successive generations of social insects are directed. They moved about in gangs. They boasted vaingloriously. They loafed conspicuously and they would take lunatic risks for no reason whatsoever.

But they would never build cities of themselves. That was the impulse of older men. In particular, the warrior age-group would be capable of immense and admirable skill in handling anything which interested them, but they would never devise automatic devices to keep a city going with next to no attention. They simply would not think so far ahead. They would fight and they would quarrel and they would brag. But if this eccentric world had survived so far, it must have additional tribal structure—it must have some more dedicated leadership than these flamboyant young men who guarded inadequately and operated perfectly the mechanism of a spaceport facility they would never have built.

"I've got to talk to somebody higher up," said Calhoun irritably. "A chief, really—a boss. Your war with your parents isn't my affair. I'm here on Med Service business. I'm supposed to check the public health situation with the local authorities and exchange information with them. So far as I'm concerned, this is a routine job."

The statement was not altogether

truthful. In a sense, preventing unnecessary deaths was routine, and in that meaning Calhoun had exactly the same purpose on Canis III as on any other planet to which he might be sent. But the health hazards here were not routine. A society is an organism. It is a whole. Instinct-theory says that it can only survive as a whole, which must be composed of such-and-such parts. This society had suffered trauma, from the predicted dissolution of Phaedra's sun. Very many lives would be lost, unnecessarily, unless the results of that traumatic experience could be healed. But Calhoun's obligation was not to be stated in such terms to these young men.

"Who is running things?" demanded Calhoun. "A man named Walker said his son was bossing things here. He was pretty bitter about it, too! Who's looking after the distribution of food, and who's assigning who to raise more, and who's seeing that the small children get fed and cared for?"

The spaceport gang looked blank. Then someone said negligently:

"We take turns getting stuff to eat, for ourselves. The ones who landed here first, mostly, go around yelling at everybody. Sometimes the things they want get done. But they're mostly married now. They live in a center over yonder."

He gestured. Calhoun accepted it as a directive.

"Can somebody take me there?" he asked.

Fredericks said grandly:

"I'll do it. Going that way, anyhow. Who's got a ground-car I can use? My girl'll be worrying about me. Been worrying because she didn't know the old folks took me prisoner."

His proposal to acquire a ground-car was greeted with derision. There were ground-cars, but those that did not need repairs were jealously reserved by individuals for themselves and their closest friends. There was squabbling. Presently a scowling young man agreed to deliver Calhoun to the general area in which the first-landed of the colonists—now grown grim and authoritative—made their homes. It was annoying to wait while so simple a matter was discussed so vociferously. By the time it was settled, Fredericks had gone off in disgust.

The scowling youth produced his ground-car. Calhoun got in. Murgatroyd, of course, was not left behind. And the car was magnificent in polish and performance. Lavish effort and real ability had gone into its grooming and adjustment. With a spinning of wheels, it shot into immediate high speed. The dark-browed younglings drove with hair-raising recklessness and expertness. He traversed the city in minutes, and at a speed which allowed Calhoun only glimpses. But he could see that it was almost unoccupied.

Canopolis had been built by the youth of Phaedra to the designs of their elders for the reception of immigrants from the mother planet. It had been put up in frantic haste and

used only as a receiving-depot. It had needed impassioned and dedicated labor, and sustained and exhausting concentration to get it and the rest of the colonial facilities built against a deadline of doom. But now its builders were fed up with it. It was practically empty. The last arrivals had scattered to places where food supplies were nearer and a more satisfactory way of life was possible. There were broken windows and spattered walls. There was untidiness everywhere. But there had been great pains taken in the building. Some partly-completed enterprises showed highly competent workmanship.

Then the city ended and was a giant pile of structures which fell swiftly behind. The highways were improvised. They could be made more perfect later. Across the horizon there were jerry-built villages—temporary by design, because there had been such desperate need for so many of them so soon.

The ground-car came to a stop with a screaming of brakes at the edge of such a jerry-built group of small houses. A woman ran to hiding. A man ran into view. Another, and another, and another. They came ominously toward the car.

"Hop out," said the scowling driver. He grinned faintly. "They don't want me here. But I stirred 'em up, eh?"

Calhoun stepped out of the ground-car. It whirled on one pair of wheels and sped back to the city, its driver turning to make a derisive gesture at the men who had appeared. They were still quite young men—younger than Calhoun. They looked at him steadily.

He growled to himself. Then he called:

"I'm looking for somebody named Walker. He's supposed to be top man here."

A tense young man said sardonically:

"I'm Walker. But I'm not tops. Where'd you come from? With a Med Service uniform and a *tormal* on your shoulder you're not one of us! Have you come to argue that we ought to give in to Phaedra?"

Calhoun snorted.

"I've a message that an attack from space is due in three days, but that's all from Phaedra. I'm a Med Service man. How's the health situation? How are you equipped for doctors and such? How about hospitals? How's the death rate?"

The younger Walker grinned savagely.

"This is a new colony. I doubt there are a hundred people on the planet over twenty-five. How many doctors would there be in a population like ours? I don't think there is a death rate. Do you know how we came to be here?"

"Your father told me," said Calhoun, "at the military base on the next planet out. They're getting ready for an attack—and they asked me to warn you about it. Three days from now."

Young Walker ground his teeth.

"They won't dare attack. We'll

smash them if they do. They lied to us! Worked us to death—"

"And no death rate?" asked Calhoun.

The younger man knitted his brows.

"There's no use your arguing with us. This is our world! We made it and we're keeping it! They made fools of us long enough!"

"And you've no health problems at all?"

The sardonic young man hesitated. One of the others said coldly:

"Make him happy. Let him talk to the women. They're worried about some of the kids."

Calhoun breathed a private sigh of relief. These relatively mature young men were the first-landed colonists. They'd had the hardest of all the tasks put upon the younger generation by the adults of Phaedra. They'd had the most back-breaking labor and the most urgent responsibilities. They'd been worked and stressed to the breaking-point. They'd finally arrived at a decision of desperation.

But apparently things could be worse. It is the custom, everywhere, for women to make themselves into whatever is most attractive to men. Young girls, in particular, will adopt any tradition which is approved of by their prospective husbands. And in a society to be formed brand-new, appalling new traditions could be started. But they hadn't. Deep-rooted instincts still worked. Women—young women—and girls appeared still to feel concern for young children which were not even their own. And Fredericks' story—

"By all means," agreed Calhoun. "If there's something wrong with the health of children—"

Young Walker gestured and turned back toward the houses. He scowled as he walked. Presently he said defensively:

"You probably noticed there aren't many people in the city?"

"Yes," said Calhoun. "I noticed."

"We're not fully organized yet," said Walker, more defensively still. "We weren't doing anything but build. We've got to get organized before we'll have a regular economic system. Some of the later-comers don't know anything but building. When they're ready for it, the city will be occupied. We'll have as sound a system for production and distribution of goods as anywhere else. But we've just finished a revolution. In a sense we're still in it. But presently this world will be pretty much like any other—only better."

"I see," said Calhoun.

"Most people live in the little settlements, like this—close to the crops we grow. People raise their own food, and so on. In a way you may think we're primitive, but we've got some good technicians! When they get over not having to work for the old folks and finish making things just for themselves—we'll do all right. After all, we weren't trained to make a complete world. Just to make a world for the older people on Phaedra to take over! But we've taken it over for ourselves!"

"Yes," agreed Calhoun politely.

"We'll work out the other things," said young Walker truculently. "We'll have money, and credit, and hiring each other and so on. Right now defending ourselves is the top thing in everybody's mind."

"Yes," agreed Calhoun again. He was regarded as not quite an enemy, but he was not accepted as wholly neutral.

"The older ones of us are married," Walker said firmly, "and we feel responsibility, and we're keeping things pretty well in line. We were lied to, though, and we resent it. And we aren't letting in the old people to try to run us, when we've proved we can make and run a world ourselves!"

Calhoun said nothing. They reached a house. Walker turned to enter it, with a gesture for Calhoun to accompany him. Calhoun halted.

"Just a moment. The person who drove me here—when he turned up, at least one woman ran away and you men came out . . . well . . . pretty pugnaciously."

Walker flushed angrily.

"I said we had technicians. Some of them made a gadget to help take care of the children. That's harmless. But they want to use it to . . . to spy on older people with it. On us! Invasion of privacy. We don't like . . . well . . . they try to set up psych circuits near our homes. They . . . think it's fun to . . . know what people say and do—"

"Psych circuits can be useful," observed Calhoun, "or they can be pretty monstrous. On the other hand—"

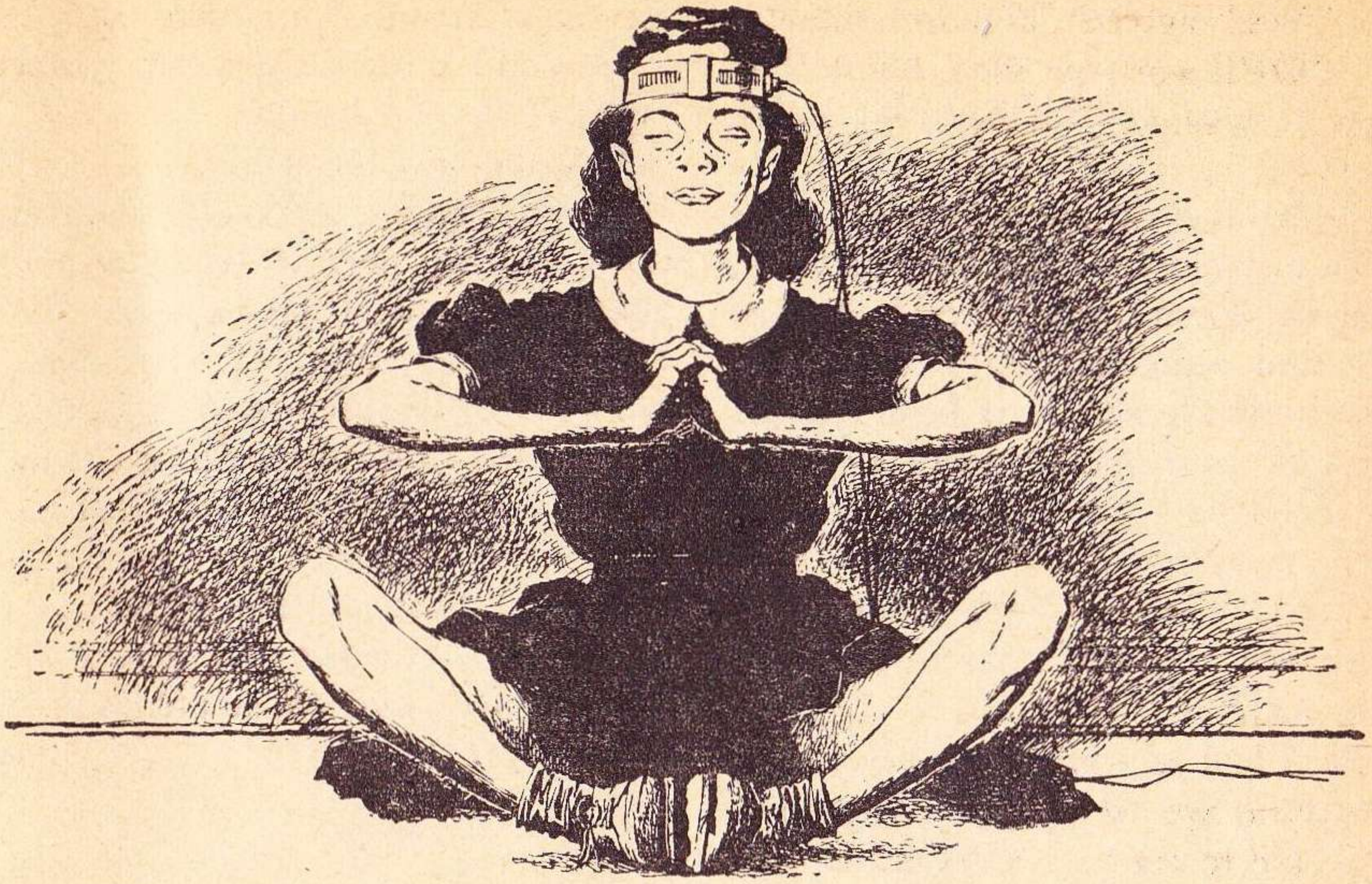
"No decent man would do it!" snapped young Walker. "And no girl would have anything to do with anybody —But there are some crazy fools—"

"You have described," said Calhoun dryly, "a criminal class. Only instead of stealing other people's possessions they want to steal their sensations. Peeping-Tom stuff, eavesdropping on what other people feel about those they care for, as well as what they do and say. In a way it's a delinquency problem, isn't it?"

"There can't be a civilization without problems," said Walker. "But we're going to—" He opened a door. "My wife works with the kids the old people dumped on us. This way."

He motioned Calhoun inside the house. It was one of the shelters built during the frenzied building program designed to make an emergency refuge for the population of a planet. It was the roughest of machine-tool constructions. The floors were not finished. The walls were not smooth. The equipment showed. But there had been attempts to do something about the crudity. Colors had been used to try to make it homelike.

When a girl came in from the next room, Calhoun understood completely. She was a little younger than her husband, but not much. She regarded Calhoun with that anxiety with which a housekeeper always regards an unexpected visitor, hoping he will



not notice defects. This young wife had those feminine instincts which are much older than tradition. Obligations and loyalties may be thrown aside, but a housewife's idea of her role is unchangeable.

"This is a Med Service man," said Walker briefly, indicating Calhoun. "I told him there was a health problem about some of the children." To Calhoun he said curtly: "This is my wife Elsa."

Murgatroyd said *"Chee!"* from where he clung to Calhoun's neck. He was suddenly reassured. He scrambled down to the floor. Elsa smiled at him.

"He's tame!" she said delightedly. "Maybe—"

Calhoun extended his hand. She took it. Murgatroyd, swaggering, extended his own black paw. Instead of conflict and hatred, here, Murgatroyd seemed to sense an amiable sociability such as he was used to. He felt more at home. He began zestfully to act like the human being he liked to pretend he was.

"He's delightful!" said the girl. "May I show him to Jak?"

Young Walker said:

"Elsa's been helping with the smaller kids. She says there's something the matter that she doesn't understand. She has one of the kids here. Bring him, Elsa."

She vanished. A moment later she brought in a small boy. He was probably six or seven. She carried him. He was thin. His eyes were bright, but he was completely passive in her arms. She put him down in a chair and he looked about alertly enough, but he simply did not move. He saw Murgatroyd, and beamed. Murgatroyd went over to the human who

was near his own size. Swaggering, he offered his paw once more. The boy giggled, but his hand lay in his lap.

"He doesn't do anything!" said Elsa distressedly. "His muscles work, but he doesn't work them! He just sits and waits for things to be done for him! He acts as if he'd lost the idea of moving, or doing anything at all! And—it's beginning to show up among the other children! They just sit! They're bright enough . . . they see and understand—but they just sit!"

Calhoun examined the boy. His expression grew carefully impassive. But he winced as he touched the pipestem arms and legs. What muscles were there were almost like dough.

When he straightened up, despite himself his mouth was awry. Young Walker's wife said anxiously:

"Do you know what's the matter with him?"

"Basically," said Calhoun with a sort of desperate irony, "he's in revolt. As the rest of you are in revolt against Phaedra, he's in revolt against you. You needed rest you didn't get and recreation you couldn't have and something besides back-breaking labor under a load that grew heavier minute by minute for years. You revolted, and you've a fine justification for the war in which you're engaged. But he has needed something he hasn't had, too. So he's revolting against his lack—as you did—and he's dying as you will presently do from exactly the same final cause."

Walker frowned ominously.

"I don't understand what you're saying!" he said harshly.

Calhoun moistened his lips.

"I spoke unprofessionally. The real cause of his present troubles and your future ones is that a social system has been shattered. The pieces can't live by themselves. And I don't know what medical measures can be taken to cure an injured civilization. As a medical man, I may be whipped. But I'd better check— Did I say, by the way, that the war fleet from Phaedra is going to attack in just three days?"

V.

". . . Truth is the accord of an idea with a thing. Very often an individual fails to discover the truth about some matter because he neglects to become informed about something. But even more often, the truth is never found out because somebody refuses to entertain an idea . . ."

Manual, Interstellar Medical Service. Pp. 101-2.

On the first day, Calhoun went grimly to the *creches* that had been set up by the first-arrived young colonists when ships began to discharge really young children at the landing grid in Canopolis. The *creches* were not too much like orphanages, of course, but the younger generation of Phaedra had been put in a very rough situation by the adults. If the time of the imminent solar explosion had been known, the matter could have been better handled. Actually, the explosion had been delayed—to date—for nearly

five years from the discovery that it must occur. If that much leeway could have been predicted, older men and many machines would have been sent at first. But the bursting could not be computed. It was a matter of probability. Such-and-such unrhythmic variables must inevitably coincide sooner or later. When they did—final and ultimate catastrophe. The sun would flare terribly and destroy all life in its solar system. It could be calculated that the odds were even that the explosion would happen within one year, two to one within two, and five to one within three. The odds were enormous against Phaedra surviving as long as it had. The people of the mother-world had had a highly improbable break.

But in cold common sense they'd done the sensible thing. They'd tried to save those of their children who could take care of themselves first, and added others as they dared. But the burden on the young colonists had been monstrous. Even adults would have tended to grow warped with such pressure to mine, build, plough, and sow, as was put upon the youngsters. There had never been more than barely enough of food—and more mouths were always on the way. There had never been extra shelter, and younger and ever younger cargoes were constantly arriving, each needing more of shelter and of care than the ones before. And there was the world of adults still to be provided for.

Calhoun met the girls who had devoted themselves to the quasi-orphaned children. They bore themselves with rather touching airs of authority among the smaller children. But they were capable of ferocity, on occasion. They had the need, sometimes, not to defend their charges but themselves against the clumsily romantic advances of loutish teen-agers who considered themselves fascinating.

They had done very well.

The small children were exactly what Calhoun had anticipated—in every way. The small boy Calhoun had seen first was an extreme case, but the results of play by proxy were visible everywhere. Calhoun constrainedly inspected one after another of the children shelters. He was anxiously watched by the sober young faces of the nurses. But they giggled when Murgatroyd tried to go through Calhoun's actions of taking temperatures and the like. He had to be stopped when he attempted to take a throat-swabbing which Calhoun had said was pure routine.

After the fourth such inspection he said to Elsa:

"I don't need to see any more. What's happened to the boys the same age as these girl nurses—the thirteen and fourteen and fifteen-year-olds?"

Elsa said uncomfortably:

"They're mostly off in the wilds. They hunt and fish and pioneer. They don't care about girls. Some of them grow things . . . I don't think there'd be enough food if they didn't, even though we're not getting anybody new to feed."

Calhoun nodded. In all the cities of the galaxy, small children of both sexes were to be seen everywhere, and girls of the early teen-ages, and adults. But the boys' age-group he'd mentioned always made itself invisible. It congregated in groups away from the public eye, and engaged in adventurous games and quite futile explorations. It was socially quite self-sufficient everywhere.

"Your husband," said Calhoun, carefully impassive, "had better try to gather in some of them. As I remember it, they're capable of a rather admirable romantic idea of duty—for a while. We're going to need some romanticists presently."

Elsa had faith in Calhoun now, because he seemed concerned about the children. She said unhappily:

"Do you really think the . . . old people will attack? I've grown older since I've been here. Those of us who came first are almost like the people on Phaedra—some ways. The younger people are inclined to be suspicious of us because we . . . try to guide them."

"If you're confiding that you think there may be two sides to this war," Calhoun told her, "you are quite right. But see what your husband can do about gathering some of the hunting-and-fishing members of the community. I've got to get back to my ship."

He got himself driven back to the landing grid. Walker did not drive him, but another of the now-suspect men of twenty-five or so, from the shelter village of the first-landed colonists. He was one of those who'd worked with Walker from the beginning and with him had been most embittered. Now he found himself almost a member of an older generation. He was still bitter against the people of Phaedra, but—

"This whole business is a mess!" he said darkly as he drove through the nearly deserted city toward the landing grid. "We've got to figure out a way to organize things that'll be better than the old way. But no organization at all is no good, either! We've got some tough young characters who like it this way, but they've got to be tamed down!"

Calhoun had his own unsettling suspicions. There have always been splendid ideas of social systems which will make earthly paradises for their inhabitants. Here, by happenchance, there had come to be a world inhabited only by the young. He tried to put aside, for the moment, what he was unhappily sure he'd find out back at the ship. He tried to think about this seemingly perfect opportunity for a new and better organization of human lives.

But he couldn't believe in it. Culture-instinct, theory is pretty well worked out. The Med Service considered it proven that the basic pattern of human societies is instinctual rather than evolved by trial and error. The individual human being passes through a series of instinct-patterns which fit him at different times to perform different functions in a social organization which can

vary but never change its kind. It has to make use of the successive functions its members are driven by instinct to perform. If it does not use its members, or give scope to their instincts, it cannot survive. The more lethal attempts at novel societies tried not only to make all their members alike, but tried to make them all alike at all ages. Which could not work.

Calhoun thought unhappily of the tests he meant to make in the Med ship. As the ground-car swerved into the great open center of the grid, he said:

"My job is doing Med Service. I can't advise you how to plan a new world. If I could, I wouldn't. But whoever does have authority here had better think about some very immediate troubles."

"We'll fight if Phaedra attacks!" said the driver darkly. "They'll never get to ground alive, and if they do —they'll wish they hadn't!"

"I wasn't thinking of Phaedra," said Calhoun.

The car stopped close by the Med ship. He got out. There had been attempts to enter the ship in his absence. The gang which occupied the control building and in theory protected Canis III against attack from the sky had tried to satisfy their curiosity about the little ship. They'd even used torches on the metal. But they hadn't gotten in.

Calhoun did. Murgatroyd chattered shrilly when he was put down. He scampered relievedly about the cabin, plainly rejoicing at being once more in familiar surroundings. Calhoun paid no attention. He closed and dogged the air-lock door. He switched on the spacephone and said shortly:

"Med Ship *Esclipus Twenty* calling Phaedrian fleet. Med Ship *Esclipus Twenty* calling—"

The loud-speaker fairly deafened him as somebody yelled into another spacephone mike in the grid-control building.

"Hey! You in the ship! Stop that! No talking with the enemy!"

Calhoun turned down the incoming volume and said patiently:

"Med Ship *Esclipus Twenty* calling fleet from Phaedra. Come in, fleet from Phaedra! Med Ship *Esclipus Twenty* calling—"

There was a chorus of yellings from the nearby building. The motley, swaggering, self-appointed landing-grid guard had tried to break into the ship out of curiosity, but they were vastly indignant when Calhoun did something of which they disapproved. They made it impossible for him to have heard a reply from the space fleet presumably overhead. But after a moment someone in the control house evidently elbowed the others aside and shouted:

"You! Keep that up and we'll smash you! We've got the grid to do it with, too!"

Calhoun said curtly:

"Med ship to Control. I've something to tell you. Suppose you listen. But not on spacephone. Have your best grid technician come outside and

then I shall tell him by speaker."

He snapped off the spacephone and watched. The control building fairly erupted indignant youths. After a moment he saw the gangling one who'd grinned so proudly when the Med ship was landed with absolute perfection. The others shouted and scowled at the ship.

Calhoun threw on the outside speaker—normally used for communication with a ground crew before lifting.

"I'm set," said Calhoun coldly, "for overdrive travel. My Duhanne cells are charged to the limit. If you try to form a force-field around this ship, I'll dump half a dozen overdrive charges into it in one jolt that will blow every coil you've got! And then how'll you fight the ships from Phaedra? I'm going to talk to them on spacephone. Listen in if you like. Monitor it. But don't try to bother me!"

He threw on the spacephone again and patiently resumed his calling:

"Med ship *Esclipus Twenty* calling fleet from Phaedra! Med ship calling fleet from Phaedra—"

He saw violent argument outside the grid's control building. Some of the young figures raged. But the youth who'd handled the grid so professionally raged at them. Calhoun hadn't made an idle threat. A grid-field could be blown out. A grid could be made useless by one of the ships it handled. When a ship like Calhoun's went into overdrive, it put out something like four ounces of pure energy to form a field in which it could travel past the speed of light. In terms of horsepower or kilowatt hours, so much force would be meaningless. It was too big. It was a quantity of energy whose mass was close to four ounces. When the ship broke out of overdrive, that power was largely returned to storage. The loss was negligible, compared to the total. But, turned loose into a grid's force-field, even three or four such charges would work havoc with the grid's equipment.

Calhoun got an answer from emptiness just as the members of the group by the control building shouted each other down and went inside to listen with bitter unease and suspicion to his talk with the enemy.

"Phaedra fleet calling," said a growling voice in the spacephone speaker. *"What do you want?"*

"To exercise my authority as a Med Service officer," said Calhoun heavily. "I warn you that I now declare this planet under quarantine. All contact with it from space is forbidden until health hazards here are under control. You will inform all other spacecraft and any other spaceport you may contact of this quarantine. Message ends."

Silence. A long silence. The growling voice rasped:

"What's that? Repeat it!"

Calhoun repeated it. He switched off the phone and unpacked the throat-swabbings he'd made at the four children's shelters in turn. He opened up his laboratory equipment.

He put a dilution of one throat-swabbing into a culture slide that allowed living organisms to be examined as they multiplied. He began to check his highly specific suspicions. Presently he was testing them with minute traces of various antibodies. He made rough but reasonably certain identifications. His expression grew very, very sober. He took another swab sample and put it through the same process. A third, and fourth, and fifth, and tenth. He looked very grim.

It was sunset outside when there was a hammering on the ship's hull. He switched on a microphone and speaker.

"What do you want?" he asked flatly.

The angry voice of young Walker came from the gathering darkness. The screens showed a dozen or more inhabitants of Canis III milling angrily about him. Some were of the young-warrior age. They engaged in bitter argument. But the younger Walker, and four or five with him, faced the ship with ominous quietness.

"What's this nonsense about quarantine?" demanded Walker harshly, from outside. *"Not that we've space-commerce to lose, but what does it mean?"*

"It means," Calhoun told him, "that your brave new world rates as a slum. You've kept kids quiet with psych circuits, and they haven't eaten properly and haven't exercised at all. They're weak from malnutrition and feeble from not doing their own playing. They're like slum children used to be in past ages. Here on Canis you're about ready to wipe yourselves out. You may have done it."

"You're crazy!" snapped Walker. But he was upset.

"In the four shelters I visited," Calhoun said drearily. "I spotted four cases of early diphtheria, two of typhoid, three of scarlet fever and measles, and samples of nearly any other disease you care to name. The kids have been developing those diseases out of weakness and from the reservoir of infections we humans always carry with us. They'd reached the contagious stage before I saw them—but all the kids are kept so quiet that nobody noticed that they were sick. They've certainly spread to each other and their nurses, and therefore out into your general population, all the infections needed for a first-rate multiple epidemic. And you've no doctors, no antibiotics—not even injectors to administer shots with if you had them."

"You're crazy!" cried young Walker. *"Crazy! Isn't this a Phaedra trick to make us give in?"*

"Phaedra's trick," said Calhoun more drearily than before, "is an atom bomb they're going to drop into this landing grid—I suspect quarantine or no quarantine—in just two days more. Considering the total situation, I don't think that matters."

VI.

". . . The most difficult of enterprises

is to secure the co-operation of others in enterprises those others did not think of first . . ."

Manual, Interstellar Medical Service. P. 189.

Calhoun worked all night, tending and inspecting the culture incubators which were part of the Med ship's technical equipment. In the children's shelters, he'd swabbed throats. In the ship, he'd diluted the swabbings and examined them microscopically. He'd been depressingly assured of his very worst fears as a medical man—all of which could have been worked out in detail from the psych circuit system of child care boastfully described by Fredericks. He could have written out his present results in advance from a glance at the child Jak shown him by the younger Walker's wife. But he hated to find that objective information agreed with what he would have predicted by theory.

In every human body there are always germs. The process of good health is in part a continual combat with slight and unnoticed infections. Because of victories over small invasions, a human body acquires defenses against larger invasions of contagion. Without such constant small victories, a body ceases to keep its defenses strong against beachheads of infection. Yet malnutrition or even exhaustion can weaken a body once admirably equipped for this sort of guerilla warfare.

If an undernourished child fails to win one skirmish, he can become overwhelmed by a contagion the same child would never have known about had he only been a little stronger. But, overwhelmed, he is a sporadic case of disease—a case not traceable to another clinical case. And then he is the origin of an epidemic. In slum conditions a disease not known in years can arise and spread like wildfire. With the best of intentions and great technical ingenuity, the younger-generation colonists of Canis III had made that process inevitable among the younger children who were their last-imposed burden. The children were under-exercised, understimulated, and hence under par in appetite and nutrition. And it is an axiom of the Med Service that a single underfed child can endanger an entire planet.

Calhoun proved the fact with appalling certainty. His cultures astounded even him. But by dawn he had applied Murgatroyd's special genetic abilities to them. Murgatroyd said *"Chee!"* in a protesting tone when Calhoun did what was necessary at that small patch on his flank which was quite insensitive. But then Murgatroyd shook himself and admiringly scowled back at Calhoun, imitating the intent and worried air that Calhoun wore. Then he followed Calhoun about in high good spirits, strutting on his hind legs, man-fashion, and pretending to set out imaginary apparatus as Calhoun did, long ahead of time for what he hoped would occur.

Presently Murgatroyd tired—a little quicker than usual—and went to sleep. Calhoun bent over him and counted his respiration and heart

beat. Murgatroyd slept on. Calhoun gnawed his fingers in anxious expectation.

He'd come on this assignment with some resentment because he thought it foolish. He'd carried on with increasing dismay as he found it not absurd. Now he watched over Murgatroyd with the emotional concern a medical man feels when lives depend upon his professional efficiency, but that efficiency depends on something beyond his control. Murgatroyd was that something this time —but there was one other.

The *tormal* was a pleasant little animal, and Calhoun liked him very much. But *tormals* were crew-members of one-man Med ships because their metabolism was very similar to that of humans, but no *tormal* had ever been known to die of an infectious disease. They could play host to human infections, but only once and only lightly. It appeared that the furry little creatures had a hair-trigger sensitivity to bacterial toxins. The presence of infective material in their blood streams produced instant and violent reaction—and the production of antibodies in large quantity. Theorists said that *tormals* had dynamic immunity-systems instead of passive ones, like humans. Their body-chemistry seemed to look truculently for microscopic enemies to destroy, rather than to wait for something to develop before they fought it.

If he reacted normally, now, in a matter of hours his blood stream would be saturated with antibodies —or an antibody—lethal to the cultures Calhoun had injected. There was, however, one unfortunate fact. Murgatroyd weighed perhaps twenty pounds. There was most of a planetary population needing antibodies only he could produce.

He slept from breakfast-time to lunch. He breathed slightly faster than he should. His heart beat was troubled.

Calhoun swore a little when noon came. He looked at the equipment all laid out for biological micro-analysis—tiny test tubes holding half a drop, reagent flasks dispensing fractions of milliliters, tools and scales much tinier than doll-size. If he could determine the structure and formula of an antibody—or antibodies—that Murgatroyd's tiny body formed—why synthesis in quantity should be possible. Only the Med ship had not materials for so great an amount of product.

There was only one chance. Calhoun threw the space-phone switch. Instantly a voice came from the speaker.

"... *ing Med Ship* Esclipus Twenty! *Phaedra fleet calling Med Ship* Esclipus Twenty!"

"Med ship answering," said Calhoun. "What is it?"

The voice went on: "*Calling Med Ship* Twenty! *Calling Med Ship* Esclipus Twenty! *Calling—*" It went on interminably. It was a very long way off, if it took so long for Calhoun's answer to be heard. But the call-formula broke off.

"Med ship! Our doctors want to know the trouble on Canis! Can we help? We've hospital ships equipped and ready!"

"The question," said Calhoun steadily, "is whether I can make a formula-and-structure identification, and whether you can synthesize what I identify. How's your lab? How are you supplied with biological crudes?"

He waited. By the interval between his answer and a reply to it, the ship he'd communicated with was some five million miles or more away. But it was still not as far as the next outward planet where the Phaedran fleet was based.

While he waited for his answer, Calhoun heard murmurings. They would come from the control building at the side of the grid. The loutish, suspicious gang there was listening. Calhoun had threatened to wreck the grid if they tried anything on the Med ship—but he could do nothing unless they tried to use a force-field. They listened in, muttering among themselves.

A long time later the voice from space came back. The fleet of the older generation of Phaedra was grounded, save for observation ships like the one speaking. The fleet had full biological equipment for any emergency. It could synthesize any desired compound up to— The degree of complexity and the classification was satisfactory.

"Day before yesterday," said Calhoun, "when you had me aground on Canis IV, your leader Walker said your children on this planet were destroying your grandchildren. He didn't say how. But the process is

well under way—only the whole population will probably go with them. Most of the population, anyhow. I'm going to need those hospital ships and your best biological chemists—I hope! Get them started this way—fast! I'll try to make a deal for at least the hospital ships to be allowed to land. Over."

He did not flick off the spacephone. He listened. And a bitter, envenomed voice came from nearby:

"Sure! Sure! We'll let 'em land ships they say are hospital ships, loaded down with men and guns! We'll land 'em ourselves, we will!"

There was a click. The spacephone in the control building was turned off.

Calhoun turned back to the sleeping Murgatroyd. There was a movement about the grid-control building. Sleek, glistening ground-cars hurtled away—two of them. Calhoun turned then to the planetary communicator. It could break in on any wave-length used for radio communication under a planet's Heaviside roof. He had to get in touch with Walker or some other of the first-landed colonists. They were still embittered against their home world, but they must be beginning to realize that Calhoun had told the truth about the youngest children. They'd find sickness if they looked for it.

But the planetary communicator picked up nothing. No radiation wave length was in use. There was no organized news service. The young people on Canis III were too self-centered to care about news. There were no entertainment programs. Only show-offs would want to broadcast, and show-offs would not make the apparatus.

So Calhoun could not communicate save by spacephone, with a range of millions of miles, and the ship's exterior loud-speakers, with a range of hundreds of feet. If he left the Med ship, he wasn't likely to be able to fight his way back in. He couldn't find the younger Walker on foot, in any case, and he did not know anyone else to seek.

Besides, there was work to be done in the ship.

Before Murgatroyd waked, the two ground-cars had returned. At intervals, nearly a dozen other cars followed to the control building, hurtling across the grid's clear center with magnificent clouds of dust following them. They braked violently when they arrived. Youths piled out. Some of them yelled at the Med ship and made threatening gestures. They swarmed into the building.

Murgatroyd said tentatively, *"Chee?"*

He was awake. Calhoun could have embraced him.

"Now we see what we see!" he said grimly. "I hope you've done your stuff, Murgatroyd!"

Murgatroyd came obligingly to him, and Calhoun lifted him to the table he had ready. Again, what he did did not hurt. A tiny patch on Murgatroyd's side had been made permanently insensitive shortly after he was born. Calhoun extracted a

quantity of what he hoped was a highly concentrated bacterial antagonist. He took thirty CCs in all. He clumped the red cells. He separated the serum. He diluted an infinitesimal bit of it and with a steady hand added it to a slide of the same cultures—living—on which Murgatroyd's dynamic immunity system had worked.

The cultures died immediately.

Calhoun had an antibody sample which could end the intolerable now-spreading disaster on the world of young people—*if* he could analyze it swiftly and accurately, and *if* the hospital ships from Phaedra could be landed, and *if* they could synthesize some highly complex antibody compounds, and *if* the inhabitants of Canis III would lay aside their hatred—

He heard a tapping sound on the Med ship's hull. He looked at a screen. Two youths stood in the doorway of the control building, leisurely shooting at the Med ship with sporting weapons.

Calhoun set to work. Sporting rifles were not apt to do much damage.

For an hour, while there was the occasional clanking of a missile against the ship's outer planking, he worked at the infinitely delicate job of separating serum from its antibody content. For another hour he tried to separate the antibody into fractions. Incredibly, it would not separate. It was one substance only.

There was a crackling sound and the whole ship shivered. The screen showed a cloud of smoke drifting away. The members of the grid-guard had detonated some explosive —intended for mining, most likely —against one of the landing-fins.

Calhoun swore. His call to the Phaedrian fleet was the cause. The grid-guard meant to allow no landing. He'd threatened to blow out their controls if they tried to use the grid on the Med ship, but they wanted it ready for use as a weapon against the space fleet. They couldn't use it against him. He couldn't damage it unless they tried. They wanted him away.

He went back to his work. From time to time, annoyedly, he looked up at the outside. Presently a young-warrior group moved toward the ship, carrying something very heavy. A larger charge of explosive, perhaps.

He waited until they were within yards of the ship. He stabbed the emergency-rocket button. A thin, pencillike rod of flame shot downward between the landing-fins. It was blue-white—the white of a sun's surface. For one instant it splashed out hungrily before it bored and melted a hole into the ground itself into which to flow. But in that instant it had ignited the covering of the burden the youths carried. They dropped it and fled. The pencil flame bored deeper and deeper into the ground. Clouds of smoke and steam arose.

There was a lurid flash. The burden that the young warriors had abandoned, vanished in a flare that

looked like a lightning bolt. The ship quivered from the detonation. A crater appeared where the explosive had been.

Calhoun cut off the emergency rocket, which had burned for ten seconds at one-quarter thrust.

Sunset came and night fell for the second time. He noticed, abruptly, that some of the ground-cars from about the control building went racing away. But they did not pass close to the Med ship in their departure. He labored on. He'd spent nearly thirty hours making cultures from the specimens swabbed from children's throats, and injecting Murgatroyd, and waiting for his reaction, and then separating a tiny quantity of antibody—which would not total more than the dust from a butterfly's wing—from the serum he obtained.

Now he worked on, through the night. Far away—some tens or scores of millions of miles—the hospital ships of the Phaedrian fleet took off from the next outward planet. They would be coming at full speed toward Canis III. They would need the results of the work Calhoun was doing, if they were to prevent an appalling multiple plague which could wipe out all the sacrifice the building of the colony had entailed. But his work had to be exact.

It was tedious. It was exacting. It was exhaustingly time-consuming. He did have the help of previous experience, and the knowledge that the most probable molecular design would include this group of radicals and probably that, and side-chains like this might be looked for, and co-polymers might— But he was bleary-eyed and worn out before dawn came again. His eyes felt as if there were grains of sand beneath their lids. His brain felt dry—felt fibrous inside his skull, as if it were excelsior. But when the first red colors showed in the east, with the towers of the city against them, he had the blueprint of what should be the complex molecule formed in Murgatroyd's furry body.

He had just begun to realize, vaguely, that his work was done, when twin glaring lights came bouncing and plunging across the empty center of the grid. They were extraordinarily bright in the ruddy darkness. They stopped. A man jumped from the ground-car and ran toward the ship.

Calhoun wearily threw on the outer microphones and speakers.

"What's the matter now?" The man was the younger Walker.

"You're right!" called Walker's voice, strained to the breaking point. "There is sickness! Everywhere! There's an epidemic! It's just beginning! People felt tired and peevish and shut themselves away. Nobody realized! But they've got fevers! They're showing rashes! There's some delirium! The smallest children are worst—they were always quiet—but it's everywhere! We've never had real sickness before! What can we do?"

Calhoun said tiredly:

"I've got the design for an antibody. Murgatroyd made it. It's what he's for. The hospital ships from Phaedra are on the way now. They'll start turning it out in quantity and their doctors will start giving everybody shots of it."

Young Walker cried out fiercely:

"But that would mean they'd land! They'd take over! I can't let them land! I haven't the power! Nobody has! Too many of us would rather die than let them land! They lied to us. It's bad enough to have them hovering outside. If they land, there'll be fighting everywhere and forever! We can't let them help us! We won't! We'll fight—we'll die first!"

Calhoun blinked, owlishly.

"That," he said exhaustedly, "is something you have to figure out for yourself. If you're determined to die, I can't stop you. Die first or die second—it's your choice. You make it. I'm going to sleep!"

He cut off the mike and speakers. He couldn't keep his eyes open.

VII.

". . . As a strictly practical matter, a man who has to leave a task that he has finished, and wishes it to remain as he leaves it, usually finds it necessary to give the credit for his work to someone who will remain on the spot and will thereby be moved to protect and defend it so long as he lives . . ."

Manual, Interstellar Medical Service. Pp. 167-8.

Murgatroyd tugged at Calhoun and shrilled anxiously into his ear.

"Chee-chee!" he cried frantically. *"Chee-chee-chee!"*

Calhoun blinked open his eyes. There was a crashing sound and the Med ship swayed upon its landing fins. It almost went over. It teetered horribly, and then slowly swung back past uprightness and tilted nearly as far in the opposite direction. There were crunching sounds as the soil partly gave way beneath one landing fin.

Then Calhoun waked thoroughly. In one movement he was up and launching himself across the cabin to the control-chair. There was another violent impact. He swept his hand across the row of studs which turned on all sources of information and communication. The screens came on, and the spacephone, and the outside mikes and loud-speakers, and even the planetary communication unit which would have reported had there been any use of the electromagnetic spectrum in the atmosphere of this planet.

Bedlam filled the cabin. From the spacephone speaker a stentorian voice shouted:

"This is our last word! Permit our landing or—"

A thunderous detonation was reported by the outside mikes. The Med ship fairly bounced. There was swirling white smoke outside the ship. It was mid-morning, now, and the giant lacy structure of the landing grid was silhouetted against a deep-blue sky. There were cracklings from some electric storm perhaps a thousand miles away. There were shout-

ings, also brought in by the outside mikes.

Two groups of figures, fifty or a hundred yards from the Med ship, labored furiously over some objects on the ground. Smoke billowed out; then a heavy, blastlike *"Boom!"* Something came spinning through the air, end over end, with sputtering sparks trailing behind it. It fell close by the base of the upright Med ship.

Calhoun struck down the emergency rocket stud as it exploded. The roar of the rocket filled the interior of the ship. The spacephone speaker bellowed again:

"We've got a megaton bomb missile headed down! This is our last word! Permit landing or we come in fighting!"

The object from the crude cannon went off violently. With the emergency rocket flaming to help, it lifted the Med ship, which jerked upward, settled back—and only two of its fins touched solidity. It began to topple because there was no support for the third.

Once toppled over, it would be helpless. It could be blasted with deliberately placed charges between its hull and the ground. A crater already existed where support for the third landing fin should have been.

Calhoun pushed the stud down full. The ship steadied and lifted. It went swinging across the level center of the landing grid. Its slender, ultra-high-velocity flame knifed down through the sod, leaving a smoking, incandescent slash behind. The figures about the bomb-throwers scattered and fled. The Med ship straightened to an upright position and began to rise.

Calhoun swore. The grid was the planet's defense against landings from space, because it could fling out missiles of any size with perfect aim at any target within some hundred thousand miles—a good twelve planetary diameters. Its operators meant to defy the fleet from Phaedra and had to get rid of the Med ship before they dared energize its coils. Now they were rid of it. Now they could throw bombs, or boulders, or anything else its forcefields could handle.

The spacephone roared again:

"On the ground there! Our missile is aimed straight for your grid! It carries a megaton fission bomb! Evacuate the area!"

Calhoun swore again. The gang, the guard, the young-warrior group at the grid would be far too self-confident to heed such a threat. If there were wiser heads on Canis III, they could not enforce their commands. A human community has to be complete or it is not workable. The civilization which had existed on Phaedra II was shattered by the coming doom of its sun. The fragments—on Phaedra, in the fleet, in each small occupied community on Canis III—were incomplete and incapable of thinking or acting in concert with any other. Every small group on this planet, certainly, gave only lip-service to the rest. The

young world was inherently incapable of organizing itself, save on a miniature scale. And one such miniature group had the grid and would fight with it regardless of the wishes of any other—because that group happened to be composed of instinct-driven members of the young-warrior group.

But he was still within the half-mile-high fence of the grid's steel structure. He strapped himself in his seat. The ship rose and rose. It came level with the top of the colony's one defense against space. The peculiar, corrugated copper lip of that structure, formed into the force-field guide which made it usable, swung toward him. He raised the rocket-thrust and shot skyward.

A deafening bellow came from the speakers:

"Yeah! Go on out and join the old folk! We'll get you!"

Obviously, the voice was from the ground below him. The ship flashed upward. Calhoun rasped into the spacephone mike, himself:

"Med ship calling fleet! Call back that missile! I've got the antibody structure! This is no time for fighting! Call your missile back!"

Derisive laughter—again from the ground. Then the heavy, growling voice of an older man.

"Keep out of the way, Med ship! These young fools are destroying themselves. Now they're destroying our grandchildren! If we hadn't been soft-hearted before—if we'd fought them from the beginning—the little ones wouldn't be dying now! Keep out of the way! If you can help us, it'll be after we've won the war!"

The sky turned purple, at the height Calhoun had reached. It went black. The sun Canis flamed and flared against a background of ebony space, sprinkled with a thousand million colored stars. The Med ship continued to rise.

Calhoun felt singularly and helplessly alone. Below him the sunlit surface of a world spread out, its edge already curving, cloud-masses in its atmosphere veiling the details of mountains and green-clad plains. There was the blue of ocean, creeping in. The city of the landing-grid was tiny, now. The brown of ploughed fields was no longer divided into rectangular shapes. It was a mere brownish haze between the colorings of as-yet-untouched virgin areas. The colonists of Canis III had so far made only a part of the new world their own. Many times more remained to be turned to human use.

The rear screen showed something coming upward. Masses of stuff, without shape but with terrific velocity. It was inchoate, indefinite stuff. It was plain dirt from the center of the landing-grid's floor, flung upward with the horrible power available for the landing and launching of ships. And, focused upon it, the force-fields of the grid could control it absolutely for a hundred thousand miles.

Calhoun swerved, ever so slightly. His own velocity had reached miles per second, but the formless mass following him was traveling at tens.

It would not matter what such a hurtling missile was. At such a velocity it would not strike like a mass, but like a meteor-shower, flaring into incandescence when it touched and vaporizing the Med ship with itself in the flame of impact.

But the grid would have to let go before it hit. There was monstrous stored power in the ship's Duhanne cells. If so much raw energy were released into anything on which a force-field was focused, it would destroy the source of the field. The grid could control its battering-ram until the very last fraction of a second, but then it must release—and its operator knew it.

Calhoun swung his ship frantically.

The mass of speeding planet-matter raced past no more than hundreds of yards away. It was released. It would go on through empty space for months or years—perhaps forever.

Calhoun swung back to his upward course. Now he sent raging commands before him:

"Pull back that missile! You can't land a bomb on Canis! There are people there! You can't drop a bomb on Canis!"

There was no answer. He raged again:

"Med ship calling Phaedra fleet! There's disease on Canis! Your children and grandchildren are stricken! You can't fight your way to help them! You can't blast your way to sickbeds! You've got to negotiate! You've got to compromise! You've got to make a bargain or you and they together—"

A snarling voice from the ground said spitefully:

"Never mind, little Med man! Let 'em try to land! Let 'em try to take over and boss us! We listened to them long enough! Let 'em try to land and see what happens! We've got their fleet spotted! We'll take care of them!"

Then the growling tones Calhoun had come to associate with Phaedra:

"You keep out of the way, Med Ship. If our young children are sick, we're going to them! We're just beyond the area in which no drive will work. When the grid has been blasted our landing ship will go down and we'll come in! Our missile is only half an hour from target now! We'll begin our landing in three hours or less! Out of the way!"

Calhoun said very bitter and extremely impolite words. But he faced an absolute emotional stalemate between enemies of whom both were in the wrong. The frantic anger of the adults of Phaedra, barred from the world to which they'd sent their children first so they could stay where doom awaited, was matched by the embittered revolt of the young people who had been worked past endurance and burdened past anyone's power to tolerate. There could be no compromise. It was not possible for either side to confess even partial defeat by the other. The quarrel had to be fought to a finish as between the opposing sides, and then

hatred would remain no matter which side won. Such hatred could not be reasoned with.

It could only be replaced by a greater hatred.

Calhoun ground his teeth. The Med ship hurtled out from the sun-lit Canis III. Somewhere—not many thousands of miles away— the fleet of Phaedra clustered. Its crews were raging, but they were sick with anxiety about the enemies they prepared to fight. Aground there was hatred among the older of the colonists—the young-warrior group in particular, because that is the group in which hate is appropriate—and there was no less a sickish disturbance because even in being right they were wrong. Every decent impulse that had been played upon to make them exhaust themselves, before their revolt, now protested the consequences of their revolt. Yet they believed that in revolting they were justified.

Murgatroyd did not like the continued roar of emergency-rockets. He climbed up on Calhoun's lap and protested.

"Chee!" he said urgently. *"Chee-chee!"*

Calhoun grunted.

"Murgatroyd," he said, "it is a Med service rule that a Med ship man is expendible in case of need. I'm very much afraid that we've got to be expended. Hang on, now! We try some action!"

He turned the Med ship end for end and fed full power to the rockets. The ship would decelerate even faster than it had gathered speed. He set the nearest-object indicator to high gain. It showed the now-retreating mass of stone and soil from Canis. Calhoun then set up a scanner to examine a particular part of the sky.

"Since fathers can be insulted," he observed, "they've made a missile to fight its way down through anything that's thrown at it. It'll be remote-controlled for the purpose. It's very doubtful that there's a spaceship on the planet to fight it back. There's been no reference to one, anyhow. So what the missile will have to fight off will be stuff from the landing-grid only. Which is good. Moreover, fathers being what they are, regardless, that missile won't be a high-speed one. They'll want to be able to call it back at the last minute. They'll hope to."

"Chee!" said Murgatroyd, insisting that he didn't like the rocket-roar.

"So we will make ourselves as unpopular as possible with the fathers," observed Calhoun, "and if we live through it we will make ourselves even more cordially hated by the sons. And then they will be able to tolerate each other a little, because they both hate us so much. And so the public-health situation on Canis III may be resolved. Ah!"

The nearest-object indicator showed something moving toward the Med ship. The scanner repeated the information in greater detail. There was a small object headed to-

ward the planet from empty space. Its velocity and course—

Calhoun put on double acceleration to intercept it, while he pointed the ship quartering so he'd continue to lose outward speed.

Ten minutes later the spacephone growled:

"Med ship! What do you think you're doing?"

"Getting in trouble," said Calhoun briefly.

Silence. The screens showed a tiny pin point of moving light, far away toward emptiness. Calhoun computed his course. He changed it.

"Med ship!" rasped the spacephone. *"Keep out of the way of our missile! It's a megaton bomb!"*

Calhoun said irrelevantly:

"Those who in quarrels interpose, must often wipe a bloody nose." He added. "I know what it is."

"Let it alone!" rasped the voice. *"The grid on the ground has spotted it. They're sending up rocks to fight it."*

"They're rotten marksmen," said Calhoun. "They missed me!"

He aimed his ship. He knew the capacities of his ship as only a man who'd handled one for a long time could. He knew quite exactly what it could do.

The rocket from remoteness—the megaton-bomb guided missile — came smoking furiously from the stars. Calhoun seemed to throw his ship into a collision course. The rocket swerved to avoid him, though guided from many thousands of miles away. There was a trivial time-lag, too, between the time its scanners picked up a picture and transmitted it, and the transmission reached the Phaedran fleet and the controlling impulses reached the missile in response. Calhoun counted on that. He had to. But he wasn't trying for a collision. He was forcing evasive action. He secured it. The rocket slanted itself to dart aside, and Calhoun threw the Med ship into a flip-flop and—it was a hair-raising thing—slashed the rocket lengthwise with his rocket flame. That flame was less than half an inch thick, but it was of the temperature of the surface of a star, and in emptiness it was some hundreds of yards long. It sliced the rocket neatly. It flamed hideously, and even so far, Calhoun felt a cushioned impact from the flame. But that was the missile's rocket fuel. An atom bomb is the one known kind of bomb which will not be exploded by being sliced in half.

The fragments of the guided missile went on toward the planet, but they were harmless.

"All right!" said the spacephone icily—but Calhoun thought there was relief in the voice. *"You've only delayed our landing and lost a good many lives to disease!"*

Calhoun swallowed something he suspected was his heart, come up into his throat.

"Now," he said, "we'll see if that's true!"

His ship had lost its spaceward velocity before it met the missile.

Now it was gaining velocity toward the planet. He cut off the rocket to observe. He swung the hull about and gave a couple of short rocket blasts.

"I'd better get economical," he told Murgatroyd. "Rocket fuel is hard to come by, this far out in space. If I don't watch out, we'll be caught in orbit, here, with no way to get down! I don't think the local inhabitants would be inclined to help us."

His lateral dash at the missile had given him something close to orbital speed relative to the planet's surface, though. The Med ship went floating, with seemingly infinite leisure, around the vast bulge of the embattled world. In less than half an hour it was deep in the blackness of Canis' nighttime shadow. In three-quarters of an hour it came out again at the sunrise edge, barely four hundred miles high.

"Not quite speed enough for a true orbit," he told Murgatroyd critically. "I'd give a lot for a good map!"

He watched alertly. He could gain more height if he needed to, but he was worried about rocket fuel. It is intended for dire emergencies only. It weighed too much to be carried in quantity.

He spotted the city of Canopolis on the horizon. He became furiously busy. He inverted the little ship and dived down into atmosphere. He killed speed with rocket flames and air friction together, falling recklessly the while. He was barely two miles high when he swept past a ridge of mountains and the city lay ahead and below. He could have crashed just short of it. But he spent more fuel to stay aloft. He used the rockets twice. Delicately.

At a ground speed of perhaps as little as two hundred miles an hour, supported at the end by a jetting, hair-thin rocket flame that was like a rod of electric arc-fire, he swept across the top of the landing grid. The swordlike flame washed briefly over the nearer edge. Very briefly. The flame cut a slash down through steel girders and heavy copper cables together. The rockets roared furiously. That one disabling cut at the grid had been on a downward, darting drift. Now the ship shouted, and swooped up, and on—and it swept above the far side of the grid only yards from the wide strip of copper which guided its force-fields out into space. Here it cut cables, girders, and force-field guide together for better than two hundred feet from the top. The grid was useless until painstaking labor had made the damage good.

Calhoun used nearly the last of his fuel for height while he said crisply on the spacephone:

"Calling fleet! Calling fleet! Med ship calling fleet! I've disabled the landing grid on Canopolis! You can come in now and take care of the sick. There are no weapons aground to speak of and if you don't get trigger-happy there should be no fighting. I'll be landed off somewhere in the hills to the north of the

town. If the local inhabitants don't pack explosives out and crack the ship to get at me, I'll have the facts on the antibody ready for you. In fact, as soon as I get down I'll give them to you by spacephone, just in case."

It was a near thing, though. His rocket fuel was exhausted when he hit the ground. The flame sputtered and stopped when the ship was three feet from touching. It fell over, splintering trees. It was distinctly a rough landing.

Murgatroyd was very indignant about it. He scolded shrilly while Calhoun unstrapped himself from the chair and when he looked out to see where they were.

* * *

It was a week later when the Med ship—brought to the grid for repair and refueling—was ready for space again. The original landing grid still stood, of course. But it was straddled and overwhelmed, huge as it was, by the utterly gigantic flying grid from Phaedra. There were not many ships aground, though. As Calhoun moved toward the control building, now connected by cable to the control quarters in the flying grid, one of the few ships remaining seemed to fall toward the sky. A second ship followed only seconds later.

He went into the control building. Walker the elder, from Phaedra, nodded remotely as he entered. The younger Walker scowled at him. He had been in consultation with his father, and the atmosphere was one of great reserve.

"Hm-m-m," said the elder Walker, gruffly. "What's the report?"

"Fairly good," said Calhoun. "There was one lot of antibody that seems to have been a trifle under strength. But the general situation seems satisfactory. There'll be a few more cases of one thing and another, of course—cases that are incubating now. But they'll do all right on the antibody shots. They have so far, at any rate." He said to the younger Walker, "You did a very good job rounding up the thirteen-to-fifteen-year-olds to escort the fleet doctors and handle the patients for them. They took themselves very seriously. They were ideal for the job. Your young-warrior group—"

"A lot of them," said young Walker dourly, "have taken to the woods. They swear they'll never give in!"

"How about the girls?"

Young Walker shrugged.

"They're fluttering about and beginning to talk about clothes. When older women arrive there'll be dressmaking—"

"And the lads in the woods," said Calhoun, "will come out to fascinate, and be fascinated instead. Do you think there'll be really much trouble?"

"No-o-o," said young Walker sourly. "Some of . . . our younger crowd seem relieved to be rid of responsibility."

"But," interposed the older Walker, gruffly, "he wants it. He thrives on it. He'll get it!" He hrrumphed. "The same with the others who showed what they could do here. We oldsters need them. We don't plan any . . . ah . . . reprisals."

Calhoun raised his eyebrows.

"Should I be surprised?"

The older Walker snorted.

"You didn't expect us to fall into each other's arms after what's happened, did you? No! But we are going to try to ignore our . . . differences as much as we can. We won't forget them, though."

"I suspect," said Calhoun, "that they'll be harder to remember than you think. You had a culture that split apart. Its pieces were incomplete—and a society has to be complete to survive. It isn't a human invention. It's something we have an instinct for—as birds have an instinct to build nests. When we build a culture according to our instincts, we get along. When that's impossible—there's trouble." Then he said, "I'm not trying to lecture you."

"Oh," said the elder Walker. "You aren't?"

Calhoun grinned.

"I thought I'd be the most unpopular man on this planet," he said cheerfully. "And I am. I interfered in everybody's business and nobody carried out his plans the way he wanted to. But at least nobody feels like he won. You'll be pleased when I lift the quarantine and take off, won't you?"

The older Walker said scornfully:

"We're paying no attention to your quarantine! Our fleet's loading up our wives on Phaedra, to ferry them here as fast as overdrive will do it! D'you think we'd pay any attention to your quarantine?"

Calhoun grinned again. The younger Walker said painfully:

"I suppose you think we should—" He stopped, and said very carefully: "What you did was for our good, all right, but it hurts us more than it does you. In twenty years, maybe, we'll be able to laugh at ourselves. Then we'll feel grateful. Now we know what we owe you, but we don't like it."

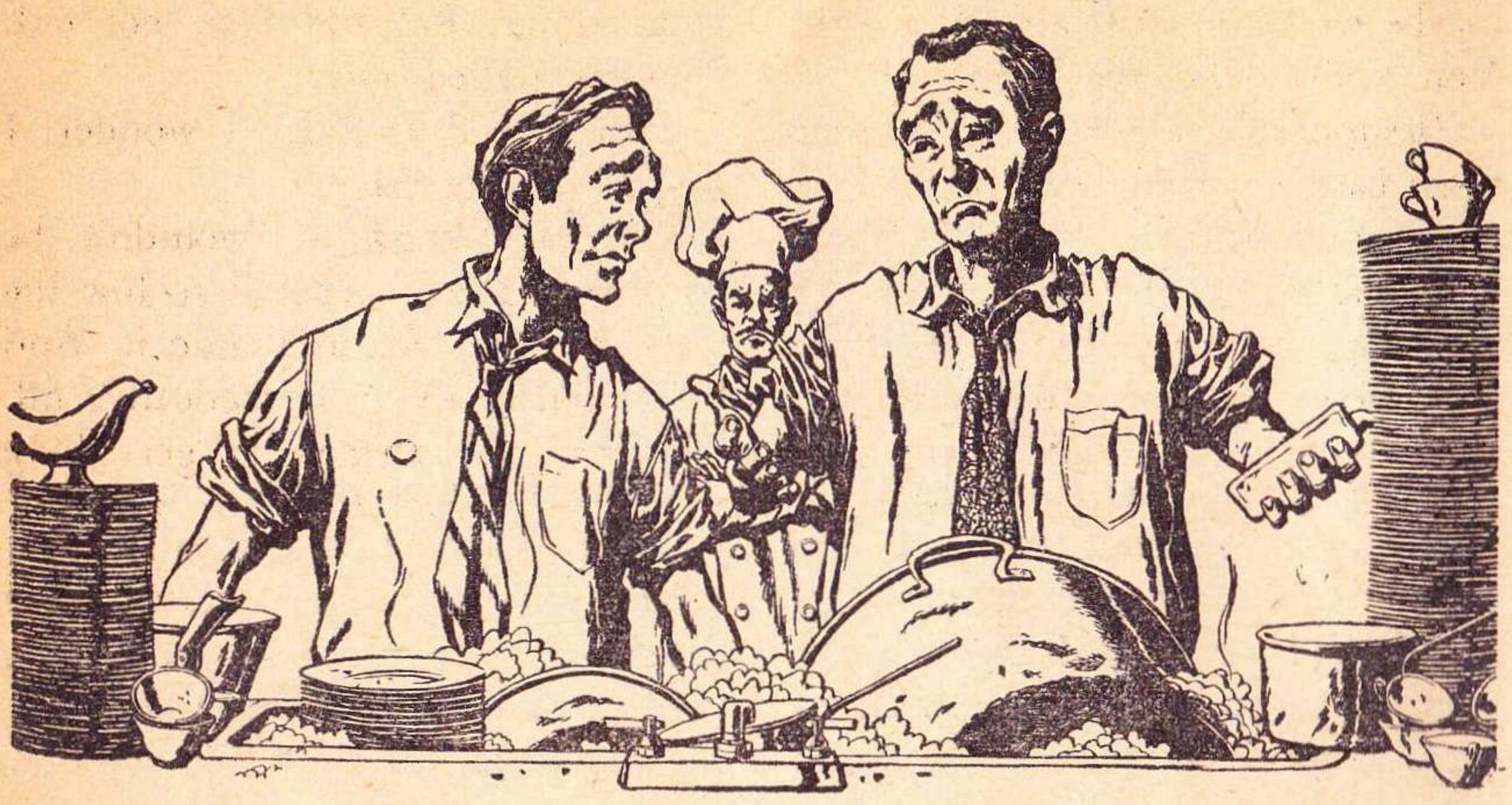
"And that," said Calhoun, "means that everything is back to normal. That's the traditional attitude toward all medical men—owe them a lot and hate to pay. I'll sign the quarantine release and take off as soon as you give me some rocket fuel, just in case of emergency."

"Right away!" said the two Walkers, in unison.

Calhoun snapped his fingers. Murgatroyd swaggered to his side. Calhoun took the little *tormal's* black paw in his hand.

"Come along, Murgatroyd," he said cheerfully. "You're the only person I really treated badly, and you don't mind. I suppose the moral of all this is that a *tormal* is a man's best friend."

THE END



COMPENSATION

Being telepaths, they knew civilization was impossible without telepathy. That nontelepaths would, to them, be as weak and helpless as a kitten.

BY CHRISTOPHER ANVIL

Illustrated by van Dongen

Sten and Ral looked the new planet over with the casual superiority of long experience.

"No roadblocks or checkpoints," said Ral, tilting his head toward the cloverleaf with cars streaming up and around it.

Sten tossed a curd of muggum into his mouth and smiled faintly. "Pushover," he said.

Ral cast around mentally. "And not a telepath among them."

"Nope," said Sten. "Nothing but static."

'Why look further?" said Ral in wonderment. "They aren't putting out on a single frequency. Their security is nonexistent. They're wide open from here to home and back."

Sten stirred uneasily. "Yeah. But

maybe we better drift around a little. You know—pad the report."

"I suppose," said Ral. "If we send them back anything less than a first-class brain-splitter, they'll think we're asleep." He looked at the whizzing harmless cars. "But, if we sent them just one thought on this place, they should be happy. It only takes one thought to describe it."

"What's that?" said Sten.

"Pre-slave," said Ral.

They smiled and started for the highway.

The city was there almost before they realized it. As they watched from the speeding car, the houses thickened beside the road, the lots grew smaller, separate buildings gave way to buildings with a common front and the buildings grew taller. The car slowed, and their host turned halfway around in his seat to face them.

"You guym rana ledout here?" he said, his forehead faintly wrinkled.

Ral moved his lips and cast a strong questioning thought at the native: "What?"

The man in the front seat squinted, "Want to get out here?"

"Oh. Yeah."

"Whaddat? Spee glub, mizzer. I'm a liddel ef."

Ral frowned, squinted. "What?"

"You wand out?"

"*Yes.*"

"Oh."

The car pulled in toward the curb at a corner. Ral and Sten got out. The car pulled away.

Sten looked at Ral. "I wonder if they're *all* like that?"

"I don't know. I wouldn't be surprised. Their output is so low the static would practically hide it. And their sensitivity is practically nil. Yet that one seemed to get along with his fellows, and look what his sensitivity was."

"Poor characteristic for slaves," said Sten sourly. "A man doesn't like to wear an amplifier just so his slaves can hear him."

"That's true," said Ral. "But they might be good for household slaves. They couldn't eavesdrop and spread gossip, at least."

Sten nodded. "That's something."

As they talked, the two of them were looking around at the city.

"Don't see a single monitor station," said Ral finally.

"No," said Sten. "Nor a watch-tower."

"There weren't any gates the way we came in."

"Nor a single checkpoint."

"Funny place," said Ral. "They must never have had any wars or difficulties. I feel a little sorry for them."

"Don't start that," said Sten. "A slave's a slave. You start feeling sorry for them, and there's no end to your troubles."

"True enough," said Ral, looking around. He smiled faintly. "Look over there."

All the cars in the street were halted, and right across the street

was a store, its windows plastered with signs, and the display cases behind heaped with piles of harmless merchandise. "Typical," said Ral. He started out.

"Watch that overhead signal," growled Sten. "When it changes color, these cars rush forward. I saw a woman almost get hit."

"Visual signal control," said Ral, crossing the street. "Maybe that's how we can get around their lack of sensitivity."

"May be," said Sten.

With a roar, the cars started up behind them.

Sten and Ral looked in the store window.

"Those devices are for measuring time," said Ral. "You see how that little pointer swings around. Apparently they only divide the day into twelve main units. That indicates they're easy-going."

"They don't *look* easy-going," said Sten. "See how they rush along."

"Hm-m-m," said Ral. "That's a point."

"Something screwy about this place," said Sten. "I don't know what it is, but something doesn't seem right."

Ral scowled and looked around. "Yes, I see what you mean. Something—"

A policeman wearing a gun and a belt of bullets, and swinging a club, strolled past.

Ral nudged Sten, who jumped.

"There's your missing piece," said Ral.

They watched the policeman vanish in the crowd, then looked at each other blankly.

"Screwier than ever," said Sten abruptly. "How come he *mingled* with them?"

"I was overhasty," said Ral, frowning. "That's another piece, all right, but it doesn't fit. It just makes things worse. I didn't get a single thought from him. Some of those people around him had faint fear-thoughts, and some had assurance-thoughts. I could swear one of them wanted to hit him. But at least two others liked him."

"Funny reactions," said Sten, his face all twisted up. "It just doesn't fit for master and slaves."

"Well, what else *could* it be?" said Ral. "That thing on his hip was a hand weapon, an explosive-powered slug-thrower if I ever saw one. And, for that matter, a man doesn't walk around with a bludgeon in his hand unless he thinks he's going to need it."

"Yeah," said Sten. "Well, it doesn't fit no matter how you twist and squeeze it. We'd better admit it and settle in for a full-length stay."

"I suppose so," said Ral gloomily.

Sten and Ral hunted around for a place to stay while they studied the city. They finally decided on a hotel as the most anonymous place to live, and as the place where they could best observe large numbers of the natives at one time. Right at the beginning, they had a few uneasy moments.

The clerk shoved a register and a pen across the desk. Ral, thinking fast, deduced that the pen was designed to produce a wavy line such as the wavy lines above it on the paper. He tried first one end of the pen, then the other, then, scrawling rapidly from right to left, produced what looked to him to be a very satisfactory wavy line with a few decorative spatterings of ink around it.

The clerk looked blank, spun the book around, stared at it, looked at Ral—who stared back at him radiating thoughts of friendly assurance—blinked, and spun the book around for Sten.

Sten picked up the pen and drew it rapidly from right to left, giving a close imitation of Ral's performance.

The clerk pulled out a handkerchief and wiped his forehead, upper lip, and neck.

Sten and Ral radiated friendliness and assurance at him.

"Hm-m-m," said the clerk. "Blew guyd Arabd dor zumthig?"

Ral made a mighty effort to increase his sensitivity. He leaned forward radiating curiosity.

"I said," said the clerk, "are you guys Arabs, or something?"

Ral caught the significance of the question. "Something like that," he radiated.

A tall man in a brown suit detached himself from a pillar in the shadows to one side and came forward quietly, his gaze intent on Ral's lips.

Ral detected suspicion and intense curiosity.

"Sten," he thought, "hold that other native off."

Sten turned toward the tall man and radiated confusion, forgetfulness, and sleepiness.

Ral radiated a sense of well-meaning friendliness at the clerk.

The clerk unhooked a set of keys.

The tall man yawned, blinked, scowled, came forward and stood uncertainly.

Ral took the keys and followed Sten to an elevator. They got off at the third floor, wandered out onto a fire escape and stared around in a sort of daze.

"Well," said Ral, "apparently we made it through the first checkpoint."

"Maybe, but now what do we do?"

"These things here are plainly keys."

"Keys to what? This is a big building."

"Let's go back in and look around."

After about five minutes, Ral said, "The faces of the doors here have some kind of symbols on them. This tag hooked to the keys has symbols on it. Apparently we have to find a door with symbols on it that match the symbols on the tag."

"Well," said Sten wearily, "let's start hunting."

Half-an-hour later, they were in their room. Another half hour passed while they lay exhausted and

tried to clear up several points about the system of symbols on the tag.

"These people," Ral concluded, "have been handicapped by their lack of telepathic faculties. Obviously they have had to adopt substitutes. Where one of us would merely visualize the entrance of the room and the route to it, these people must first *mark* the room, then refer to it by the mark. It's easy to see how their handicap has thwarted them."

"Wait a minute now," said Sten, scowling. "Which is easier? Visualize the whole thing? Or just refer to a mark?"

"Well— But they have to *go* there first, and *mark* it."

"All right. We have to go there first and *see* it."

"Well—" Ral blinked. "Wait a minute, now. We can get it from someone *else* who's seen it."

"*If* he's a good observer."

"Well, sure—"

"How many of *them* are there? You remember that escaped prisoner on Gulmatz? The officer on the spot relayed his appearance mentally through sixteen passengers on sixteen different ships that happened to make an extended circuit from Gulmatz to Srin, where the prisoner was supposed to be headed. Then the official set off for Srin. Five minutes after he stepped off the ship he was locked in irons. It took him a week to talk his way out of it."

"Well, yes. But *sixteen*—"

"The officer sent out a description of the *prisoner*. By the time it reached Srin, it was a good description of *himself*."

"Yes, all right, but *sixteen*—"

"They never *did* catch that prisoner!"

"A relay through *sixteen people* is too many!"

"I bet you could relay something like this symbol through sixteen people."

Ral glared at the little number on the tag. He shook his head fiercely. "All right. Considering they aren't telepathic, they've compensated pretty well."

"And now I think of it, those surface cars of theirs are quiet, smooth and fast."

"So are ours."

"We don't have that many. And I would like to know, just how do these nontelepaths get complex ideas across to each other, anyway? Making a surface car is no simple matter. Who controls the sub-groups of workers to see that they co-ordinate properly? We've seen development like this before, but *not on a nontelepathic planet.*"

Ral scowled, "I don't know. Anyway, does it matter? The important thing to remember is: These people are soft, spoiled. How many people have we seen that could possibly stand up to a master?"

"That's true," said Sten, thoughtfully. "Yes, that's so. Just one. Or," he frowned, "possibly two. The man that came over while we were downstairs had something dangerous about him."

"True. Well—" Ral shook his head. "I admit I'm a little uncertain how we're finally going to decide this; but I still have to file my initial report."

Sten nodded gloomily. "There's no getting away from that."

Ral lay back and thought intently. After a long time, an answering flicker reached out to him. Slowly, forming each thought fully and carefully, he sent home his report. Time passed. Beads of perspiration stood out on his forehead. His collar grew limp and flaccid. His breath came hard and heavy. He writhed like a man caught in the grip of a giant snake, then shivered and lay limp.

"Your turn," he said in a dull, hollow voice.

Sten began to sweat.

At the end, they stared at each other.

"Well, misbegotten thought!" snarled Sten. "They don't believe us!"

Ral sat up, bared his teeth, and made a gargling sound deep in his throat. For a moment, he sat red with anger, then ran his hand through his hair, groaned, and lay back on the bed. After a moment, he said, "I thought they'd believe me when you told them the same thing."

"They didn't believe a thought I sent them."

"Did they spring the same explanation on you they did on me?"

"I can only stand so much," said Sten. "I made myself as unreceptive as possible while you were sending. What they told *me* was that it was impossible. Quote: Civilization as we know it can't exist without telepathy. Co-ordination of large-scale enterprises would be impossible. End quote."

Ral sat up and looked out the window at tall buildings, and ranks of distant smokestacks belching clouds of gray and black.

"Yeah," he said. "We aren't seeing that."

"Mass-hypnosis," said Sten with a sour smile. "Obviously if it can't be so, and we see it, somebody has us under illusion."

"I don't think that idea improves the situation," said Ral angrily. "If it's a choice between having someone strong enough to beat you up, and having someone suggestive enough to convince you you're beat up—down to the point where you spit out pieces of clinking tooth—which is worse, anyway?"

"Don't blame me. I didn't say it."

"Well—" Ral glared around the room. He jumped up, banged the wall with his fist, whirled, snatched up a blanket on the bed and felt its texture. He strode into the bathroom, gripped the bar of soap, seized a glass, dropped it, heard the crash, bent over and felt the pieces. He gathered them together, looked around in disgust, and dropped the pieces in the sink. He went back into the bedroom. "It's the most real illusion *I* ever saw," he said. "When

an illusion gets *that* real, what's the difference?"

Sten tossed a curd of muggum into his mouth and shrugged helplessly.

Ral sat down again. "This is going to ruin our standing."

"It sure is."

"Every time they think of our names from now on, there's going to be a fuzzy aura of unreliability around them." He got up and paced.

"Yep," said Sten.

"You going to just *sit* there?" said Ral.

"Can you think of anything better?"

Ral sucked in a deep breath, frowned angrily, blew out his cheeks, and shook his head. "No."

"Let's go to sleep. This is bad enough without thinking about it."

Ral went into the bathroom and threw the broken glass out the window. Then he washed up and got ready for bed.

The next day was beautiful, but neither Sten nor Ral could appreciate it. They sampled the native food, and found it strange but edible, got into a tangle with a waiter over "pay," which the native insisted on receiving in return for the food, ended up radiating charm and good will at the manager, and nevertheless soon found themselves in the kitchen up to their elbows in soapy water.

Sten made the situation worse by radiating images of giant fungoid monstrosities, and Ral enlarged on that by putting in mental pictures of loathsome creatures all teeth, claws, and stinging spines. Sten's funguses immediately snaked out strangling tentacles. Ral's monsters promptly writhed around and sank their teeth in them.

As Ral and Sten left the place, the manager leaned against the cashier's desk grinning. The cashier was blushing a bright pink.

Ral turned his receptivity to the highest point, then looked sourly at Sten.

"They think they *heard* us. At least we were able to get across to them somehow."

"That's nice," said Sten. "Now let's go somewhere where it's peaceful and figure out this 'money' business."

They radiated happy friendliness past the hotel clerk's desk, got up to their room, and lay down exhausted. They discussed the matter a while, then cast out mentally. It was a hard job, but gradually a few weak bare images came to them, from one part of the city, then another. They kept at it with dogged persistence, extracting all the pertinent information they could. Finally they looked at each other sourly.

"The stuff is changing hands all over the city."

They lay back and stared at the ceiling.

"Well," said Sten, "I hate to say this. But this 'money' system is better than having to remember every item you've ever bought from anybody, and then having to

trade mental images till it balances out."

Weakly, Ral answered, "It's crude. Clumsy. It's—physical."

"It works," said Sten doggedly.

Ral let his breath out with a sigh. "Wait till we try to explain *this*."

"It isn't only that that worries me," said Sten. "I'm getting hungry again. I don't want to have to go through what we went through this morning every time we want a meal."

Ral rolled over on his face and didn't say anything for a long while. He cast around mentally for the needed information, then muttered, "We're going to have to get a job."

"*Job*," said Sten. "What's that?"

Ral explained.

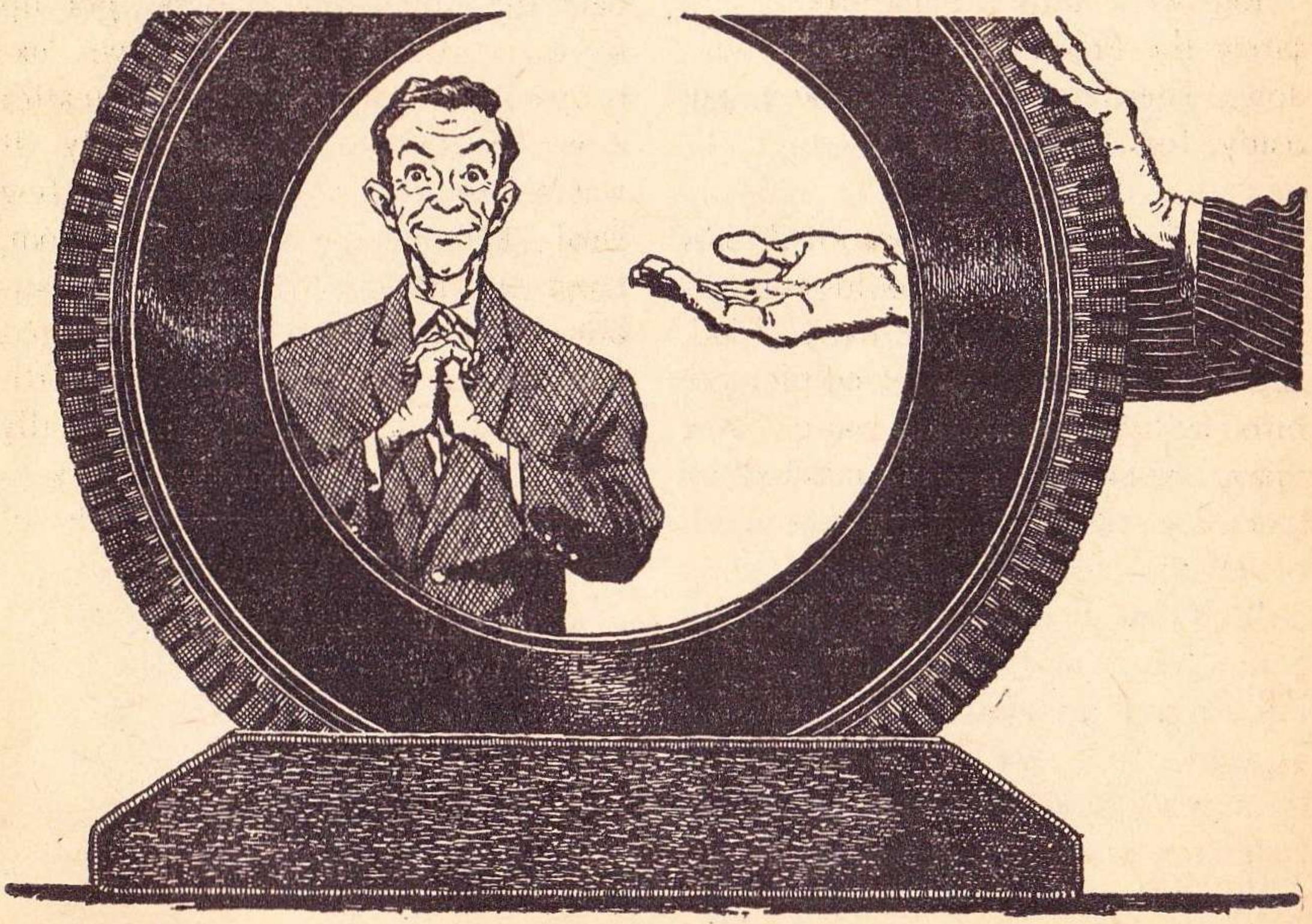
Sten angrily created a fantasy so monstrous that Ral had to turn his sensitivity down to its lowest possible level. At last Sten lay back shaking.

"No," he said grimly, "there's a better way."

"You name it," said Ral.

"There's a lot of this 'money' around. Everybody seems to have it. All right. Let's *take* some. How will *they* know? They aren't telepathic."

'Hm-m-m," said Ral, turning the idea over in his mind. "Yes. That's *right*." He sat up. "Of *course* they won't know. How could they? At home, of course, somebody would be sure to know the minute we so



much as thought of the idea, but *here*—" Ral let out a sigh of relief. "I'm glad you thought of that."

"The idea just came to me," said Sten modestly.

"It's very original," said Ral. "Well, let's not just lie here. Let's go out and do it."

They got up and went downstairs. On the way past the desk, they had to exert their powers to the limit.

"That clerk," said Sten angrily, "seems to get more untrusting all the time."

"It's these clothes," said Ral. "We should have made three or four sets of them before we left the ship. As it is, they're a little— Well, all those dishes and everything—"

"We'll settle that," Sten growled, "as soon as we get a store of this 'money.' "

They paused outside the hotel, and cast around in thought. The mental images from the people in the city were, as usual, relatively few and scanty. But where large amounts of "money" was concerned, the images seemed somewhat more numerous and clearer. In a few moments Sten and Ral were headed toward a place where a large stock of money was being transferred.

"It's in a ground-vehicle," said Sten. "They're putting it inside a building. I got that much perfectly. It stands to reason there's bound to be a few stacks of it sitting around forgotten for the moment."

"Sounds ideal," said Ral.

They reached the spot where the transfer was taking place.

A squat armor-plated truck sat at the curb. The long snout of a gun stuck out of a turret on top. A man with a gun at his side stood at the rear of the truck. Two men, wearing guns, carried bags into a nearby building. The building had heavy bars on the windows, massive metal doors, and walls so thick the place looked as if it were built to withstand a siege. At the door of the building stood another man with a gun.

Ral and Sten looked at each other, hesitated, then turned around and headed moodily back toward the hotel. On the way they stopped to look in store windows.

"Some of this stuff looks sort of nice," growled Sten, looking in the display window of a big department store.

"Yeah," said Ral. "But that doesn't help us any."

Sten scowled. "Let's go in and just see how they work it. I mean, how they transfer this 'money' for these goods. Maybe we could think of something."

"It's worth a try," said Ral. "We couldn't be much worse off than we are now."

They strolled around inside for a while, watched people being waited on, fought off several remarkably persuasive attempts to sell them refrigerators, dining-room suites, portable drills and sanders, and new, guaranteed puncture-proof, no-bump tires.

Ral finally found himself staring at Sten outside the store.

"I just barely got you out of there," said Sten. "Another couple of instants and you'd have had us loaded down with a set of no-bump, easy-cushion, self-sealing tubeless tires—whatever they are."

Ral blinked. "I remember I wanted them, Sten, but I don't know why."

"Me either. I was sort of interested in that big red drill you could switch around into a lathe."

Ral scratched his head. He seemed to have the beginnings of an idea, but he couldn't quite get hold of it. He scowled and shrugged. "Well, now we have a better idea how that 'money' works. Let's look around some more."

They found themselves outside a jewelry store. Brilliant overhead lights shone down on flashing rings, necklaces, earrings and bracelets. They moved around toward the doorway, and abruptly Ral felt as if he had come to for a moment. Sten, his expression somewhat vacant and staring, was just opening the door. Ral glanced up and saw a man, inside, look Sten's clothes over with pursed lips, study Sten's face, then come forward, beaming, his eyes riveted on Sten. He put an arm around Sten and led him off to a counter. With another hand he beckoned to a girl rearranging necklaces in a showcase. The girl came over. She smiled at Sten, all attention.

With a sort of horrified fascination, Ral watched the girl lead Sten off to another counter, where she modeled bracelets, dangling earrings, and necklaces that flashed like the milky way on a string.

Meanwhile the first man signaled to a second, who whipped out a large pad and came forward to watch Sten and the girl closely, then slide in behind the counter. The girl, still talking, slid out smiling as the man slid in smiling. The man put down the pad and drew out a pencil. Sten was holding a thing that sent out blinding flashes of light as he turned it.

Ral rushed inside, heard the man with the pad say ". . . And just how much did you plan to pay on this per week, sir? How much—May I ask? Just what is your salary?"

Ral grabbed Sten by the arm, wrenched the blazing stone from Sten's grip, and heaved him backwards toward the door. One of the men in the store started toward them staring. Ral sent a blast of friendliness at him, followed it up with an overwhelming jolt of sleepiness, and hastily backed Sten out the doorway. Then he turned him around and walked him fast back toward the hotel.

"What hit me?" said Sten.

"You almost bought a big jewel."

"What in space would I want *that* for?"

"I don't know. But I just got an idea."

They walked rapidly into the hotel past the desk, pouring friendliness and trust at the clerk, made it to their room and lay down.

"This place may not have telepathy," said Sten, "but it certainly has something."

"I know it," said Ral, "but the point we've got to hang onto is that these people are *soft, vulnerable.* Their stuff may be good, and they certainly seem to be able to make people want it, but nevertheless, they're *weak.* We've got to hang onto that fact. They're weak. Soft and weak."

"Yeah," said Sten.

"If we can remember that, we may be able to get our reputations back yet."

"How do we live meanwhile?" said Sten.

"When we were in that department store, I noticed there were people who sold things and people who bought things. Now we can't buy anything. No money. But why couldn't we *sell* things? Maybe that's their strong point, but did they ever try it with *telepathy?*"

"Hm-m-m," said Sten.

They lay back to comb the city for every available scrap of information on salesmanship. Then they washed, carefully combed their hair, cleaned their teeth, examined their fingernails went over the spots on their clothes with a moist towel, polished their shoes as best they could, and set out to look for jobs.

Sten found a job selling washing machines in a department store, and Ral located a job in a used-car lot.

Sales of Jiffy-Swish washers and Double-A-Plus used cars boomed all week.

Unfortunately, Sten and Ral were not satisfied.

They sat on the front porch of the rooming house they'd moved into, and petted the landlady's cat.

"In the first place," said Sten, "the people back home simply don't believe a word of it. Maybe they thought it was funny at first, but now they're getting scared. They say the illusion is too consistent."

"I know," said Ral. "I'd give up if it weren't that these people are so soft. Soft as this animal, this what-do-you-call-it?"

"'Cat,'" said Sten.

"Yes, 'cat.' All fur and love for luxury. Well, if it weren't for that I'd quit. But there's got to be *some* way—"

"Yes," Sten agreed, looking a little glassy-eyed, "that's the way I feel, too. If it weren't that I haven't quite got the down-payment for my lathe—and of course the natives are so weak—I'd quit, too."

Ral stopped stroking the cat, which continued to purr, and stared at Sten. "'Down payment,'" he said. "I thought we agreed not to buy any—"

"Well, we work so hard all the time. Radiating friendliness and fascinated interest all day long is *hard* on a man. I need a little relaxation."

"Well, sure, so do I, but—that stuff may be all right for the people who live here, but it's pretty powerful for us." Ral pulled out a handkerchief and wiped off his brow. "Just this afternoon," he said, "the boss almost sold me a three-tone late-model car."

Sten sat up straight. "What in space do we need a *car* for? The bus goes right past here. The ship is well hidden not over two hours away."

Ral shrugged helplessly. "What do we need a lathe for, either? I tell you, if they weren't such a natural pushover—"

From overhead came an uncanny reverberating crash and thunder. A track of white vapor was drawn across the sky, high up. A group of boys walking past with a bicycle stopped to look up.

"Boy," came their thought, "there goes one of them Sky Slashers. I heard where one of them can carry a city-buster under each wing."

The cat suddenly decided to get up. Ral didn't let go. The cat put forth eighteen claws and got up.

Sten and Ral glanced at the cat, looked up at the track in the sky, and stared at each other.

A chronological report on unidentified flying objects lists for that night a flash of extraordinary brilliance, which traveled from low on the horizon, zoomed skyward, and vanished quickly. The best expert opinion is, it was a lighted weather balloon.

THE END

THE ANALYTICAL LABORATORY

We don't rate the articles in this department, largely because the great difference in intent and character makes them not-commensurable on the same scale of measure as the stories. In the July issue, Isaac Asimov had the lead novelette—"lead" in two senses, as the tabulation below, and the July cover show!—and an article, "The Sea Urchin and We." I don't know quite where it would have rated—but a lot of letters, directed to Asimov or to the magazine here, said, in effect, "Oh, I liked your story in the same issue, too," after one to four pages of discussion on the article.

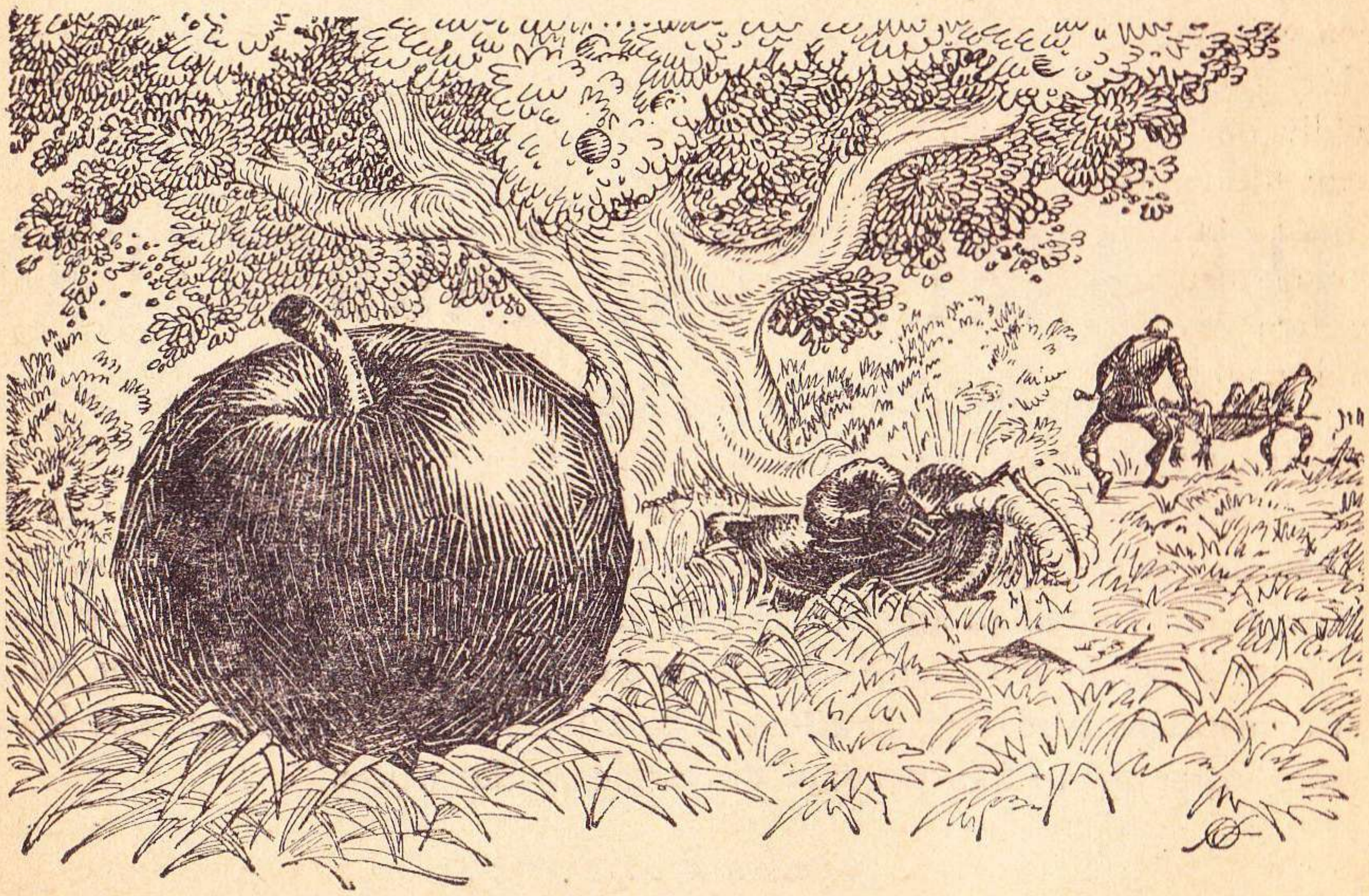
(*Continued on page* 86)

GENTLEMEN:
PLEASE NOTE

Ever wonder what would have happened if the great Isaac had encountered a modern laboratory directorate...?

BY RANDALL GARRETT

Illustrated by Freas



18 June 1957
Trinity College
Cambridge

Sir James Trowbridge
No. 14 Berkeley Mews
London

My dear James,

I'm sorry to have lost touch with you over the past few years; we haven't seen each other since the French War, back in 1948. Nine years! It doesn't seem it.

I'll tell you right off I want a favour of you. (No, I do *not* want to borrow another five shillings! I haven't had my pocket picked again, thank you.) This has to do with a little historical research I'm doing here. I stumbled across something rather queer, and I'm hoping you can help me with it.

I am enclosing copies of some old letters received by Isaac Newton nearly three hundred years ago. As you will notice, they are addressed to "Mr. Isaac Newton, A.B."; it rings oddly on the ear to hear the great man addressed as anything but "your Grace," but of course he was only a young man at the time. He hadn't written his famous *Principia* yet—and wouldn't for twenty years.

Reading these letters is somewhat like listening to a conversation when only one of the speakers is audible, but they seem to indicate another side to the man, one which has not heretofore been brought to light.

Dr. Henry Blake, the mathematician, has looked them over, and he feels that it is possible that Newton stumbled on something that modern thought has only recently come up with—the gravitational and light theories of the Swiss mathematician, Albert Einstein.

I know it's fantastic to think that a man of even Newton's acknowledged genius could have conceived of such things three centuries before their proper place in history, but Blake says it's possible. And if it is, Blake himself will probably do to Newton's correspondents the same thing that was done to Oliver Cromwell at the beginning of the Restoration—disinter the bodies and have them publicly hanged or some such thing.

Actually, Blake has managed to infect me with his excitement; he has pointed out phrases in several of the letters which tally very well with Einstein's theory. But, alas, the information we have is woefully incomplete.

What we need, you see, are Newton's letters—the ones he sent which provoked these answers. We have searched through everything here at Cambridge, and we haven't found even a trace; evidently the Newton manuscripts were simply discarded on the basis that they were worthless, anyway. Besides, records of that sort were poorly kept at that time.

But we thought perhaps the War Office did a somewhat better job of record-keeping.

Now, I realise full well that, due to the present trouble with the Austro-Hungarian Empire the War Office can't take a chance and allow just anyone to prowl through their files.

It wouldn't do to allow one of the Emperor's spies to have a look at them. However, I wondered if it wouldn't be possible for you to use your connexions and influence at the War Office to look for Newton's letters to one of the correspondents, General Sir Edward Ballister-ffoulkes. You can find the approximate dates by checking the datelines on the copies I am sending you.

The manuscripts are arranged in chronological order, just as they were received by Newton himself. Of them all, only the last one, as you will see, is perfectly clear and understandable in all its implications.

Let me know what can be done, will you, old friend?

With best wishes,

SAM

Dr. Samuel Hackett
Department of History

12 November 1666
London

Mr. Isaac Newton, A.B.
Woolsthorpe

Dear Mr. Newton:

It was very good of you to offer your services to His Majesty's Government at this time. The situation on the Continent, while not dangerous in the extreme, is certainly capable of becoming so.

Your letter was naturally referred to me, since no one else at the War Office would have any need for the services of a trained mathematician.

According to your précis, you have done most of your work in geometry and algebra. I feel that these fields may be precisely what are needed in our programme, and, although you have had no experience, your record at Trinity College is certainly good enough to warrant our using your services.

If you will fill in the enclosed application blank, along with the proper recommendations and endorsements, we can put you to work immediately.

Sincerely,

Edward Ballister-ffoulkes, Bart.
General of Artillery
Ballistics Research Dept.

12 November 1666
Cambridge

Mr. Isaac Newton, A.B.
Woolsthorpe

My dear Isaac,

I am sorry to hear of your decision to remain at home for a while longer instead of returning to the College, but if you feel that your health is delicate, by all means rest until you are in better spirits.

I think, however, that you should attempt to return as soon as possible; you have a great deal of work ahead of you, my boy. Mathematicians—like Rome—are not built in a day—nor in four years.

If, however, you would like to do a part of your studies by post, I see no objection to it, under the circumstances, although, of course, it will be necessary to spend a part of your time in residence here, and the final examinations will have to be taken here.

Later on, when you are feeling

better, I will send an outline of some work I intend to do on conic sections; I think it would be of great benefit to you to work with me on this. I have always had confidence in your ability. You are young yet, but, given time and plenty of study, you should make a place for yourself in the world of mathematics.

I think that the work I have in mind for you should prove stimulating.

Most sincerely,
Isaac Barrow, Ph.D.

16 November 1666
London

Dear Mr. Newton:

It would most certainly be quite convenient for you to do your work there at Woolsthorpe.

An explanation of the work we are trying to do and some of the problems we are up against will be despatched to you as soon as possible.

Sincerely,
Ballister-ffoulkes

21 November 1666
Cambridge

My dear Isaac,

Your paper has arrived. I haven't had time to look it over yet, but I shall find time to peruse it during the forthcoming hol'days. I am, of course, very interested in what problems concerned you during the summer.

A very merry Christmas to you, my boy.

Is. Barrow

22 November 1666

FROM: Ballistics Research Dept., British Army Artillery
TO: Isaac Newton, A.B., Woolsthorpe
SUBJECT: Ballistics research data.
ENCLOSURE: Range table sample for 9-lb. artillery.
2nd ENCLOSURE: Outline and general discussion of ballistics

1. In order to better understand the problems facing this Department, you will familiarise yourself with the enclosed material.

2. This material is confidential, and is not to be allowed to fall into unauthorised hands.

By order of the Commanding General

SECOND ENCLOSURE

The purpose of this project is to determine, with as great a degree of precision as possible, the range of artillery used by His Majesty's Armed Forces, and the methods of accurately firing upon targets at various distances from the cannon.

After a great deal of research, the following factors have been found to affect the distance which a cannon ball may be hurled by exploding gunpowder:

1. Weight of the cannon ball.
2. Weight of powder used.
3. Angle of elevation of cannon.
4. Length of cannon barrel.

The first two factors are obvious; the heavier the cannon ball, the

more powder it will take to blow it a certain distance, and contrariwise.

The third is somewhat unwieldly to work with and definitely problematical in its effects. Up to a certain point, increasing the angle seems to increase the range, but after that point is reached, an increase in elevation decreases the range of the weapon. In view of this, it has been decided that all cannon will be fixed at the best angle for maximum range and the other factors varied to change the actual distance the cannon ball is fired.

(Here it may be noted, incidentally, that the angle of elevation is of no use in the Royal Navy, since that angle is indeterminate, due to the roll of the ship.)

The fourth factor, too, may be discarded, since a barrel of too great a length would make it unwieldy on the battlefield, although those of fixed fortresses could be somewhat greater. And, in view of the fact that changing the length of a cannon barrel on the field is out of the question, we may safely say that the fourth factor is a fixed quantity in each cannon and thus ignore it.

It has, therefore, been decided to test each of the various types of cannon presently in use by Army Artillery and publish for each a range table for various cannon balls and charges of powder, and to furnish a copy of such table to the battery leader of each field piece.

This programme, as may well be imagined, has required a great deal of cannon testing in the past year, and will undoubtedly require a great deal more before the project is finished. We hope, however, that it will be of at least limited use in the very near future, and will eventually greatly advance the science of cannon-firing.

2 January 1667

My dear Isaac,

Your Christmas was, I trust, a pleasant one? I hope your mother is in good health, and I hope your own is improved.

My dear boy, I have some advice for you; I do hope that you will take it as it is intended—as from an old friend and tutor who wishes you only well.

It has come to my attention that you are—shall we say—prostituting your talents. A friend of mine who works at the War Office tells me that you are doing some mathematical work by correspondence—something to do with cannon, I believe.

Now, I quite understand that you are in a somewhat precarious financial position, and believe me, I deeply sympathise with you. I know that the earning of a few pounds can mean a great deal to you in furthering your education.

I do not say that such work is menial, either. I would not have you think that I deplore your choice of work in any way; it is necessary work, and money is certainly necessary for life.

However, let me warn you: a simple task like this, which pays rather well, can become soporific in its

effect. Many men of talent, finding themselves comfortably fixed in a mediocre position, have found their minds have become stultified through long disuse. *Please,* dear boy, don't fall into that trap; don't throw away a fine career in mathematics for the sake of a few paltry pounds. You are young and inexperienced, I know, and have a great deal yet to learn, so please take the advice of one who is somewhat older and wiser.

No, I haven't gotten round to reading your paper yet; I'll do it this evening, my boy, I promise.

Most sincerely,

Isaac Barrow

3 January 1667
Cambridge

My dear Isaac,

I read your paper, and I am, I must confess, somewhat nonplussed. What *are* you doing?

I see that my letter of yesterday was somewhat premature; I should have waited until I had read your paper, since it is in exactly the same category.

You ask: "What is the optimum shape for a wine barrel? Should it be tall and thin, or squat and broad?"

And I ask: "What on Earth difference does it make?"

Surely you are not thinking of becoming a wine merchant? If so, what need is there to waste your time studying mathematics? On the other hand, if you intend to become a mathematician, why should you debase a noble and lofty study by applying it to wine barrels?

As I told you, I have no objection to your making a few pounds by doing minor calculations for the Army, but this is foolishness. You have gone to a great deal of trouble for nothing; as you gain more experience, you will realize the folly of such things.

As to your theory of "fluxions," I admit myself to be completely at a loss. You seem to be assuming that a curve is made up of an infinite number of infinitely small lines. Where is your authority for such a statement? You append no bibliography and no references, and I cannot find it in the literature.

Apparently, you are attempting to handle *zero* and *infinity* as though they were arithmetical entities. Where did you learn such nonsense?

My boy, please keep it in mind that four years of undergraduate work does not qualify one as a mathematician. It is merely the first stepping stone on the way. You have a great deal of studying yet to do, a great many books yet to read and absorb—books, I may say, written by men older, wiser, and more learned than yourself.

Please don't waste your time with such frivolous nonsense as toying with symbols derived from wine barrels. No good can come out of a wine barrel, my boy.

I hope you will soon find yourself in a position to aid me in some of the calculations on conic sections as I outlined them to you in my letter

of the 28th December last.* I feel that this is important work and will do a great deal to further your career.

With all best wishes,
Sincerely,
Isaac Barrow

* This letter was either lost or returned to Dr. Barrow.—S. H.

5 January 1667
London

Dear Mr. Newton:

Thank you for your tabulations on the seven-pounder. I must say you were very prompt in your work; there was no need to work over the holidays.

Your questions show that you are unacquainted with the difficulties of manufacturing military arms; I am not at all surprised at this, because it takes years of training and practical experience in order to learn how to handle the various problems that come up. It is something that no university or college can teach, nor can it be learned from books; only

experience in the field can teach it, and you have had none of that.

I can, however, explain our method of approach thus:

Each cannon to be tested is fired with several balls—some of iron, some of lead, some of brass, and some which have been hollowed out to make room for a charge of gunpowder in order that they may explode upon reaching the target. With each type of ball, we find the amount of powder required to drive the ball five yards from the muzzle of the piece; this is considered the minimum range. (Naturally, with the testing of hollow, explosive missiles, we do not fill them with gunpowder, but with common earth of equal weight. To do otherwise would endanger the cannoneer.)

After the minimum range is found, more balls are fired, using greater amounts of powder, added in carefully measured increments, and the distance achieved is measured off.

This process is kept up until the safety limit of the weapon is reached; this point is considered the maximum range.

Naturally, the weights of different balls will vary, even if they are made of the same metal, and the bores of cannon will vary, too, but that can't be helped. What would you have us do? Make all cannon identical to the nearest quarter-inch? It would not be at all practical.

I am happy to see that you are enthusiastic over the work we are doing, but please, I beg you, wait until you have learned a great deal more about the problem than you have done before you attempt to make suggestions of such a nature.

As to the paper which you enclosed with your tabulations, I am afraid that it was of little interest to me. I am a military man, not a mathematician.

Thanking you again for your excellent work, I remain.

Yours sincerely,
Edward Ballister-ffoulkes, Bart.

9 January 1667
Cambridge

My dear Isaac,

I have known you for more than five years, and I have, I might say, a more than parental interest in you and your career. Therefore, I feel it my duty to point out to you once again that your erratic temper will one day do you great harm unless you learn to curb it.

You take me to task for saying to you what is most certainly true, viz.: that you are not yet a mathematician in the full sense of the word. You are young yet. When you have put in as many years at study as I have, you will understand how little you now know. Youth is inclined to be impetuous, to rush in, as the saying goes, where angels fear to tread. But better men than yourself have come to realise that the brashness of youth is no substitute for the wisdom of maturity.

As to your other remarks, you know perfectly well what I meant when I said that no good can come out of a wine barrel. To accuse me of sacrilege and blasphemy is ridiculous. You are twisting my words.

Please let us have no more of this name-calling, and get down to more important work.

Sincerely,
Isaac Barrow

12 January 1667
London

Dear Mr. Newton:

Thank you again for your rapid work in tabulating our results. It is most gratifying to find a young man with such zeal for his work.

As I have said before, I am no mathematician, but I must confess that your explanation makes very little more sense to me than your original mathematical formulae.

As I understand it, you are proposing a set of equations which will show the range of any weapon by computing the weight of the ball against the weight of the powder. (Perhaps I err here, but that is my

understanding.) It seems to me that you are building a castle-in-Spain on rather insubstantial ground. Where is your data? What research have you done on cannon-fire? Without a considerable body of facts to work with, such broad generalisations as you propose are quite out of order.

Even if such a thing could be done —which, pardon me, I take the liberty to doubt—I fear it would be impractical. I realise that you know nothing of military problems, so I must point out to you that our cannoneers are enlisted men—untutored, rough soldiers, not educated gentlemen. Many of them cannot read, much less compute abstruse geometrical formulae. It will be difficult enough to teach them to use the range tables when we complete them.

Indeed, I may say that this last point is one of the many stumbling-blocks in the path of our project. More than one of the staff at the War Office has considered it to be insurmountable, and many times I have fought for the continuance of the research in the face of great opposition.

I greatly fear that using any but methods known to be practicable would result in our appropriation being cut off in Parliament.

Again, however, I thank you for your interest.

Most sincerely,

Ballister-ffoulkes

24 January 1667
Cambridge

My dear Isaac,

I am truly sorry I didn't get around to looking over your second manuscript until now, but, to be perfectly truthful, I have been outlining our course of work on conic sections, and had little time for it.

As it turns out, it was all for the best that I did so; it would have been sinful to take valuable time away from my work for such trivialities.

You are still harping on your wine-barrel fluxions and your Army cannon balls. Am I to presume that the whole thing is a joke? Or are you seriously proposing that the path of a cannon ball is related to the phases of the moon? That is rank superstition! Sheer magic! One would think that even a lad as young as yourself would have grasped the basic concept of the Scientific Method by this time.

How have you tested this absurd thing experimentally? Where are your measurements, your data? Your references?

Do not think, my boy, that fame and fortune in the sciences can be achieved by pulling wild hypotheses out of your imagination. There is no short-cut to mastery of a difficult subject like mathematics; it requires years of hard work and study.

As an example of what can happen when one has not learned enough of the subject, look at your own work. You appear to be handling Time as though it were a spatial dimension. You even end up, in several equations, with square seconds! Now, a yardstick will show that a foot up-and-down is the same

as a foot East-and-West or a foot North-and-South. But where can you find a foot of time?

Please, dear boy, use your time to study the things you have yet to learn; don't waste it exploring a nonsensical cul-de-sac.

I will send you the outline on conic sections within the week.

Sincerely,
Isaac Barrow

1 February 1667
London

Dear Mr. Newton:

In reference to your letter of 14 January 1667, on the simplified algebraic formulae for the prediction of the paths of cannon balls, our staff has considered the matter and found that not only is your mathematics incomprehensibly confusing, but the results are highly inaccurate. Where, may I ask, did you get such data as that? On what experimental evidence do you base your deductions? The actual data we have on hand are not at all in agreement with your computations.

Men with more experience than yours, sir, have been working on this problem for several years, and nothing in our results suggests anything like what you put forth. Finding data is a matter of hard work and observation, not of sitting back in one's armchair and letting one's mind wander.

It would, indeed, be gratifying if our cannon would shoot as far as your equations say they should—but they do not. I am afraid we shall have to depend on our test results rather than on your theories. It is fact—not fancy—which is required in dealing with military operations.

Sincerely,
Edward Ballister-ffoulkes, Bart.
General, Army Artillery

3 February 1667
Cambridge

My dear Isaac:

I feel it would clear the air all round if we came to an understanding on this thing. Your continued insistence that I pay attention to theories which have no corroboration in the literature and are based on, to say the least, insufficient confirmatory data, is becoming tedious. Permit me, as a friend, to show you where, in your youthful impetuosity, you err.

In the first place, your contention that there is a similarity between the path of a cannon ball and the motion of the moon is patently ridiculous. I cannot imagine where you obtained such erroneous information. A cannon ball, when fired, strikes the earth within seconds; the moon, as anyone knows, has been in the sky since—according to Bishop Ussher—4004 B.C. Your contention that it remains held up by a force which pulls it down is verbal nonsense. Such a statement is semantically nothing but pure noise.

You state that the path followed by a cannon ball is parabolic in nature. How do you know? Can you honestly say that you have measured the path of a cannon ball? Have you traced its path, measured it, and

analysed it mathematically? Can you prove analytically that it is not an hyperbola or part of an ellipse? Have you any data whatsoever to back up your statements, or any authority to which you can refer?

You make broad generalisations on the assumption that "every body is attracted equally to every other body"; that the earth attracts the moon in the same way that it attracts an apple or a cannon ball. Where is your data? You have not, I dare say, measured the attraction between every body in the universe. Have you checked the variations in apples according to sugar content or the variations in cannon balls with reference to their diameters? If not, have you checked with any reliable authority to see if such work has already been done?

And where did you learn that anyone can just sit down and make up one's own mathematical systems? I am certain that I taught you no such thing. Mathematics, my boy, is based on logical interpretation of known facts. One cannot just go off half-cocked and make up one's own system. What would happen to mathematics as a science if anyone should just arbitrarily decide that two added to two yields five or that two multiplied by two equals one hundred?

You said that the whole thing came to you "in a flash" last summer when you were sitting under an apple tree and one of the fruit fell and struck you on the head. I suggest that you see a good physician; blows on the head often have queer effects.

If you have the data to prove your contentions, and can show how your postulates were logically deduced, then I will be very happy to discuss the problem with you.

As soon as you feel better, and are in a more reasonable frame of mind, I hope you will return to Cambridge and continue with the studies which you so badly need.

Sincerely,

Dr. Isaac Barrow

P.S.: It occurs to me that you may have meant your whole scheme as some sort of straight-faced pseudo-scientific joke, similar to that of another gentleman who bears our common Christian name.* If so, I fail to comprehend it, but if you would be so kind as to explain it to me, I will be only too happy to apologise for anything I have said.

Is. Barrow

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* I have no idea who this might be. The reference is as obscure as the joke.—S.H.

8 February 1667
London

Dear Mr. Newton:

I have tried to be patient with you, but your last letter was sulphurous beyond all reason. I may not, as you intimate, be qualified to judge the mathematical worth of your theories, but I can and do feel qualified to judge their practical worth.

For instance, you claim that the reason your computations did not tally with the data obtained from actual tests was that the cannon ball was flying through the air instead of a

vacuum. By whose authority do you claim it would act thus-and-so in a vacuum? Do you have any data to substantiate your claim? Have you ever fired a cannon in a vacuum? For that matter have you ever fired a cannon?

What would you have our cannoneers do—use a giant-sized Von Guericke Air Pump to evacuate the space between the cannon and the target? I fear this would be, to say the very least, somewhat impractical and even dangerous under battle conditions. I presume a tube of some kind would have to be built between the enemy target and the gun emplacement, and I dare say that by that time the enemy would become suspicious and move the target.

You speak of "ideal conditions." My dear Newton, kindly keep it in mind that battles are never fought under ideal conditions; if they were, we should always win them.

If you wish to spend your time playing with airy-fairy mathematical abstrusities which have no basis in fact, that is perfectly all right with me. This is a free country, and no one proposes to dictate one's private life. However, I would appreciate it if you would do me the honor of not burdening my already overtaxed mind with such patent nonsense.

Otherwise, your work with the tabulations has been most excellent; I am enclosing a cheque for £20 to cover your work so far.

Sincerely,

Edward Ballister-ffoulkes, Bart.

12 February 1667

Cambridge

My dear Newton:

You have stretched the bonds of friendship too far. You have presumed upon me as a friend, and have quite evidently forgotten my position as head of the Department of Mathematics at this College.

The harsh language in which you have presumed to address me is too shocking for any self-respecting man to bear, and I, for one, refuse to accept such language from my social inferiors. As a Professor of Mathematics in one of the most ancient of universities, I will not allow myself or my position to be ridiculed by a young jackanapes who has no respect for those in authority or for his elders.

Your childish twaddle about glass prisms producing rainbows—a fact which any schoolboy knows—is bad enough; but to say that I am such a fool that I would refuse to recognise "one of the most important advances in mathematics" is beyond the pale of social intercourse.

Repeatedly during the last few months, you have attempted to foist off on me and others implausible and unscientific theories which have no basis whatever in fact and which no reputable scientist would be foolish enough to endorse. You are not a mathematician, sir; you are a charlatan and a mountebank!

You have no data; you admit working from "intuition" and hypotheses cut out of whole cloth; you cannot and will not give any re-

liable authority for any of your statements, nor will you accept the reliable statements of better men than yourself.

This unseemly behaviour forces me to exercise my prerogative and my authority in defence of the college and the university. I shall recommend to the authorities that you be refused readmission.

Isaac Barrow, Ph.D.
Department of Mathematics
Trinity College

16 February 1667

FROM: Ballistics Research Department, Army Artillery
TO: Mr. Isaac Newton, A.B., Woolsthorpe
SUBJECT: Reduction in personnell
ENCLOSURE: Cheque for £2/10s/6d

1. In view of the increased personality friction between yourself and certain members of this department, this department feels that it would be to our mutual disadvantage to continue retaining your services as mathematical consultant.

2. As of 16 February 1667 your employment is hereby terminated.

3. Enclosed is a cheque covering your services from 8 February 1667 to date.

By order of the Commanding General
Major Rupert Knowles,
Adjutant
for

General Sir Edward Ballister-ffoulkes

12 March 1667
Whitehall

My dear fellow,

I am making this communication quite informal because of your equally informal method of—shall we say—getting my ear.

I have been nagged at day and night for the past three weeks by a certain lady of our mutual acquaintance; she wants me to "do something for that nice young Mr. Newton." She seems to think you are a man of some intelligence, so, more in order to stop her nagging tongue than anything else, I have personally investigated the circumstances of your set-to with the Ballistics Research Department.

I have spoken with General B-f, and looked over all the correspondence. Can't make head or tail of what you're talking about, myself, but that's beside the point. I did notice that your language toward the general became somewhat acid toward the last. Can't actually say I blame you; the military mind can get a bit stiff at times.

And I'm afraid it's for that very reason that my hands are tied. You can't expect a man to run a kingdom if he doesn't back up his general officers, now, can you? Political history and the history of my own family show that the monarch is much better off if the Army and Navy are behind him.

So I'm afraid that, our little lady notwithstanding, I must refuse to interfere in this matter.

CAROLUS II REX

19 March 1667
Whitehall

Newton:

No! That is my final word!

C II R

21 May 1667
Cambridge

My dear Isaac,

Please accept the humble apologies of an old friend; I have erred, and I beg you, in your Christian charity, to forgive me. I did not realise at the time I wrote my last letter that you were ill and overwrought, and I have not written since then because of your condition.

As a matter of fact, when your dear mother wrote and told me of your unbalanced state of mind, I wanted desperately to say something to you, but the blessed woman assured me that you were in no condition for communication.

Believe me, my dear boy, had I had any inkling at all of how ill you really were, I should have shown greater forbearance than to address you in such an uncharitable manner. Forgive me for an ungoverned tongue and a hasty pen.

I see now that the error was mine, and it has preyed on my mind for these many weeks. I should have recognised instantly that your letters to me were the work of a feverish mind and a disordered imagination.

I shall never forgive myself for not understanding it at the time.

As to your returning to the College for further study, please rest assured that you are most certainly welcome to return. I have spoken to the proper authorities, and, after an explanation of the nature of your illness, all barriers to your re-entrance have been dropped. Let me assure you that they are well aware of what such an unhappy affliction can do to unsettle a man temporarily, and they understand and sympathise.

I can well understand your decision not to continue your studies in mathematics; I feel that overwork in attempting something that was a bit beyond one of your tender years was as much responsible for your condition as that blow on the head from that apple. It is probably that which accounts for the fact that serious symptoms did not appear until late in March.

I feel that you will do well in whatever new field you may choose, but please do not work so hard at it.

Again, my apologies,

Isaac Barrow

3 April 1687
York

To His Grace,
The Most Reverend Dr. Isaac
Newton,
By Divine Providence the Lord
Archbishop of Canterbury
My Lord Archbishop,

May I take this opportunity to give you my earnest and heartfelt thanks for the copy of your great work which you so graciously sent; I shall treasure it always.

May I say, your Grace, that, once I had begun the book, I found it almost impossible to lay it down again. In truth, I could not rest until I had completed it, and now I feel that I shall have to read it again and again.

In my humble opinion, your Grace is the greatest theological logician since the Angelic Doctor, St. Thomas Aquinas. And as for beauty and lucidity of writing, it ranks easily with *"De Civitate Deo"* of St. Augustine of Hippo, and *"De Imitatione Christi"* of St. Thomas á Kempis.

I was most especially impressed by your reasoning on the mystical levitation of the soul, in which you show clearly that the closer a human soul approaches the perfection of God, the greater the attraction between that soul and the Spirit of God.

Surely it must be clear to anyone that the more saintly a man becomes, the greater his love for God, and the greater God's love for His servant; and yet, you have put it so clearly and concisely, with such beautifully worded theological reasoning, that it becomes infinitely more clear. It is almost as though one could, in some mystical way, measure the distance between an individual soul and the Holy Presence of God by the measure of the mutual love and attraction between that soul and the Blessed Trinity.

Your masterful analysis of the relative worthiness of those who have

come to the Kingdom of Heaven on the Day of Judgment is almost awe-inspiring in its beauty. Even those souls which have been cleansed as white as snow by the forgiving Grace of God differ, one from another, and your comparison between those souls and a ray of pure white light striking a prism of clearest crystal is magnificent.

The Church has always held that those whose entire lives have been lived in holy purity and in the Grace of God would hold a higher place in Heaven than those whose lives have been sinful, even though God, in His graciousness, has forgiven them their sins. But no one had shown how this might be so. Your analogy, showing how the white light of the sun may be graded into the colours of the rainbow, ranging from red to violet, illustrates wonderfully how Our Lord will grade His chosen servants on the Last Day, when the sinful souls of the damned are cast into Darkness.

There are other instances, almost too numerous to mention, which show your immense theological understanding and deep thought. So thought-provoking are they that I would not dare to comment on them until I have re-read and studied them carefully, for fear I should show my own shallowness of mind.

It is my belief that your "*Principia Theologica*" will be read, honored, and loved by Christians for many centuries to come.

I shall, of course, write to you further and at greater length on this monumental work.

Praying for God's blessing on you and your work, and for the fullness of God's grace during the coming Eastertide,

I am,

Most faithfully yours,
William Sancroft
By Divine Permission
Lord Archbishop of York

THE END

THE ANALYTICAL LABORATORY

(*Continued from page 69*)

In any case, the score came out:

	STORY	AUTHOR	POINTS
1.	Profession	Isaac Asimov	1.82
2.	The Best Policy	David Gordon	2.41
3.	Divine Right	Lester del Rey	2.58
4.	Hot Potato	Algis Budrys	4.00
5.	Run Of The Mill	Robert Silverberg	4.36

THE EDITOR.

OVERFLOWING THE PERIODIC TABLE

BY ISAAC ASIMOV

The "Sound of Panting" problem—keeping up with the literature—pursues Asimov even beyond the end of the periodic table of elements. This was written before Nobelium had been constructed. A hard-working science fiction writer can't even keep up, let alone get ahead, of things these days.

Between 1898 and 1913, about forty elements were discovered, more than in any like period before or since. Of course, most of those elements turned out not to be elements. In fact, only five survived. Nevertheless, the names of all forty are still in the books to this very day to confuse and confound the student.

The trouble was that, prior to 1913, no chemist had ever heard of isotopes. In the innocent days preceding World War I, each element was considered to have its own particular type of atom with a particular atomic weight. All atoms of a given element had the same weight and this weight was different from that of all atoms of all other elements.

Each element had its own unique set of properties and, conversely, whenever you found two elementary substances with different sets of properties, you were obviously dealing with two different elements.

Obvious, yes—but wrong!

What is really unique about an element is its atomic number and not its atomic weight, but the atomic number wasn't discovered until 1913, either. The atomic number of an atom is equal to the number of pro-

tons in its nucleus, which is in turn equal to the number of electrons in the outer reaches of the atom.

It is the number of electrons in an atom that determines its chemical properties. It follows then that all atoms with the same atomic number have the same chemical properties and vice versa.

The atomic weight of an atom—which was the property that chemists, prior to 1913, had thought to be crucial—is equal to the number of protons plus neutrons in the nucleus. (The neutrons don't affect the number of electrons in an atom, hence don't affect the chemical properties.)

Suppose one atom has x protons and y neutrons in the nucleus and another atom has x protons and z neutrons in the nucleus. Both have the same atomic number, x, so both have the same chemical properties. The atomic weights, however, are different. The first has an atomic weight of x + y, the second has one of x + z. The two atoms are isotopes of the same element.

As a matter of fact, most of the elements are made up of two or more isotopes. In each case, the chemical properties of the isotopes are just about indistinguishable, so no one noticed them.

But then, in 1896, radioactivity was discovered. Different isotopes of an element might and did turn out to have radically different radioactive properties.

The radioactive properties of an atom, you see, depend on the stability of the nucleus and that depends on the number and interrelationships of both protons and neutrons in that nucleus. Add one neutron to a nucleus and though the chemical properties of the atom as a whole are unaffected, the balance of the nucleus may be radically altered. The nucleus may be changed from a stable one to an unstable one or vice versa. It might alter the degree of instability.

Between 1896, then, when chemists first started studying and measuring the radioactive properties of elements, and 1913, when the British chemist, Frederick Soddy, had completely worked out the theory of isotopes—without the proton and neutron details, since neutrons weren't discovered till 1931—what happened to chemistry shouldn't happen to a dog.

To begin with, two elements were known which turned out to be radioactive. In 1896, the French chemist, Antoine-Henri Becquerel, made the first discovery when he found that a *uranium* compound would fog a photographic plate in complete darkness. In 1898, Marie Sklodowska Curie—a Polish chemist working in France—discovered that *thorium* was radioactive. In 1896, uranium had been known for one hundred and seven years. In 1898, thorium had been known for sixty-nine years.

Next, Madame Curie made an important observation. She was working with pitchblende, an ore that contained uranium atoms. She knew how much uranium was contained in a given amount of that sample of

ore. She knew how much radioactivity was to be expected of that amount of uranium.

What she didn't know was why the pitchblende should be producing four to five times as much radioactivity as was to be accounted for by the uranium content. Conclusion: There was something in the pitchblende, besides uranium, that was radioactive.

But she knew practically everything that was in the pitchblende and none of it was radioactive except for the uranium. Further conclusion: The extra radioactivity came from some element that was present only in traces and if such a trace element produced all that radioactivity, it had to be a devil of a lot more radioactive than uranium.

Marie Curie and her husband, Pierre, started looking. In July, 1898, they discovered a new element, *polonium,* and in December, 1898, they discovered another new element, *radium.*

So far, so good, but chemists couldn't stop. For ten more years, they kept discovering elements.

In 1900, the British chemist, Sir William Crookes, found that he could isolate from a solution of a uranium compound, a substance which was more active than uranium. Since it displayed radioactive properties that were different from those of any known element, it had to be a new element. He hadn't the slightest idea of any of its other properties since radioactivity could be studied quite adequately in amounts of substances too small to test directly by any ordinary chemical method. So he called it simply *uranium X.*

But then, other men isolated other substances from uranium, also with new and different radioactive properties and therefore considered to be new and different elements. What Crookes had called uranium X became *uranium* X_1 and another substance became *uranium* X_2. There was also a *uranium Z.* Ordinary uranium was called *uranium I* and there was also a *uranium II.*

Each of the uraniums was given a different symbol as was their right. (After all, weren't they different elements?) Uranium I was UI and uranium II was UII. There was also UX_1 and UX_2. A *uranium Y* was discovered (UY) and furthermore there was a variety of uranium that gave rise to a different set of radioactive substances altogether. It was called *actino-uranium,* and its symbol was AcU.

These names sound provisional, you see, and the symbols do, too, because they're not like the symbols for other elements. The hope was that when enough was collected of each of these new radioactive elements to enable other, more usual properties to be studied, why, then other and more reasonable names would be given them.

Occasionally, some chemists jumped the gun. For instance Kasimir Fajans—an American chemist—and O. H. Göhring—a German—who dis-

covered uranium X_2 in 1913, called it *brevium* from the Latin word meaning "short" because it existed for such a short time. (It had a half-life of just over one minute.) The name didn't stick, however.

Another example of that involves the American chemist, B. B. Boltwood and co-workers who, in 1904, first showed that radium was produced as one of the products of uranium breakdown. In 1907, Boltwood further showed that there was an element in between. It was formed from uranium and broke down into radium and had properties different from either. He called the new element *ionium*—symbol, Io—because, like all radioactive elements, it produced ions in the substances it irradiated. That name stuck.

The German physicist, Friedrich Ernst Dorn had shown in 1900 that when radium broke down, a gas was produced. Since the gas emanated—that is, flowed forth—from radium, it was first called *radium emanation.* However, since the gas was shown to resemble the inert gases—argon, neon, et cetera—in chemical properties, it was given a name of similar form, *niton*—from a Greek word meaning "shining." Later, *radon* was substituted, in order to show the relationship to radium, and that name became official.

Thorium also gave rise to a gas with inert gas properties. This was first called *thorium emanation* and then *thoron.*

Actino-uranium was found to break down to *protactinium* and then to *actinium.* In fact, actinium was discovered first. The French chemist, Andre Debierne discovered it in 1899 and named it from a Greek word meaning "ray." In 1917, Otto Hahn—German—and Lise Meitner—Austrian—discovered protactinium and named it that because it was the ancestor of actinium. Later still, when a variety of uranium was found to produce protactinium, it was called actino-uranium.

However, the point is that actinium in breaking down gives rise to a gas which was called *actinium emanation* or *actinon.*

That's three radioactive gases, radon, thoron and actinon, each with different radioactive properties, and hence to all appearances, three separate elements. What's more, all three were inert gases and there just wasn't any room in the periodic table for three new inert gases. Chemists were turning good and sick by then.

Between 1902 and 1904, the British physicist, Sir Ernest Rutherford found that radon broke down in a series of steps which could be followed by changes in characteristic radioactive properties. He called the individual products, *radium A, radium B, radium C, radium D, radium E, radium F,* and *radium G.* Radium F, it turned out, was the polonium that had been discovered six years earlier by the Curies. Radium G was, finally, a stable compound. In fact, it was lead.

Each of these different substances possessed its own symbol, RaA, RaB, RaC and so on. When further

studies by the team of Hahn and Meitner discovered two radioactive substances between radium C and radium D—this was in 1909—what were they to be called but radium C' and radium C''.

The whole succession of elements, worked out between 1900 and 1909, from uranium down through the other uraniums, ionium, radium, radon and then the remaining radiums was called the uranium-radium series.

As a result of the work of a number of chemists and physicists of all nations—I have been stressing nationalities in this article to show how international scientific research is—it was show that actinon and thoron both broke down in a series of steps similar to that of radon. As a result the substances, *actinium A, actinium B, actinium C, actinium C', actinium C'', actinium D, thorium A, thorium B, thorium C, thorium C', thorium C''* and *thorium D* were discovered. One set belonged to what was then termed the actinium series, the other to the thorium series. Three independent radioactive breakdown series were thus worked out.

Furthermore, Hahn started the research which ended in discovering the substances produced in the thorium series between thorium itself and thoron. These included *mesothorium I, mesothorium II, radiothorium,* and *thorium X.*

By 1913, the horrible facts of the matter were this. There were about forty types of radioactive substances known, each one different from the rest. By all the rules of chemistry they seemed to be forty different elements. All of them had to fit into the periodic table between element number 82 (lead) and element number 92 (uranium).

Slice it however you wished that meant trying to squeeze forty elements into a place where only nine elements could go. Something had to give; either the periodic table or chemists' notions about elements. Down went the notions. Up went new and better notions.

The first hint of the new notions came as early as 1900 in the case of radium D—which was not yet known as radium D. The German chemists, K. A. Hofmann and E. Strauss noticed that it seemed to behave a good deal like lead. The more it was studied, the closer the resemblance grew. If it were mixed with lead, it couldn't be separated out again, no matter what. People took to calling it radium D, *radio-lead.*

And yet this was awfully disturbing. Radium D was radioactive and lead was not. To suppose that radium D was a kind of lead was to suppose that the same element could have two sets of properties and that was a very hard supposition to swallow at the time.

It took ten years for the inevitable conclusion to grind its way into acceptance. The American chemists, Herbert N. McCoy and W. H. Ross in 1904 through 1907 pointed out the identical behaviors (chemically speaking) of certain other radioactive

TABLE

Element	*Isotope*	*Phantom Element*
Uranium (atomic No. 92)	uranium-238	uranium I
	uranium-235	actino-uranium
	uranium-234	uranium II
Protactinium (atomic No. 91)	protactinium-234	uranium X_2, brevium
		uranium Z
	protactinium-231	protactinium
Thorium (atomic No. 90)	thorium-234	uranium X_1
	thorium-232	thorium
	thorium-231	uranium Y
	thorium-230	ionium
	thorium-228	radiothorium
	thorium-227	radioactinium
Actinium (atomic No. 89)	actinium-228	mesothorium 2
	actinium-227	actinium
Radium (atomic No. 88)	radium-228	mesothorium 1
	radium-226	radium
	radium-224	thorium X
	radium-223	actinium X
Radon (atomic No. 86)	radon-222	radium emanation, niton, radon
	radon-220	thorium emanation, thoron
	radon-219	actinium emanation, actinon

Polonium (atomic No. 84)	polonium-218	radium A
	polonium-216	thorium A
	polonium-215	actinium A
	polonium-214	radium C'
	polonium-212	thorium C'
	polonium-211	actinium C'
	polonium-210	radium F
Bismuth (atomic No. 83)	bismuth-214	radium C
	bismuth-212	thorium C
	bismuth-211	actinium C
	bismuth-210	radium E
Lead (atomic No. 82)	lead-214	radium B
	lead-212	thorium B
	lead-211	actinium B
	lead-210	radium D, radio-lead
	lead-208 (stable)	thorium D, thorium-lead
	lead-207 (stable)	actinium D, actinium-lead
	lead-206 (stable)	radium G,
Thallium (atomic No. 81)	thallium-210	radium C''
	thallium-208	thorium C''
	thallium-207	actinium C''

substances which had different properties (radioactively speaking). Still, things hung fire.

Then, in the period 1911 to 1913, Frederick Soddy advanced his theory of isotopes and described how one isotope broke down to another according to whether it emitted an alpha particle or a beta particle. An alpha particle emission meant a decrease of two in atomic number and four in atomic weight. A beta particle emission meant an increase of one in atomic number, no change in atomic weight.

If this were so then the lead with which all three of the radioactive series end—radium G, actinium D and thorium D—were not merely lead, but were different varieties of lead.

(In those days, that sounded like saying "triangles with different numbers of sides.") Radium G ought to be lead with an atomic weight of 206; actinium D, lead with an atomic weight of 207; and thorium D, lead with an atomic weight of 208.

Now good old ordinary lead, the kind you dig out of the ground, has an atomic weight of 207.21. Everyone knew that. It had been very carefully measured by extremely capable chemists.

You can imagine the excitement, then, when, in 1914, the Harvard chemist, Theodore W. Richards, announced that the atomic weight of lead isolated from uranium ores was far below 207.21.

From that moment on, there was no further question. The isotope theory was accepted. It explained almost everything. For instance, radon, actinon, and thoron are all isotopes of the same element. Only one place in the periodic table need be found, not three, and one place was ready and waiting. (The element is today called radon, but some people wonder if a better name might not be *emanon,* covering all three "emanations" and not preferring one to the others.)

One later improvement that had to be made on Soddy's theory was to allow for the existence of nuclear isomers. That is, a given nucleus could be made up of a particular number of protons and neutrons which might yet take up two—or even three—different arrangements. Each arrangement would have different radioactive properties. For instance, uranium X_2 and uranium Z are the same isotope but are nuclear isomers.

Now we can summarize the phantom elements that were discovered in the first decade of the Twentieth Century and equate them with the isotopes of the various elements as we know them today. I refer you to the accompanying table.

Note that the isotopes of ten different elements are involved. Of these, five—uranium, thorium, bismuth, lead and thallium—were known before 1898. Therefore, only five real elements were discovered during all that flurry: polonium and radium (the Curies in 1898), actinium (Debierne in 1899), radon (Dorn in 1900) and protactinium (Hahn and Meitner in 1917).

Furthermore, despite all the isotopes discovered, two blanks remained in that region of the periodic table. No isotopes were found of elements 85 and 87. Actually, such isotopes are formed in one or the other of the series but in such small quantities that they were not detected until the late '30s and early '40s. (Also, beginning in 1939, missing elements 43 and 61 were formed by nuclear bombardment, element 93 was discovered and found to be the parent of a fourth radioactive series, and elements 94 through 101 were also manufactured.)

Having gotten that straightened out, you might think that chemists

would shift, thankfully, from the old system to the new as far as naming the members of the radioactive series are concerned.

Imagine, after all, having to explain to a student that radium A and radium F are not isotopes of radium, but isotopes of polonium; that radium C and radium E are isotopes of bismuth, that radium B, radium D and radium G are isotopes of lead; that none of them are radium at all; that radium G isn't even radioactive.

Imagine having to explain that mesothorium 2 is really an isotope of actinium, while radioactinium is really an isotope of thorium. We could drive the poor kids mad.

But alas, chemists have not seen fit to make the change. The very latest handbooks and textbooks list the radioactive series complete with alphabet soup, assorted prefixes, primes and double primes and so on.

In fact, when the French chemist, Marguerite Perey, first discovered that an isotope of element 87 was formed in the actinium series, between actinium and actinium X, she called it *actinium K*. Then in 1946, when she named element 87 *francium,* as was her right, did she say that actinum K was francium-223? No, she recommended that it still be called actinium K.

I'm not sure what moral one ought to deduce from this—perhaps that scientists, as a group, tend to be somewhat more conservative than elderly corporation lawyers.

THE END

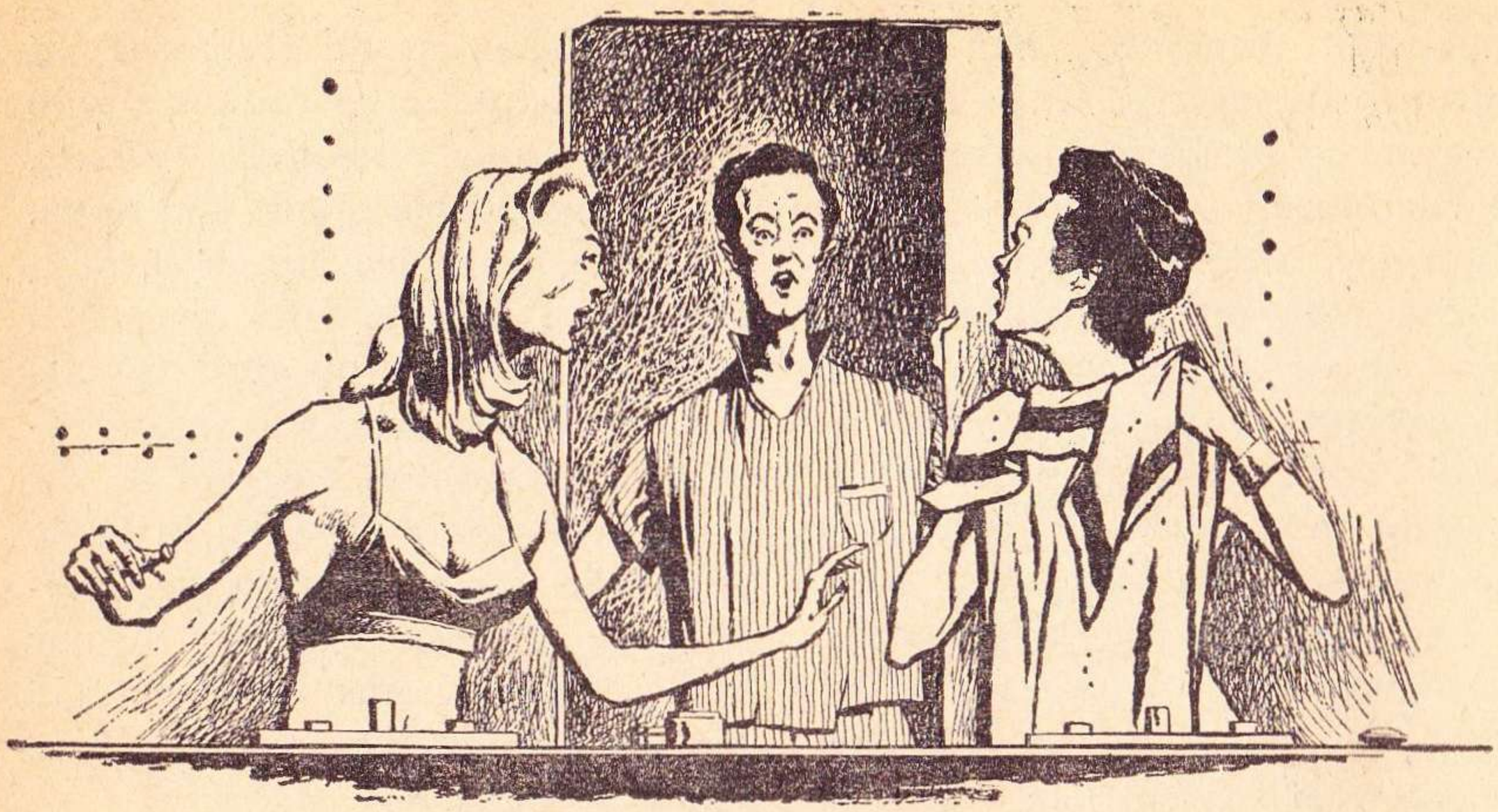
IN TIMES TO COME

Next month's lead novelette is another of Christopher Anvil's "variations on a theme" stories—the theme being old (but what theme isn't?) and the variation new. The Alien Invaders—a theme we seem to recall having seen somewhere before—with the interesting question of the important difference between *weather* and *climate.* Of course, some while back H. G. Wells suggested that the Martians might be able to lick all Earth's armies with one tentacle tied behind 'em, and still comply with the request to "Drop Dead!" due to bacteria.

However, history suggests other possibilities. The English and the Dutch tried, and failed to get the Swedes out of New Jersey in the early colonial days . . . but the mosquitoes succeeded.

Just when does a nuisance become a catastrophe? What are the army-defeating potentialities of hayfever, for instance? Particularly, an alien-to-this-Earth army? Wonder what an Alien Invader's commanders would do after an encounter between their base and a Kansas tornado? If an Alien encountered a scorpion, he might know he'd been stung, but how long would it take him to figure out which nasty-looking end it was that did the deed?

Christopher Anvil's had fun with the yarn . . . but his Invaders didn't. It's titled, by the way, "The Gentle Earth." THE EDITOR.



CITIZEN OF THE GALAXY

Second of Four Parts.

Old Baslim was dead... but the power of the name of the one-eyed beggar of Jubbulpore was by no means dead! Like a magic talisman, that name alone made Thorby a full citizen of the freest culture in the Galaxy!

BY ROBERT A. HEINLEIN

Illustrated by van Dongen

A slave auction was going on in the Great Plaza of Jubbulpore. The merchandise now on the block was almost worthless — a young boy, starved and covered with sores, feral from too many masters and too many whips, ground-sick after light-years in the hold of a slaver. The auctioneer knocked down this damaged chattel for small change to an old beggar, rather than annoy nobles and ladies by holding up the sale.

BASLIM THE BEGGAR *(one-eyed, one-legged, gaunt and aged) took his slave home to a burrow under the ruins of the old amphitheater. He washed, bandaged, and fed the child, won his confidence, learned that his name was* THORBY—*but that was all, for* THORBY, *even under hypnosis, knew nothing of his people or his planet. His only identification was a slave-factor's serial number tattoed on a thigh. Years of abuse had made the boy jumpy*

as a stray dog, beset by nightmares; BASLIM *slowly straightened him out with hypnotherapy and firm kindness.*

BASLIM *trained* THORBY *as a beggar. Daily they made their pitch together in the Great Plaza of Jubbulpore.*

Jubbulpore is a metropolis almost unknown to civilization; there has been little or no intercourse with any of the Nine Worlds since they broke with the mother planet. But Jubbulpore is the Sargon's capital and is a big and bustling place, technically advanced and politically decadent, corrupt throughout.

As a beggar THORBY *learned the ways of an underworld, but in the privacy of their hideaway* BASLIM *taught him many other things—languages, mathematics, science, history, and galactography.* BASLIM *sternly and forcefully required* THORBY *to study and helped him along both through advanced training aids and through the ancient Terran mental discipline of "renshawing." Under such tutoring* THORBY *acquired an exceptionally broad education.*

THORBY *was too young when this started to see anything strange in a penniless old beggar owning expensive teaching equipment, or in his being able to tutor complex subjects. As the years passed he gradually became aware of these contradictions but they did not worry him—Pop was Pop and could do anything.* THORBY *made the same adjustment to his discovery that Pop had other activities besides begging, business which took him out at night disguised as a nobleman, complete with false leg, false eye, and finery. Anyone more sophisticated would have known that* BASLIM *was engaged in something illegal and probably treasonable to the Sargon; to* THORBY, *anything Pop did was all right.* BASLIM—*or "Pop"—was the foundation of his world.*

BASLIM *used* THORBY *as a secret courier inside the city and also to deliver messages to skippers of* FREE TRADERS, *tramp merchant starships which visit not only ports of the Nine Worlds but also ports throughout the frontiers of the explored sector of the galaxy including colony worlds of the Terran Hegemony.* BASLIM *tried to arrange to have* THORBY *shipped out to a free world via one of these tramp ships, but* THORBY *bitterly refused—he did not want to leave Pop.*

BASLIM *was much worried about what would happen to his adopted son on his death. Unable to persuade the boy to leave him, he took two steps: he granted his slave manumission and had him recorded as a freedman — and he implanted in* THORBY *a message which* must *be delivered to any one of five skippers of* FREE TRADERS *after* BASLIM'S *death. The message was in a language not known to* THORBY; *the old man used hypnopedia to make him letter perfect.*

When THORBY *had reached gangling adolescence, man-tall but*

not filled out, a dust-up occurred in which he was almost captured by the Sargon's police while trying to deliver one of BASLIM'S *secret messages to a man in the Sargon's starship dockyards. The incident did not worry* THORBY—*as a gutter rat a brush with the snoopies was all in the day's work to him—but it caused the old beggar to hurry home and start destroying records. That night he implanted a very long message in code in the boy's brain by hypnopedia.*

The next day BASLIM *was absent;* THORBY *made his pitch in the Plaza alone. For years it had always been his responsibility, in Pop's absence, to keep careful track of slave auctions and of the arrivals and departures of starships, especially slavers. That day the Free Trader* SISU *grounded; it was not a slaver but its skipper was one of the five to whom* THORBY *must deliver a message—someday, when* BASLIM *was dead.* THORBY *decided to go home and tell Pop of its arrival.*

He found the ruins in which they lived staked out by police; THORBY evaded them and reached their underground home. It had been searched and wrecked—and Pop's false leg lay smashed on the floor.

Once the first stunning shock had worn off THORBY *undertook the impossible task of finding Pop and freeing him from .the Sargon's police. He sneaked back to the honky-tonk area between the Plaza and the spaceport—only to receive a worse shock there, for he learned that* BASLIM *was already dead, having suicided before the police could question him.*

The additional fact that there was now a reward out on THORBY'S *head as well hardly made an impression on him—save that he must, somehow, avoid arrest until he could deliver* BASLIM'S *message to the skipper of Starship* SISU.

THORBY *managed to hide with* MOTHER SHAUM, *disreputable owner of an even less reputable hotel; for the sake of her old friend* BASLIM *she arranged a meeting with the skipper of the* SISU. CAPTAIN KRAUSA *was shocked and incredulous to hear that* BASLIM *was dead. He interrupted* THORBY'S *reciting of the message. "Is that true?"*

"Is what true?" MOTHER SHAUM. *"I don't understand that yammer."*

"Oh, sorry—it's my own language. The lad is telling me that an old beggar who called himself 'Baslim the Cripple' is dead. Well?"

"Oh. Of course it's true. And a sorry thing it is, too."

"Yes. It is." CAPTAIN KRAUSA *looked at* THORBY. *"'Debts are always paid,'" he said slowly.* "BASLIM *says that I am to take you with me. Are you ready?"*

THORBY *gulped. "Yes, sir. If that's what Pop wanted."*

MOTHER SHAUM *looked shocked. "Are you two crazy? The street is crawling with police!"*

MOTHER SHAUM, CAPTAIN KRAUSA, *and much bribery got*

THORBY *aboard the* SISU—*crated as a bale of verga leaves.*

PART 2

VII.

Inside the first few million miles Thorby was unhappily convinced that he had made a mistake.

He passed out from inhaling fumes of verga leaves and awakened in a tiny, one-bunk stateroom. Waking was painful; although the *Sisu* maintained one standard gravity of internal field throughout a jump his body had recognized both the slight difference from Jubbul-surface gravity and the more subtle difference between an artificial field and the natural condition. His body decided that he was in the hold of a slaver and threw him into the first nightmare he had had in years.

Then his tired, fume-sodden brain took a long time struggling up out of the horror.

At last he was awake, aware of his surrounding, and concluded that he was aboard the *Sisu* and safe. He felt a glow of relief and gathering excitement that he was traveling, going somewhere. His grief over Baslim was pushed aside by strangeness and change. He looked around.

The compartment was a cube, only a foot or so higher and wider than his own height. He was resting on a shelf that filled half the room and under him was a mattress strangely and delightfully soft, of material warm and springy and smooth. He stretched and yawned in surprised wonder that traders lived in such luxury. Then he swung his feet over and stood up.

The bunk swung noiselessly up and fitted itself into the bulkhead. Thorby could not puzzle out how to open it again. Presently he gave up. He did not want a bed then; he did want to look around.

When he woke the ceiling was glowing faintly. When he stood up it glowed brightly and remained so. But the light did not show where the door was. There were vertical metal panels on three sides, any of which might have been a door, save that none displayed thumb slot, hinge, or other familiar mark.

He considered the possibility that he had been locked in, but was not troubled. Living in a cave, working in the Plaza, he was afflicted neither with claustrophobia nor agoraphobia; he simply wanted to find the door and was annoyed that he could not recognize it. If it were locked, he did not think that Captain Krausa would let it stay locked unduly long. But he could not find it.

He did find a pair of shorts and a singlet, on the deck. When he woke he had been bare, the way he usually slept. He picked up these garments, touched them timidly, wondered at their magnificence. He recognized them as being the sort of thing most spacemen wore and for a moment let himself be dazzled at the thought of wearing such luxuries. But his mind shied away from such impudence.

Then he recalled Captain Krausa's distaste at his coming aboard in the clothes he normally wore—why, the captain had even intended to take him to a tailoring shop in Joy Street which catered to spacemen! He had *said* so.

Thorby concluded that these clothes must be for him. For *him!* His breechclout was missing and the captain certainly had not intended him to appear in the *Sisu* naked. Thorby was not troubled by modesty; the taboo was spotty on Jubbul and applied more to the upper classes. Nevertheless clothes were worn.

Marveling at his own daring, Thorby tried them on. He got the shorts on backwards, figured out his mistake, and put them on properly. He got the pullover shirt on backwards, too, but the error was not as glaring; he left it that way, thinking that he had it right. Then he wished mightily that he could see himself.

Both garments were of simple cut, undecorated light green, and fashioned of strong, cheap material; they were working clothes from the ship's slop chest, a type of garment much used by both sexes on many planets through many centuries. Yet Solomon in all his glory was not arrayed as Thorby! He smoothed the cloth against his skin and wanted someone to see him in his finery. He set about finding the door with renewed eagerness.

It found him. While running his hands over the panels on one bulkhead he became aware of a breeze, turned and found that one panel had disappeared. The door let out into a passageway.

A young man dressed much as Thorby was—Thorby was overjoyed to find that he had dressed properly for the occasion—was walking down the curved corridor toward Thorby. Thorby stepped out and spoke a greeting in Sargonese trade talk.

The man's eyes flicked toward Thorby, then he marched on past as if no one were there. Thorby blinked, puzzled and a little hurt. Then he called out to the receding back in Interlingua.

No answer and the man disappeared before he could try other languages.

Thorby shrugged and let it roll off; a beggar does not gain by being touchy. He set out to explore.

In twenty minutes he discovered many things. First, the *Sisu* was much larger than he had imagined. He had never before seen a starship close up, other than from the doubtful vantage of a slaver's hold. Ships in the distance, sitting on the field of Jubbul's port, had seemed large but not this enormous. Second, he was surprised to find so many people. He understood that the Sargon's freighters operating among the Nine Worlds were usually worked by crews of six or seven. But in his first few minutes he encountered several times that number of both sexes and all ages.

Third, he became dismally aware that he was being snubbed. People did not look at him, nor did they answer when he spoke; they'd prob-

ably walk right through him if he did not jump. The nearest he accomplished to social relations was with a female child, a toddler who regarded him with steady, grave, eyes in answer to his overtures—until snatched up by a woman who did not even glance at Thorby.

Thorby recognized the treatment; it was the way a noble treated one of Thorby's caste. A noble could not see him, he did not exist—even a noble giving alms usually did so by handing it through a slave. Thorby had not been hurt by such treatment on Jubbul; that was natural, that was the way things had always been. It had made him neither lonely nor depressed; he had had plenty of warm company in his misery and had not known that it was misery.

But had he known ahead of time that the entire ship's company of the *Sisu* would behave like nobles he would never have shipped in her, snoopies or not. But he had not expected such treatment. Captain Krausa, once Baslim's message had been delivered, had been friendly and gruffly paternal; Thorby had expected the crew of the *Sisu* to reflect the attitude of her master.

He wandered the steel corridors, feeling like a ghost among living, and at last decided sadly to go back to the cubicle in which he had awakened. Then he discovered that he was lost. He retraced what he thought was the route—and in fact was; Baslim's renshawing had not been wasted—but all he found was a featureless tunnel. So he set out again, uncomfortably aware that whether he found his own room or not, he must soon find where they hid the washroom, even if he had to grab someone and shake him.

He blundered into a place where he was greeted by squeals of female indignation; he retreated hastily and heard a door slam behind him.

Shortly thereafter he was overtaken by a hurrying man who spoke to him, in Interlingua: "What the devil are you doing wandering around and butting into things?"

Thorby felt a wave of relief. The grimmest place in the world, lonelier than being alone, is Coventry, and even a reprimand is better than being ignored. "I'm lost," he said meekly.

"Why didn't you stay where you were?"

"I didn't know I was supposed to—I'm sorry, noble sir—and there wasn't any washroom."

"Oh. But there is, right across from your bunkie."

"Noble sir, I did not know."

"I suppose you didn't. I'm not 'noble sir;' I'm First Assistant Power Boss—see that you remember it. Come along." He grabbed Thorby by an arm, hurried him back through the maze, stopped in the same tunnel that had stumped Thorby, ran his hand down a seam in the metal. "Here's your bunkie." The panel slid aside.

The man turned, did the same on the other side. "Here's the starboard bachelor's washroom." The man advised him scornfully when

Thorby was confused by strange fixtures, then chaperoned him back to his room. "Now stay here. Your meals will be fetched."

"First Assistant Power Boss, sir?"

"Eh?"

"Could I speak with Captain Krausa?"

The man looked astonished. "Do you think the skipper has nothing better to do than talk to *you*?"

"But—"

The man had left; Thorby was talking to a steel panel.

Food appeared eventually, served by a youngster who behaved as if he were placing a tray in an empty room. More food appeared later and the first tray was removed. Thorby almost managed to be noticed; he hung onto the first tray and spoke to the boy in Interlingua. He detected a flicker of understanding, but he was answered by one short word. The word was "Fraki!" and Thorby did not recognize it—but he could recognize the contempt with which it was uttered. A fraki is a small, shapeless, semi-saurian scavenger of Alpha Centaura Prime III, one of the first worlds populated by men. It is ugly, almost mindless, and has disgusting habits. Its flesh can be eaten only by a starving man. Its skin is unpleasant to touch and leaves a foul odor.

But "fraki" means more than this. It means a groundhog, an earthcrawler, a dirt dweller, one who never goes into space, not of our tribe, not human, a goy, an auslander, a savage, beneath contempt. In Old Terran cultures almost every animal name has been used as an insult: pig, dog, sow, cow, shark, louse, skunk, worm—the list is endless. No such idiom carries more insult than "fraki."

Fortunately all Thorby got was the fact that the youngster did not care for him—which he knew.

Presently Thorby became sleepy. But, although he had mastered the gesture by which doors were opened, he still could not find any combination of swipes, scratches, punches, or other actions which would open the bed; he spent that night on the floorplates. His breakfast appeared next morning but he was unable to detain the person serving it, even to be insulted again. He did encounter other boys and young men in the washroom across the corridor; while he was still ignored, he learned one thing by watching—he could wash his clothing there. A gadget would accept a garment, hold it a few minutes, spew it forth dry and fresh. He was so delighted that he laundered his new finery three times that day. Besides, he had nothing else to do. He again slept on the floor that night.

He was squatting in his bunkie, feeling a great aching loneliness for Pop and wishing that he had never left Jubbul, when someone scratched at his door. "May I come in?" a voice inquired in careful, badly-accented Sargonese.

"Come in!" Thorby answered eagerly and jumped up to open the

door. He found himself facing a middle-aged woman with a pleasant face. "Welcome," he said in Sargonese, and stood aside.

"I thank you for your gracious—" she stumbled and said quickly, "Do you speak Interlingua?"

"Certainly, madam."

She muttered in System English, "Thank goodness for that—I've run out of Sargonese," then went on in Interlingua, "then we will speak it, if you don't mind."

"As you wish, madam," Thorby answered in the same language, then added in System English, "unless you would rather use another language."

She looked startled. "How many languages do you speak?"

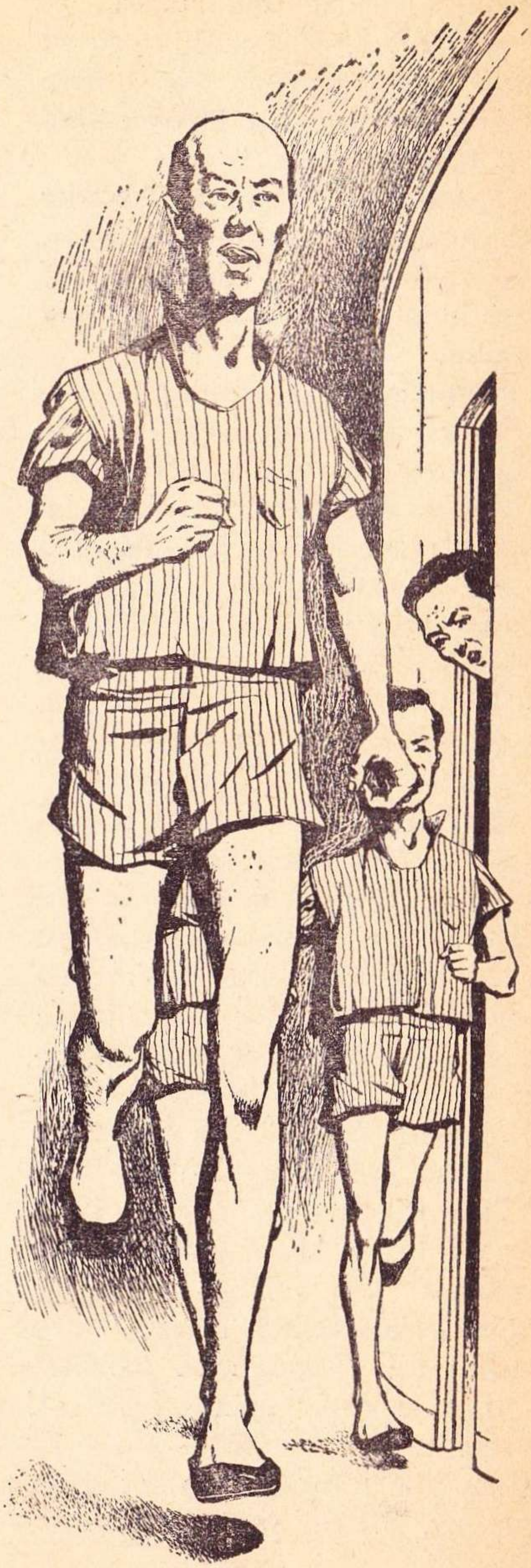
Thorby thought. "Seven, ma'am. I can puzzle out some others, but I cannot say that I speak them."

She looked even more surprised and said slowly, "Perhaps I have made a mistake. But—correct me if I am wrong and forgive my ignorance—I was told that you were a beggar's boy in Jubbulpore."

"I am the son of Baslim the Cripple," Thorby said proudly, "a licensed beggar under the mercy of the Sargon. My late father was a learned man. His wisdom was famous from one side of the Plaza to the other."

"I believe it. Uh . . . are all beggars on Jubbul linguists?"

"What, ma'am? Most of them speak only gutter argot. But my father did not permit me to speak it . . . other than professionally, of course."



"Of course." She blinked. "I wish I could have met your father."

"Thank you, ma'am. Will you sit down? I am ashamed that I have nothing but the floor to offer—but what I have is yours."

"Thank you." She sat on the floor with more effort than did Thorby, who had remained thousands of hours in lotus seat, shouting his plea for alms.

Thorby wondered whether to close the door, whether this lady—in Sargonese he thought of her as "my lady" even though her friendly manner made her status unclear—had left it open on purpose. He was floundering in a sea of unknown customs, facing a social situation totally new to him. He solved it with common sense; he asked, "Do you prefer the door open or closed, ma'am?"

"Eh? It doesn't matter. Oh, perhaps you had better leave it open; these are bachelor quarters of the starboard moiety and I'm supposed to live in port purdah, with the unmarried females. But I'm allowed some of the privileges and immunities of . . . well, of a pet dog. I'm a tolerated 'fraki.'" She spoke the last word with a wry smile.

Thorby had missed most of the key words. "A 'dog?' That's a wolf creature?"

She looked at him sharply. "You learned this language on Jubbul?"

"I have never been off Jubbul, ma'am—except when I was very young. I'm sorry if I do not speak correctly. Would you prefer Interlingua?"

"Oh, no. You speak System English beautifully . . . a better Terran accent than mine—I've never been able to get my birthplace out of my vowels. But it's up to me to make myself understood. Let me introduce myself. I'm not a trader; I'm an anthropologist they are allowing to travel with them. My name is Dr. Margaret Mader."

Thorby ducked his head and pressed his palms together. "I am honored. My name is Thorby, son of Baslim."

"The pleasure is mine, Thorby. Call me 'Margaret.' My title doesn't count here anyhow, since it is not a ship's title. Do you know what an anthropologist is?"

"Uh, I am sorry, ma'am . . . Margaret."

"It's simpler than it sounds. An anthropologist is a scientist who studies how people live together."

Thorby looked doubtful. "This is a science?"

"Sometimes I wonder. Actually, Thorby, it is a complicated study, because the patterns that men work out to live together seem unlimited. There are only six things that all men have in common with all other men and not with animals—three of them part of our physical makeup, the way our bodies work, and three of them are learned. Everything else that a man does, or believes, all his customs and economic practices, vary enormously. Anthropologists study those variables. Do you understand 'variable?'"

"Uh," Thorby said doubtfully, "the 'x' in an equation?"

"Correct!" she agreed with delight. "We study the 'x's in the human equations. That's what I'm doing. I'm studying the way the Free Traders live. They have worked out possibly the oddest solutions to the difficult problem of how to be human and survive of any society in history. They are unique." She moved restlessly. "Thorby, would you mind if I sat in a chair? I don't bend as well as I used to."

Thorby blushed. "Ma'am . . . I have none. I am dis—"

"There's one right behind you. And another behind me." She stood up and touched the wall. A panel slid aside; an upholstered arm chair unfolded from the shallow space disclosed.

Seeing his face she said, "Didn't they show you?" and did the same on the other wall; another chair sprang out.

Thorby sat down cautiously, then let his weight relax into cushions as the chair felt him out and adjusted itself to him. A big grin spread over his face. "Gosh!"

"Do you know how to open your work table?"

"Table?"

"Good heavens, didn't they show you anything?"

"Well . . . there was a bed in here once. But I've lost it."

Dr. Mader muttered something, then said, "I might have known it. Thorby, I admire these Traders. I even like them. But they can be the most stiff-necked, self-centered, contrary, self-righteous, unco-operative . . . but I should not criticize our hosts. Here." She reached out both hands, touched two spots on the wall and the disappearing bed swung down. With the chairs open, there remained hardly room for one person to stand. "I'd better close it. You saw what I did?"

"Let me try."

She showed Thorby other built-in facilities of what had seemed to be a bare cell: two chairs, a bed, clothes cupboards (Thorby learned that he owned, or at least had, two more work suits, two pairs of soft ship's shoes, and minor items some of which were strange, bookshelf and spool racks—empty, except for the Laws of *Sisu*—a drinking fountain, a bed reading light, an intercom, a clock, a mirror, a room thermostat, and gadgets which were useless to him as his background included no need. "What's that?" he asked at last.

"That? Probably the microphone to the Chief Officer's cabin. Or it may be a dummy with the real one hidden. But don't worry; almost no one in this ship speaks System English and she isn't one of the few. They talk their 'secret language'—only it isn't secret; it's just Finnish. Each Trader ship has its own language—one of the Terran tongues. And the culture has an over-all 'secret' language which is merely degenerate Church Latin—and at that they don't use it; 'Free Ships' talk to each other in Interlingua."

Thorby was only half listening. He had been excessively cheered by her company and now, in contrast, he was brooding over his treatment from others. "Margaret . . . why won't they *speak* to people?"

"Eh?"

"You're the first person who's spoken to me!"

"Oh." She looked distressed. "I should have realized it. You've been ignored."

"Well . . . they fed me."

"But they don't talk with you. Oh, you poor dear! Thorby, they don't speak to you because you are *not* 'people.' Nor am I."

"They don't talk to you either?"

"They do now. But it took direct orders from the Chief Officer and much patience on my part." She frowned. "Thorby, every excessively clannish culture—and I know of none more clannish than this—every such culture has the same key word in its language . . . and the word is 'people' however they say it. It means themselves. 'Me and my wife, son John and his wife, us four and no more' —cutting off their group from all others and denying that others are even human. Have you heard the word 'fraki' yet?"

"Yes. I don't know what it means."

"A fraki is just a harmless, rather repulsive little animal. But when they say it, it means 'stranger.' "

"Uh, well, I guess I am a stranger."

"Yes, but it also means you can never be anything else. It means that you and I are subhuman breeds outside the law—*their* law."

Thorby looked bleak. "Does that mean I have to stay in this room and never, ever talk to anybody?"

"Goodness! I don't know. *I'll* talk to you—"

"Thanks!"

"Let me see what I can find out. They're not cruel; they're just pigheaded and provincial. The fact that you have feelings never occurs to them. I'll talk to the captain; I have an appointment with him as soon as the ship goes irrational." She glanced at her anklet. "Heavens, look at the time! I came here to talk about Jubbul and we haven't said a word about it. May I come back and discuss it with you?"

"I wish you would."

"Good. Jubbul is a well analyzed culture, but I don't think any student has ever had opportunity to examine it from the perspective you had. I was more than delighted when I heard that you were a professed mendicant."

"Excuse me?"

"A beggar. Investigators who have been allowed to live there have all been guests of the upper classes. That forces them to see . . . well, the way slaves live for example, from the outside, not the inside. You see?"

"I guess so." Thorby added, "If you want to know about slaves, I was one."

"You *were*?"

"I'm a freedman. Uh, I should have told you," he added uncomfortably, afraid that his new-found

friend would scorn him, now that she knew his class.

"No reason to, but I'm overjoyed that you mentioned it. Thorby, you're a treasure trove! Look, dear, I've got to run; I'm late now. But may I come back soon?"

"Huh? Why, surely, Margaret." He added honestly, "I really don't have much else to do."

Thorby slept in his wonderful new bed that night. He was left alone the next morning but he was not bored, as he had so many toys to play with. He opened things out and caused them to fold up again, delighted at how each gadget folded in on itself to occupy minimum space. He concluded that it must be witchcraft. Baslim had taught him that magic and witchcraft were nonsense but the teaching had not fully stuck—Pop had known everything but just the same, how could you fly in the face of experience? Jubbul had plenty of witches and if they weren't practicing magic, what were they doing?

He had just opened his bed for the sixth time when he was almost shocked out of the shoes he had dared to try on by an unholy racket. It was just the ship's alarm, calling all hands to General Quarters, and it was merely a drill, but Thorby did not know that. When he reswallowed his heart, he opened the door and looked out. People were running at break-neck speed.

Shortly the corridors were empty. He went back into his bunkie, waited and tried to understand. Presently his sharp ears detected the absence of the soft sigh of the ventilation system. But there was nothing he could do about it. He should have mustered in the innermost compartment, along with children and other noncombatants, but he did not know.

So he waited.

The alarm rang again, in conjunction with a horn signal, and again there were running people in the passageways. Again it was repeated, until the crew had run through General Quarters, Hull Broach, Power Failure, Air Hazard, Radiation Hazard, and so forth—all the general drills of a taut ship. Once the lights went out and once for frightening moments Thorby experienced the bewildering sensation of free fall as the ship's artificial field cut off.

After a long time of such inexplicable buffoonery he heard the soothing strains of recall and the ventilation system whispered back to normal. No one bothered to look for him; the old woman who mustered nonparticipants hadn't noticed the absence of the fraki although she had counted the animal pets aboard.

Immediately thereafter Thorby was dragged up to see the Chief Officer.

A man opened his door, grabbed his shoulder and marched him away. Thorby put up with it for a short distance, then he rebelled; he had his bellyful of such treatment.

The gutter fighting he had learned in order to survive in Jubbulpore was lacking in rules. Unfortunately this man learned in a school equally cold-

blooded but more scientific; Thorby got in one swipe, then found himself pinned against the bulkhead with his left wrist in danger of breaking. "Cut out the nonsense!"

"Quit pushing me around!"

"I said, 'Cut out the nonsense.' You're going up to see the Chief Officer. Don't give me trouble, Fraki, or I'll stuff your head in your mouth."

"I want to see Captain Krausa!"

The man relaxed the pressure and said, "You'll see him. But the Chief Officer has ordered you to report—and she can't be kept waiting. So will you go quietly? Or shall I carry you there in pieces?"

Thorby went quietly. Pressure on a wrist joint combined with pressure on a nerve between the bones of the palm carries its own rough logic. Several decks up he was shoved through an open door. "Chief Officer, here's the fraki."

"Thank you, Third Deck Master. You may go."

Thorby understood only the word "fraki." He picked himself up and found himself in a room many times as large as his own. The most prominent thing in it was an imposing bed, but the small figure in the bed dominated the room. Only after he had looked at her did he notice that Captain Krausa stood silent on one side of the bed and that a woman perhaps the captain's age stood on the other.

The woman in bed was shrunken with age but radiated authority. She was richly dressed—the scarf over her thin hair represented more money than Thorby had ever seen at one time—but Thorby noticed only her fierce, sunken eyes. She looked at him. "So! Oldest Son, I have trouble believing it." She spoke in Suomic.

"My Mother, the message could not have been faked."

She sniffed.

Captain Krausa went on with humble stubbornness, "Hear the message yourself, My Mother." He turned to Thorby and said in Interlingua, "Repeat the message from your father."

Obediently, not understanding but enormously relieved to be in the presence of Pop's friend, Thorby repeated the message by rote. The old woman heard him through, then turned to Captain Krausa. "What is this? He speaks our language! A *fraki*!"

"No, My Mother, he understands not a word. That is Baslim's voice."

She looked back at Thorby, spilled a stream of Suomic on him. He looked questioningly at Captain Krausa. She said, "Have him repeat it again."

The captain gave the order; Thorby, confused but willing, did so. She lay silent after he had concluded while the others waited. Her face screwed up in anger and exasperation. At last she rasped, "Debts must be paid!"

"That was my thought, My Mother."

"But why should the draft be drawn on us?" she answered angrily.

The captain said nothing. She went

on more quietly, "The message is authentic. I thought surely it must be faked. Had I known what you intended I would have forbidden it. But, Oldest Son, stupid as you are, you were right. And debts must be paid." Her son continued to say nothing; she added angrily, "Well? Speak up! What coin do you propose to tender?"

"I have been thinking, My Mother," Krausa said slowly. "Baslim demands that we care for the boy only a limited time—until we can turn him over to a Hegemonic military vessel. How long will that be? A year, two years. But even that presents problems. However, we have a precedent—the fraki female. The Family had accepted her . . . oh, a little grumbling, but they are used to her now, even amused by her. If My Mother intervened for this lad in the same way—"

"Nonsense!"

"But, My Mother, we are obligated. Debts must—"

"Silence!"

Krausa shut up.

She went on quietly, "Did you not listen to the wording of the burden Baslim placed on you? '. . . succor and admonish him as if you were I.' What was Baslim to this fraki?"

"Why he speaks of him as his adopted son. I thought—"

"You didn't think. If you take Baslim's place, what does that make *you*? Is there more than one way to read the words?"

Krausa looked troubled. The ancient went on, "*Sisu* pays debts in full. No half measures, no short weights—in *full*. The fraki must be adopted . . . by you."

Krausa's face was suddenly blank. The other woman, who had been moving around quietly with makework, dropped a tray.

The captain said, "But, My Mother, what will the Family—"

"*I* am the Family!" She turned suddenly to the other woman. "Oldest Son's Wife, have all my senior daughters attend me."

"Yes, Husband's Mother." She curtsied and left.

The Chief Officer looked grimly at the overhead, then almost smiled. "This is not all bad, Oldest Son. What will happen at the next Gathering of the People?"

"Why, we will be thanked."

"Thanks buy no cargo." She licked her thin lips. "The People will be in debt to *Sisu* . . . and there will be a change in status of ships. We won't suffer."

Krausa smiled slowly. "You always were a shrewd one, My Mother."

"A good thing for *Sisu* that I am. Take the fraki boy and prepare him. We'll do this quickly."

VIII.

Thorby had two choices: be adopted quietly, or make a fuss and be adopted anyhow. He chose the first, which was sensible, as opposing the will of the Chief Officer was unpleasant and almost always futile. Besides, while he felt odd and rather

unhappy about acquiring a new family so soon after the death of Pop, nevertheless he could see that the change was to his advantage. As a fraki, his status had never been lower. Even a slave has equals.

But most important, Pop had told him to do what Captain Krausa said for him to do.

The adoption took place in the dining saloon at the evening meal that day. Thorby understood little of what went on and none of what was said, since the ceremonies were in the "secret language," but the captain had coached him in what to expect. The entire ship's company was there, except those on watch. Even Dr. Mader was there, inside the main door and taking no part but where she could see and hear.

The Chief Officer was carried in and everyone stood. She was settled on a lounge at the head of the officers' table, where her daughter-in-law, the captain's wife, attended her. When she was comfortable, she made a gesture and they sat down, the captain seating himself on her right. Girls from the port moiety, the watch with the day's duty, then served all hands with bowls of thin mush. No one touched it. The Chief Officer banged her spoon on her bowl and spoke briefly and emphatically.

Her son followed her. Thorby was surprised to discover that he recognized a portion of the captain's speech as being identical with part of the message Thorby had delivered; he could spot the sequence of sounds.

The Chief Engineer, a man older than Krausa, answered, then several older people, both men and women, spoke. The Chief Officer asked a question and was answered in chorus —a unanimous assent. The old woman did not ask for dissenting votes.

Thorby was trying to catch Dr. Mader's eye when the captain called to him in Interlingua. Thorby had been seated on a stool alone and was feeling conspicuous, especially as persons he caught looking at him did not seem very friendly.

"Come here!"

Thorby looked up, saw both the captain and his mother looking at him. She seemed irritated or it may have been the permanent set of her features. Thorby hurried over.

She dipped her spoon in his dish, barely licked it. Feeling as if he were doing something horribly wrong but having been coached, he dipped his spoon in her bowl, timidly took a mouthful. She reached up, pulled his head down and pecked him with withered lips on both cheeks. He returned the symbolic caress and felt gooseflesh.

Captain Krausa ate from Thorby's bowl; he ate from the captain's. Then Krausa took a knife, held the point between thumb and forefinger and whispered in Interlingua, "Mind you don't cry out." He stabbed Thorby in his upper arm.

Thorby thought with contempt that Baslim had taught him to ignore ten times that much pain. But blood flowed freely. Krausa led him to a spot where all might see, said some-

thing loudly, and held his arm so that a puddle of blood formed on the deck. The captain stepped on it, rubbed it in with his foot, spoke loudly again—and a cheer went up. Krausa said to Thorby in Interlingua, "Your blood is now in the steel; our steel is in your blood."

Thorby had encountered sympathetic magic all his life and its wild, almost reasonable logic he understood. He felt a burst of pride that he was now part of the ship.

The captain's wife slapped a plaster over the cut. Then Thorby exchanged food and kisses with her, after which he had to do it right around the room, every table, his brothers and his uncles, his sisters and his cousins and his aunts. Instead of kissing him, the men and boys grasped his hands then clapped him across the shoulders. When he came to the table of unmarried females he hesitated—and discovered that they did not kiss him; they giggled and squealed and blushed and hastily touched forefingers to his forehead.

Close behind him, girls with the serving duty cleared away the bowls of mush—purely ritualistic food symbolizing the meager rations on which the People would cross space if necessary—and were serving a feast. Thorby would have been clogged to his ears with mush had he not caught onto the trick: don't eat it, just dip the spoon, then barely taste it. But when at last he was seated, an accepted member of the Family, at the starboard bachelor's table, he had no appetite for the banquet in his honor. Eighty-odd new relatives were too much. He felt tired, nervous, and let down.

But he tried to eat. Presently he heard a remark in which he understood only the word "fraki." He looked up and saw a youth across the table grinning unpleasantly.

The president of the table, seated on Thorby's right, rapped for attention. "We'll speak nothing but Interlingua tonight," he announced, "and thereafter follow the customs in allowing a new relative gradually to acquire our language." His eye rested coldly on the youngster who had sneered at Thorby. "As for you, Cross-Cousin-in-Law by Marriage, I'll remind you—just once—that my Adopted Younger Brother is senior to you. And I'll see you in my bunkie after dinner."

The younger boy looked startled. "Aw, Senior Cousin, I was just saying—"

"Drop it." The young man said quietly to Thorby, "Use your fork. People do not eat meat with fingers."

"Fork?"

"Left of your plate. Watch me; you'll learn. Don't let them get you riled. Some of these young oafs have yet to learn that when Grandmother speaks, she means business."

Thorby was moved from his bunkie into a less luxurious larger room intended for four bachelors. His roommates were Fritz Krausa, who was his eldest unmarried foster brother and president of the starboard bachelor table, Chelan Krausa-

Drotar, Thorby's foster ortho-second-cousin by marriage, and Jeri Kingsolver, his foster nephew by his eldest married brother.

It resulted in his learning Suomic rapidly. But the words he needed first were not Suomish; they were words borrowed or invented to describe family relationships in great detail. Languages reflect cultures; most languages distinguish brother, sister, father, mother, aunt, uncle and link generations by "great" or "grand." Some languages make no distinction between (for example) "father" and "uncle" and the language reflects tribal custom. Contrariwise, some languages (e.g., Norwegian) split "uncle" into maternal and paternal ("morbror" and "farbror").

The Free Traders can state a relationship such as "my maternal foster half-stepuncle by marriage, once removed and now deceased" in *one* word, one which means that relationship and no other. The relation between any spot on a family tree and any other spot can be so stated. Where most cultures find a dozen titles for relatives sufficient the

Traders use more than two thousand. The languages name discreetly and quickly such variables as generation, lineal or collateral, natural or adopted, age within generation, sex of speaker, sex or relative referred to, sexes of relatives forming linkage, consanguinuity or affinity, and vital status.

Thorby's first task was to learn the word and the relationship defined by it with which he must address each of more than eighty new relatives; he had to understand the precise flavor of relationship, close or distant, senior or junior; he had to learn other titles by which he would be addressed by each of them. Until he had learned all this, he could not talk because as soon as he opened his mouth he would commit a grave breach in manners.

He had to associate five things for each member of the *Sisu's* company, a face, a full name—his own name was now Thorby Baslim-Krausa—a family title, that person's family title for him, and that person's ship's rank—such as "Chief Officer" or "Starboard Second Assistant Cook." He learned that each person must be addressed by family title in family matters, by ship's rank concerning ship's duties, and by given names on social occasions if the senior permitted it—nicknames hardly existed, since a nickname could be used only down, *never* up.

Until he grasped these distinctions, he could not be a functioning member of the family even though he was legally such. The life of the ship was a caste system of such complex obligations, privileges and required reactions to obligatory actions, as to make the stratified, protocol-ridden society of Jubbul seem like chaos. The captain's wife was Thorby's "mother" but she was also Deputy Chief Officer; how he addressed her depended on what he had to say. Since he was in bachelor quarters, the mothering phase ceased before it started; nevertheless she treated him warmly as a son and offered her cheek for his kiss just as she did for Thorby's roommate and elder brother Fritz.

But as Deputy Chief Officer she could be as cold as a tax collector.

Not that her status was easier; she would not be Chief Officer until the old woman had the grace to die. In the meantime she was hand and voice and body servant for her mother-in-law. Theoretically senior offices were elective; practically it was a one-party system with a single slate. Krausa was captain because his father had been; his wife was deputy chief officer because she was his wife, and would some day become chief officer —and boss him and his ship as his mother did—for the same reason. Meanwhile his wife's high rank carried with it the worst job in the ship, with no respite, for senior officers served for life . . . unless impeached, convicted, and expelled—onto a planet for unsatisfactory performance, into the chilly thinness of space for breaking the ancient and pig-headed laws of *Sisu.*

But such an event was as scarce

as a double eclipse; Thorby's mother's hope lay in heart failure, stroke, or other hazard of old age.

Thorby as adopted youngest son of Captain Krausa, senior male of the Krausa sept, titular head of *Sisu* clan—the captain's mother being the real head—was senior to three-fourths of his new relatives in clan status—he had not yet acquired ship's rank. But seniority did not make life easier. With rank goeth privileges—so it ever shall be. But also with it go responsibility and obligation, always more onerous than privileges are pleasant.

It was easier to learn to be a beggar.

He was swept up in his new problems and did not see Dr. Margaret Mader for days. He was hurrying down the trunk corridor of fourth deck—he was always hurrying now—when he ran into her.

He stopped and said: "Hello, Margaret."

"Hello, Trader. I thought for a moment that you were no longer speaking to fraki."

"Aw, Margaret!"

She smiled. "I was joking. Congratulations, Thorby. I'm happy for you—it's the best solution under the circumstances."

"Thanks. I guess so."

She shifted to System English and said with motherly concern, "You seem doubtful, Thorby. Aren't things going well?"

"Uh, things are all right." He suddenly blurted the truth. "Margaret, I'm never going to understand these people!"

She said gently, "I've felt the same way at the beginning of every field study and this one has been the most puzzling. What is bothering you?"

"Uh . . . I don't know. I never know. Well, take Fritz—he's my elder brother. He's helped me a lot—then I miss something that he expects me to understand and he blasts my ears off. Once he hit me. I hit back and I thought he was going to explode."

"Peck rights," said Margaret.

"What?"

"Never mind. It isn't scientifically parallel; humans aren't chickens. What happened?"

"Well, just as quickly he went absolutely cold, told me he would forget it, wipe it out, because of my ignorance."

"Noblesse oblige."

"Huh?"

"Sorry. My mind is a junk yard. And did he?"

"Completely. He was sweet as sugar. I don't know why he got sore . . . and I don't know why he quit being sore when I hit him." He spread his hands. "It's not natural."

"No, it isn't. But few things are. Thorby, I might be able to help. It's possible that I know how Fritz works better than he knows. Because I'm *not* one of the 'People.' "

"I don't understand."

"I do, I think. It's my job to. Fritz was born into the People; most of what he knows—and he is a very sophisticated young man—is subcon-

scious. He can't explain it because he doesn't know he knows it; he simply functions. But what I have learned these past two years I have learned consciously. Perhaps I can advise you when you are shy about asking one of them. You can speak freely with me; I have no status."

"Gee, Margaret, would you?"

"Whenever you have time. I haven't forgotten that you promised to discuss Jubbul with me, either. But don't let me hold you; you seemed in a hurry."

"I wasn't, not really." He grinned sheepishly. "When I hurry I don't have to speak to as many people . . . and I usually don't know *how*."

"Ah, yes. Thorby, I have photographs, names, family classification, ship's job, on everyone. Would it help?"

"Huh? I should say so! Fritz thinks it's enough just to point somebody out once and say who he is."

"Then come to my room. It's all right; I have a dispensation to interview anyone there. The door opens into a public corridor; you don't cross purdah line."

Arranged by case cards with photographs, the data Thorby had had trouble learning piecemeal he soaked up in half an hour—thanks to Baslim's training and Dr. Mader's orderliness. In addition, she had prepared a family tree for the *Sisu;* it was the first he had seen; his relatives did not need diagrams, they simply knew.

She showed him his own place. "The plus mark means that while you are in the direct sept, you were not born there. Here are a couple more, transferred from collateral branches to sept . . . to put them into line of command I suspect. You people call yourselves a 'family' but the grouping is a phratry."

"A what?"

"A related group without a common ancestor which practices exogamy—that means marrying outside the group. The exogamy taboo holds, modified by rule of moiety. You know how the two moities work?"

"They take turns having the day's duty."

"Yes, but do you know why the starboard watch has more bachelors and the port watch more single women?"

"Uh, I don't think so."

"Females adopted from other ships are in port moiety; native bachelors are starboard. Every girl in your side must be exchanged . . . unless she can find a husband among a very few eligible men. You should have been adopted on this side, but that would have required a different foster father. See the names with a blue circle-and-cross? One of those girls is your future wife . . . unless you find a bride on another ship."

Thorby felt dismayed at the thought. "Do I *have* to?"

"If you gain ship's rank to match your family rank, you'll have to carry a club to beat them off."

It fretted him. Swamped with family, he felt more need for a third leg than he did for a wife.

"Most societies," she went on, "practice both exogamy and endogamy—a man must marry outside his family but inside his nation, race, religion, or some large group, and you Free Traders are no exception; you must cross to another moiety but you can't marry fraki. But your rules produce an unusual setup; each ship is a patrilocal matriarchy."

"A what?"

" 'Patrilocal' means that wives join their husband's families; a matriarcy . . . well, who bosses this ship?"

"Why, the captain."

"He does?"

"Well, Father listens to Grandmother, but she is getting old and—"

"No 'buts'. The Chief Officer is boss. It surprised me; I thought it must be just this ship. But it extends all through the People. Men do the trading, conn the ship and mind its power plant—but a woman always is boss. It makes sense within its framework; it makes your marriage customs tolerable."

Thorby wished she would not keep referring to marriage.

"You haven't seen ships trade daughters. Girls leaving weep and wail and almost have to be dragged . . . but girls arriving have dried their eyes and are ready to smile and flirt, eyes open for husbands. If a girl catches the right man and pushes him, someday she can be sovereign of an independent state. Until she leaves her native ship, she isn't anybody—which is why her tears dry quickly. But if men were boss, girl-swapping would be slavery; as it is, it's a girl's big chance."

Dr. Mader turned away from the chart. "Human customs that help people live together are almost never planned. But they *are* useful, or they don't survive. Thorby, you have been fretted about how to behave toward your relatives."

"I certainly have!"

"What's the most important thing to a Trader?"

Thorby thought. "Why, the Family."

"Not at all. His ship."

"Well, when you say 'ship' you mean 'family.' "

"Just backwards. If a Trader becomes dissatisfied, where can he go? Space won't have him without a ship around him; nor can he imagine living on a planet among fraki, the idea is disgusting. His ship is his life, the air he breathes comes from his ship; somehow he must learn to live in it. But the pressure of personalities is almost unbearable and there is no way to get away from each other. Pressure could build up until somebody gets killed . . . or until the ship itself is destroyed. But humans devise ways to adjust to any conditions. You people lubricate with rituals, formalism, set patterns of speech, obligatory actions and responses. When things grow difficult you hide behind a pattern. That's why Fritz didn't stay angry."

"Huh?"

"He couldn't. You had done something wrong . . . but the fact itself showed that you were ignorant. Fritz

had momentarily forgotten, then he remembered and his anger disappeared. The People do not permit themselves to be angry with a child; instead they set him back on the proper path . . . until he follows your complex customs as automatically as Fritz does."

"Uh, I think I see." Thorby sighed. "But it isn't easy."

"Because you weren't born to it. But you'll learn and it will be no more effort than breathing—and as useful. Customs tell a man who he is, where he belongs, what he must do. Better illogical customs than none; men cannot live together without them. From an anthropologist's view, 'justice' is a search for workable customs."

"My father—my other father, I mean; Baslim the Cripple—used to say the way to find justice is to deal fairly with other people and not worry about how they deal with you."

"Doesn't that fit what I said?"

"Uh, I guess so."

"I think Baslim the Cripple would regard the People as just." She patted his shoulder. "Never mind, Thorby. Do your best and one day you'll marry one of those nice girls. You'll be happy."

The prophecy did not cheer Thorby.

IX.

By the time *Sisu* approached Losian Thorby had a battle station worthy of a man. His first assignment had been to assist in the central dressing station, an unnecessary job. But his background in mathematics got him promoted.

He had been attending the ship's school. Baslim had given him a broad education, but this fact did not stand out to his instructors, since most of what they regarded as necessary—the Finnish language as they spoke it, the history of the People and of *Sisu*, trading customs, business practices, export and import laws of many planets, hydroponics and ship's economy, ship safety and damage control—were subjects that Baslim had not even touched; he had emphasized languages, science, mathematics, galactography and history. The new subjects Thorby gobbled with a speed possible only to one renshawed by Baslim's strenuous methods. The traders needed applied mathematics — bookkeeping and accounting, astrogation, nucleonics for a hydrogen-fusion-powered n-ship. Thorby splashed through the first, the second was hardly more difficult, but as for the third, the ship's schoolmaster was astounded that this exfraki had already studied multidimensional geometries.

So he reported to the captain that they had a mathematical genius aboard.

This was not true. But it got Thorby reassigned to the starboard fire-control computer.

The greatest hazard to trading ships is in the first and last legs of each jump, when a ship is below speed-of-light. It is theoretically pos-

sible to detect and intercept a ship going many times speed-of-light, when it is irrational to the four-dimensional space of the senses; in practice it is about as easy as hitting a particular rain drop with bow and arrow during a storm at midnight. But it is feasible to hunt down a ship moving below speed-of-light if the attacker is fast and the victim is a big lumbering freighter.

The *Sisu* had acceleration of one hundred standard gravities and used it all to cut down the hazard time. But a ship which speeds up by a kilometer per second each second will take three and one half standard days to reach speed-of-light.

Half a week is a long, nervous time to wait. Doubling acceleration would have cut danger time by half and made the *Sisu* as agile as a raider—but it would have meant a hydrogen-fission chamber eight times as big with parallel increase in radiation shielding, auxiliary equipment, and paramagnetic capsule to contain the hydrogen reaction; the added mass would eliminate cargo capacity. Traders are working people; even if there were no parasites preying on them they could not afford to burn their profits in the inexorable workings of an exponential law of multi-dimensional physics. So the *Sisu* had the best legs she could afford—but not long enough to outrun a ship unburdened by cargo.

Nor could *Sisu* maneuver easily. She had to go precisely in the right direction when she entered the trackless night of n-space, else when she came out she would be too far from market; such a mistake could turn the ledger from black to red. Still more hampering, her skipper had to be prepared to cut power entirely, or risk having his in-ship artificial gravity field destroyed—and thereby make strawberry jam of the Family as soft bodies were suddenly exposed to one hundred gravities.

This is why captains get stomach ulcers; it isn't dickering for cargoes, figuring discounts and commissions, and trying to guess what goods will show the best return. It's not long jumps through the black—that is when he can relax and dandle babies. It is starting and ending a jump that kills him off, the long aching hours when he may have to make a split-second decision involving the lives—or freedom—of his family.

If raiders wished to destroy merchant ships, *Sisu* and her sisters would not stand a chance. But the raider wants loot and slaves; it gains him nothing simply to blast a ship.

Merchantmen are limited by no qualms; an attacking ship's destruction is the ideal outcome. Atomic target-seekers are dreadfully expensive, and using them up is rough on profit-and-loss—but there is no holding back if the computer says the target can be reached—whereas a raider will use destruction weapons only to save himself. His tactic is to blind the trader, burn out her instruments so that he can get close enough to paralyze everyone aboard—or, failing that, kill without destroying ship and cargo.

The trader runs if she can, fights if she must. But when she fights, she fights to kill.

Whenever *Sisu* was below speed-of-light, she listened with artificial senses to every disturbance in multi-space, the whisper of n-space communication or the "white" roar of a ship boosting at many gravities. Data poured into the ship's astrogational analogue of space and the questions were: Where is this other ship? What is its course? Speed? acceleration? Can it catch us before we reach n-space?

If the answers were threatening, digested data channeled into port and starboard fire-control computers and *Sisu* braced herself to fight. Ordnancemen armed A-bomb target seekers, caressed their sleek sides and muttered charms; the Chief Engineer unlocked the suicide switch which could let the power plant become a hydrogen bomb of monstrous size and prayed that, in final extremity, he would have the courage to deliver his people into the shelter of death; the captain sounded the clangor calling the ship from watch-and-watch to General Quarters. Cooks switched off fires; auxiliary engineers closed down air circulation; farmers said good-by to their green growing things and hurried to fighting stations; mothers with babies mustered, then strapped down and held those babies tightly.

Then the waiting started.

But not for Thorby—not for those assigned to fire-control computers. Sweating into their straps, for the next minutes or hours the life of *Sisu* is in their hands. The fire-control computer machines, chewing with millisecond meditation data from the analogue, decide whether or not torpedoes can reach target, then offer four answers: ballistic "possible" or "impossible" for projected condition, yes or no for condition changed by one ship, or the other, or both, through cutting power. These answers automatic circuits could handle alone, but machines do not think. Half of each computer is designed to allow the operator to ask what the situation might be in the far future of five minutes or so from now if variables change—and whether the target might be reached under such changes.

Any variable can be shaded by human judgment; an intuitive projection by a human operator can save his ship—or lose it. A paralysis beam travels at speed-of-light; torpedoes never have time to get up to more than a few hundred kilometers per second—yet it is possible for a raider to come within beaming range, have his pencil of paralyzing radiation on its way, and the trader to launch a target-seeker before the beam strikes . . . and still be saved when the outlaw flames into atomic mist a little later.

But if the operator is too eager by a few seconds, or overly cautious by the same, he can lose his ship. Too eager, the missile will fail to reach target; too cautious, it will never be launched.

Seasoned oldsters are not good at these jobs. The perfect fire-controlman is an adolescent, or young man or woman, fast in thought and action, confident, with intuitive grasp of mathematical relations beyond rote and rule, and not afraid of death he cannot yet imagine.

The traders must be always alert for such youngsters; Thorby seemed to have the feel for mathematics; he might have the other talents for a job something like chess played under terrific pressure and a fast game of spat ball. His mentor was Jeri Kingslover, his nephew and roommate. Jeri was junior in family rank but appeared to be older; he called Thorby "Uncle" outside the computer room; on the job Thorby called him "Starboard Senior Fire-controlman" and added "Sir."

During long weeks of the dive through dark toward Losian Jeri drilled Thorby. Thorby was supposed to be training for hydroponics and Jeri was the Supercargo's Senior Clerk, but the ship had plenty of farmers and the Supercargo's office was never very busy in space; Captain Krausa directed Jeri to keep Thorby hard at it in the computer room.

Since the ship remained at battle stations for half a week while boosting to speed-of-light, each fighting station had two persons assigned watch-and-watch. Jeri's junior controlman was his younger sister Mata. The computer had twin consoles, either of which could command by means of a selector switch. At General Quarters they sat side by side, with Jeri controlling and Mata ready to take over.

After a stiff course in what the machine could do Jeri put Thorby at one console, Mata at the other and fed them problems from the ship's control room. Each console recorded; it was possible to see what decisions each operator had made and how these compared with those made in battle, for the data were from records, real or threatened battles in the past.

Shortly Thorby became extremely irked; Mata was enormously better at it than he was.

So he tried harder and got worse. While he sweated trying to outguess a slave raider which had once been on *Sisu's* screens he was painfully aware of a slender, dark, rather pretty girl beside him, her swift fingers making tiny adjustments among keys and knobs, changing a bias or modifying a vector, herself relaxed and unhurried. It was humiliating afterwards to find that his pacesetter had "saved the ship" while he had failed.

Worse still, he was aware of her as a girl and did not know it—all he knew was that she made him uneasy.

After one run Jeri called from ship's control, "End of drill. Stand by." He appeared shortly and examined their tapes, reading marks on sensitized paper as another might read print. He pursed his lips over Thorby's record. "Trainee, you fired three times . . . and not a one of your beasts got within fifty thousand

kilometers of the enemy. We don't mind expense—it's merely Grandmother's blood. But the object is to blast him, not scare him into a fit. You have to wait until you can hit."

"I did my best!"

"Not good enough. Let's see yours, Sis."

The nickname irritated Thorby still more. Brother and sister were fond of each other and did not bother with titles. So Thorby had tried using their names . . . and had been snubbed; he was "Trainee," they were "Senior Controlman" and "Junior Controlman." There was nothing he could do; at drill he was junior. For a week, Thorby addressed Jeri as "Foster Ortho-Nephew" outside of drills and Jeri had carefully addressed him by family title. Then Thorby decided it was silly and went back to calling him Jeri. But Jeri continued to call him "Trainee" during drill, and so did Mata.

Jeri looked over his sister's record and nodded. "Very nice, Sis! You're within a second of post-analyzed optimum, and three seconds better than the shot that got the so-and-so. I have to admit that's sweet shooting . . . because the real run is my

own. That raider off Ingstel . . . remember?"

"I certainly do." She glanced at Thorby.

Thorby felt disgusted. "It's not fair!" He started hauling at safety-belt buckles.

Jeri looked surprised. "What, Trainee?"

"I said it's not fair! You send down a problem, I tackle it cold—and get bawled out because I'm not perfect. But all she had to do is to fiddle with controls to get an answer she already knows . . . to make me look cheap!"

Mata was looking stricken. Thorby headed for the door. "I never asked for this! I'm going to the captain and ask for another job."

"Trainee!"

Thorby stopped. Jeri went on quietly. "Sit down. When I'm through, you can see the captain—if you think it's advisable."

Thorby sat down.

"I've two things to say," Jeri continued coldly. "First—" He turned to his sister. "Junior Controlman, did you know what problem this was when you were tracking?"

"No, Senior Controlman."

"Have you worked it before?"

"I don't think so."

"How was it you remembered it?"

"What? Why, you said it was the raider off Ingstel. I'll never forget because of the dinner afterwards—you sat with Great Grandmo . . . with the Chief Officer."

Jeri turned to Thorby. "You see? She tackled it cold . . . as cold as I had to when it happened. And she did even better than I did; I'm proud to have her as my junior tracker. For your information, Mister Stupid Junior Trainee, this engagement took place before the Junior Controlman became a trainee. She hasn't even run it in practice. She's just better at it than you are."

"All right," Thorby said sullenly. "I'll probably never be any good. I said I wanted to quit."

"I'm talking. Nobody asks for this job; it's a headache. Nobody quits it, either. After a while the job quits him, when post-analysis shows that he is losing his touch. Maybe I'm beginning to. But I promise you this: you'll either learn, or *I* will go to the captain and tell him you don't measure up. In the meantime—if I have any lip out of you, I'll haul you up before the Chief Officer!" He snapped, "Extra drill run. Battle Stations. Cast loose your equipment." He left the room.

Moments later his voice reached them. "Bogie! Starboard computer room, report!"

The call to dinner sounded; Mata said gravely, "Starboard tracker manned. Data showing, starting run." Her fingers started caressing keys. Thorby bent over his own controls; he wasn't hungry anyhow. For days Thorby spoke with Jeri only formally. He saw Mata at drill, or across the lounge at meals; he treated her with cold correctness and tried to do as well as she did. He could have seen her at other times; young

people associated freely in public places. She was taboo to him, both as his niece and because they were of the same moiety, but that was no bar to social relations.

Jeri he could not avoid; they ate at the same table, slept in the same room. But Thorby could and did throw up a barrier of formality. No one said anything—these things happened. Even Fritz pretended not to notice.

But one afternoon Thorby dropped into the lounge to see a story film with a Sargonese background; Thorby sat through it to pick it to pieces. But when it was over he could not avoid noticing Mata because she walked over, stood in front of him, addressed him humbly as her uncle and asked if he would care for a game of spat ball before supper?

He was about to refuse when he noticed her face; she was watching him with tragic eagerness. So he answered, "Why, thanks, Mata. Work up an appetite."

She broke into smiles. "Good! I've got Ilsa holding a table. Let's!"

Thorby beat her three games and tied one . . . a remarkable score, since she was female champion and was allowed only one point handicap when playing the male champion. But he did not think about it; he was enjoying himself.

His performance picked up, partly through the grimness with which he worked, partly because he did have feeling for complex geometry, and partly because the beggar's boy had had his brain sharpened by an ancient discipline. Jeri never again compared aloud the performances of Mata and Thorby and gave only brief comments on Thorby's results: "Better," or "Coming along," and eventually, "You're getting there." Thorby's morale soared; he loosened up and spent more time socially, playing spat ball with Mata rather frequently.

Toward the end of journey through darkness they finished the last drill one morning and Jeri called out, "Stand easy! I'll be a few minutes." Thorby relaxed from pleasant strain. But after a moment he fidgeted; he had a hunch that he had been in tune with his instruments. "Junior Controlman . . . do you suppose he would mind if I looked at my tape?"

"I don't think so," Mata answered. "I'll take it out; then it's my responsibility."

"I don't want to get you in trouble."

"You won't," Mata answered serenely. She reached back of Thorby's console, pulled out the strip record, blew on it to keep it from curling, and examined it. Then she pulled her own strip, compared the two.

She looked at him gravely. "That's a very good run, Thorby."

It was the first time she had ever spoken his name. But Thorby hardly noticed. "Really? You mean it?"

"It's a *very* good run . . . Thorby. We both got hits But yours is optimum between 'possible' and 'critical limit'—whereas mine is too eager. See?"

Thorby could read strips only haltingly, but he was happy to take her word for it. Jeri came in, took both strips, looked at Thorby's, then looked more closely. "I dug up the post-analysis before I came down," he said.

"Yes, sir?" Thorby said eagerly.

"I'll check it after chow—but it looks as if your mistakes had cancelled out."

Mata said, "Why, Bud, that's a perfect run and you know it!"

"Suppose it is?" Jeri grinned. "You wouldn't want your star pupil to get a swelled head, would you?"

"Pooh!"

"Right back at you, small and ugly sister. Let's go to chow."

They went through a narrow passage into trunk corridor of second deck, where they walked abreast. Thorby gave a deep sigh.

"Trouble?" his nephew asked.

"Not a bit!" Thorby put an arm around each of them. "Jeri, you and Mata are going to make a marksman out of me yet."

It was the first time Thorby had addressed his teacher by name since the day he had reieived the scorching. But Jeri accepted his uncle's overture without stiffness. "Don't get your hopes up, bunkmate. But I think we've got it licked." He added, "I see Great Aunt Tora is giving us her famous cold eye. If anybody wants my opinion, I think Sis can walk unassisted—I'm sure Great Aunt thinks so."

"Pooh to her, too! Mata said briskly. "Thorby just made a perfect run."

Sisu came out of darkness, dropping below speed-of-light. Losian's sun blazed less than fifty billion kilometers away; in a few days they would reach their next market. The ship went to watch-and-watch battle stations.

Mata took her watch alone; Jeri required the trainee to stand watches with him. The first watch was always free from strain; even if a raider had accurate information via n-space communicator of *Sisu's* time of departure and destination, it was impossible in a jump of many light-years to predict the exact time and place where she would poke her nose out into rational space.

Jeri settled in his chair some minutes after Thorby had strapped down with that age-old tense feeling that this time it was not practice. Jeri grinned at him. "Relax. If you get your blood stream loaded, your back will ache, and you'll never last."

Thorby grinned feebly. "I'll try."

"That's better. We're going to play a game." Jeri pulled a boxlike contrivance out of a pocket, snapped it open.

"What is that?"

"A 'killjoy.' It fits here." Jeri slipped it over the switch that determined which console was in command. "Can you see the switch?"

"Huh? No."

"Hand the man the prize." Jeri fiddled with the switch behind the screen. "Which of us is in control in case we have to launch a bomb now?"

"How can I tell? Take that off, Jeri; it makes me nervous."

"That's the game. Maybe I'm controlling and you are just going through motions; maybe *you* are the man at the trigger and I'm asleep in my chair. Every so often I'll fiddle with the switch—but you won't know how I've left it. So when a flap comes—and one will; I feel it in my bones—you can't assume that good old Jeri, the man with the micrometer fingers, has the situation under control. You might have to save the firm. *You.*"

Thorby had a queasy vision of waiting men and bombs in the missile room below—waiting for him to solve precisely an impossible problem of life and death, of warped space and shifting vectors and complex geometry. "You're kidding," he said feebly. "You wouldn't leave me in control. Why, the captain would skin you alive."

"Ah, that's where you're wrong. There always comes a day when a trainee makes his first real run. After that, he's a controlman . . . or an angel. But we don't let you worry at the time. Oh no! we just keep you worried all the time. Now here's the game. Any time I say, 'Now!' you guess who has control. You guess right, I owe you one dessert; you guess wrong, you owe me one. *Now!*"

Thorby thought quickly. "I guess I've got it."

"Wrong." Jeri lifted the killjoy. "You owe me one dessert—and it's berry tart tonight; my mouth is watering. But faster; you're supposed to make quick decisions. Now!"

"You've still got it!"

"So I have. Even. Now!"

"You!"

"Nope. See? And I eat your tart —I ought to quit while I'm ahead. Love that juice! Now!"

When Mata relieved them, Jeri owned Thorby's desserts for the next four days. "We start again with that score," Jeri said, "except that I'm going to collect that nice juicy berry tart. But I forgot to tell you the big prize."

"Which is?"

"Comes the real thing, we bet three desserts. After it's over, you guess and we settle. Always bet more on real ones."

Mata sniffed. "Bud, are you trying to make him nervous?"

"Are you nervous, Thorby?"

"Nope!"

"Quit fretting, Sis. Got it firmly in your grubby little hands?"

"I relieve you, sir."

"Come on, Thorby; let's eat. Berry tarts—aaah!"

Three days later the score stood even, but only because Thorby had missed most of his desserts. *Sisu* was enormously slowed, almost to planetary speeds, and Losian's sun loomed large on the screens. Thorby decided, with mildest regret, that his ability to fight would not be tested this jump.

Then the general alarm made him rear up against safety belts. Jeri had been talking; his head jerked around, he looked at displays, and his hands moved to his controls.

"Get on it!" he yelped. "This one's real."

Thorby snapped out of shock and bent over his board. The analogue globe was pouring data to them; the ballistic situation had built up. Good heavens, it was *close!* And matching in fast! How had anything moved in so close without being detected? Then he quit thinking and started investigating answers . . . no, not yet . . . before long though . . . could the bandit turn a little at that boost and reduce his approach? . . . try a projection at an assumed six gravities of turning . . . would a missile reach him? . . . would it still reach him if he did not—

He hardly felt Mata's gentle touch on his shoulder. But he heard Jeri snap, "Stay out, Sis! We're on it, we're on it!"

A light blinked on Thorby's board; the squawk horn sounded, "Friendly craft! Losian planetary patrol, easily identified. Return to watch-and-watch."

Thorby took a deep breath, felt a great load lift.

"Continue your run!" screamed Jeri.

"Huh?"

"Finish your run! That's no Losian craft; *that's a raider!* Losians can't maneuver that way! You've got it boy, you've got it! *Nail him!"*

Thorby heard Mata's frightened gasp, but he was again at his problem. Change anything? Could he reach him? Could he still reach him in the cone of possible maneuver? *Now!* He armed his board and let the computer give the order, on projection.

He heard Jeri's voice faintly; Jeri seemed to be talking very slowly. "Missile away. I think you got him . . . but you were eager. Get off another one before their beam hits us."

Automatically Thorby complied. Time was too short to try another solution; he ordered the machine to send another missile according to projection. He then saw by his board that the target was no longer under power and decided with a curiously empty feeling that his first missile had destroyed it.

"That's all!" Jeri announced. "Now!"

"What?"

"Who had it? You or me? Three desserts."

"*I* had it," Thorby said with certainty. In another level he decided that he would never really be a Trader—to Jeri that target had been —just fraki. Or three desserts.

"Wrong. That puts me three up. I turned coward and kept control myself. Of course the bombs were disarmed and the launchers locked as soon as the captain gave the word . . . but I didn't have the nerve to risk an accident with a friendly ship."

"Friendly ship!"

"Of course. But for *you*, Assistant Junior Controlman, it was your first real one . . . as I intended."

Thorby's head floated. Mata said, "Bud, you're mean to collect. You cheated."

"Sure I cheated. But he's a blooded controlman now, just the same. And I'm going to collect, just the very same. Ice cream tonight!"

X.

Thorby did not stay an assistant junior fire-controlman; Jeri moved up to astrogation trainee; Mata took charge of the starboard room, and Thorby was officially posted as the new Starboard Junior Fire-controlman, with life and death in his forefinger. He was not sure that he liked it.

Then that arrangement tumbled almost as quickly.

Losian is a "safe" planet. Inhabited by civilized non-humans, it is a port safe from ground raids; no dirtside defensive watches were necessary. Men could leave the ship for pleasure and even women could do so. (Some of the women aboard had not left the ship, save at Gatherings of the People, since being exchanged to *Sisu* as girls.)

Losian was to Thorby his "first" foreign land, Jubbul being the only planet clear in his memory. So he was very eager to see it. But work came first. When he was confirmed as a fire-controlman, he was transferred from hydroponics into the junior vacancy among the Supercargo's clerks. It increased Thorby's status; business carried more prestige than housekeeping. Theoretically he was now qualified to check cargo; in fact a senior clerk did that while Thorby sweated, along with junior male relatives from every department. Cargo was an all-hands operation, as *Sisu* never permitted stevedores inside, even if it meant paying for featherbedding.

The Losians have never invented tariff; crated bales of verga leaves were turned over to purchaser right outside the ship. In spite of blowers the hold reeked of their spicy, narcotic fragrance and reminded Thorby of months past and light-years away when he had huddled, a fugitive in danger of being shortened, into a hole in one crate while a friendly stranger smuggled him through the Sargon's police.

It didn't seem possible. *Sisu* was home. Even as he mused, he thought in the Family's language.

He realized with sudden guilt that he had not thought about Pop very often lately. Was he forgetting Pop? No, no! He could never forget, not anything . . . Pop's tones of voice, the detached look when he was about to comment unfavorably, his creaking movements on chilly mornings, his unfailing patience no matter what—why, in all those years Pop had never been angry with him . . . yes, he had, once.

"'I am not your master!'"

Pop had been angry that once. It had scared Thorby; he hadn't understood.

Now, across long space and time, Thorby suddenly understood. Only one thing could make Pop angry; Pop had been explosively insulted at the assertion that Baslim the Cripple was master to a slave. Pop, who main-

tained that a wise man could not be insulted, since truth could not insult and untruth was not worthy of notice.

Yet Pop had been insulted by the truth, for certainly Pop had been his master; Pop had bought him off the block. No, that was nonsense! He hadn't been Pop's slave; he had been Pop's son . . . Pop was never his master, even the times he had given him a quick one across the behind for goofing. Pop . . . was just "Pop."

Thorby knew then that the one thing that Pop truly hated was slavery.

Thorby was not sure why he was sure, but he was. He could not recall that Pop had ever said a word about the slavery, as such; all Thorby could remember Pop saying was that a man need never be other than free in his own mind.

"Hey!"

The Supercargo looking at him. "Sir?"

"Are you moving that crate, or making a bed of it?"

Three local days later Thorby had finished showering, about to hit dirt with Fritz, when the deckmaster stuck his head in the washroom, spotted him, and said, "Captain's compliments and Clerk Thorby Baslim-Krausa will attend him."

"Aye, aye, Deckmaster," Thorby answered and added something under his breath. He hurried into clothes, stuck his head into his bunkie, gave the sad word to Fritz and rushed to the Cabin, hoping that the Deckmaster had told the captain that Thorby had been showering.

The door was open. Thorby started to report formally when the captain looked up. "Hello, Son. Come in."

Thorby shifted gears from Ship to Family. "Yes, Father."

"I'm about to hit dirt. Want to come along?' "

"Sir? I mean, 'Yes, Father!' That 'ud be swell!"

"Good. I see you're ready. Let's go." He reached in a drawer and handed Thorby some twisted bits of wire. "Here's pocket money; you may want a souvenir."

Thorby examined it. "What's this stuff worth, Father?"

"Nothing—once we're off Losian. So give me back what you have left so I can turn it in for credit. They pay us off in thorium and goods."

"Yes, but how will I know how much to pay for a thing?"

"Take their word for it. They won't cheat and won't bargain. Odd ones. Not like Lotarf . . . on Lotarf, if you buy a beer without an hour's dickering you're ahead."

Thorby felt that he understood Lotarf better than he did Losians. There was something indecent about a purchase without a polite amount of dickering. But fraki had barbaric customs; you had to cater to them—*Sisu* prided herself on never having trouble with fraki.

"Come along. We can talk as we go."

As they were being lowered Thorby looked at the ship nearest them,

Free Trader *El Nido,* Garcia clan. "Father, are we going to visit with them?"

"No, I exchanged calls the first day."

"I didn't mean that. Will there be any parties?"

"Oh. Captain Garcia and I agreed to dispense with hospitality; he's anxious to jump. No reason why you shouldn't visit them though, subject to your duties." He added, "Hardly worth it; she's like *Sisu,* only not as modern."

"Thought I might look at her computer rooms."

They hit ground and stepped off. "Doubt if they'd let you. They're a superstitious lot." As they stepped clear of the hoist a baby Losian came streaking up, circled and sniffed their legs. Captain Krausa let the little thing investigate him, then said mildly, "That's enough," and gently pushed it away. Its mother whistled it back, picked it up and spanked it. Captain Krausa waved to her, called out, "Hello, friend!"

"Hello Trader Man," she answered in Interlingua shrill and sibilant. She was two-thirds Thorby's height, on four legs with forelimbs elevated—the baby had been on all six. Both were sleek and pretty and sharp-eyed. Thorby was amused by them and only slightly put off by the double mouth arrangement—one for eating, one for breathing and talking.

Captain Krausa continued talking. "That was a nice run you made on that Losian craft."

Thorby blushed. "You knew about that, Father?"

"What kind of a captain am I if I don't? Oh, I know what's worrying you. Forget it. If I give you a target, you burn it. It's up to me to kill your circuits if we make friendly identification. If I slap the God-be-thanked switch, you can't get your computer to fire, the bombs are disarmed, the launching gear is locked, the chief can't move the suicide switch. So even if you hear me call off the action—or you get excited and don't hear—it doesn't matter. Finish your run; it's good practice."

"Oh, I didn't know, Father."

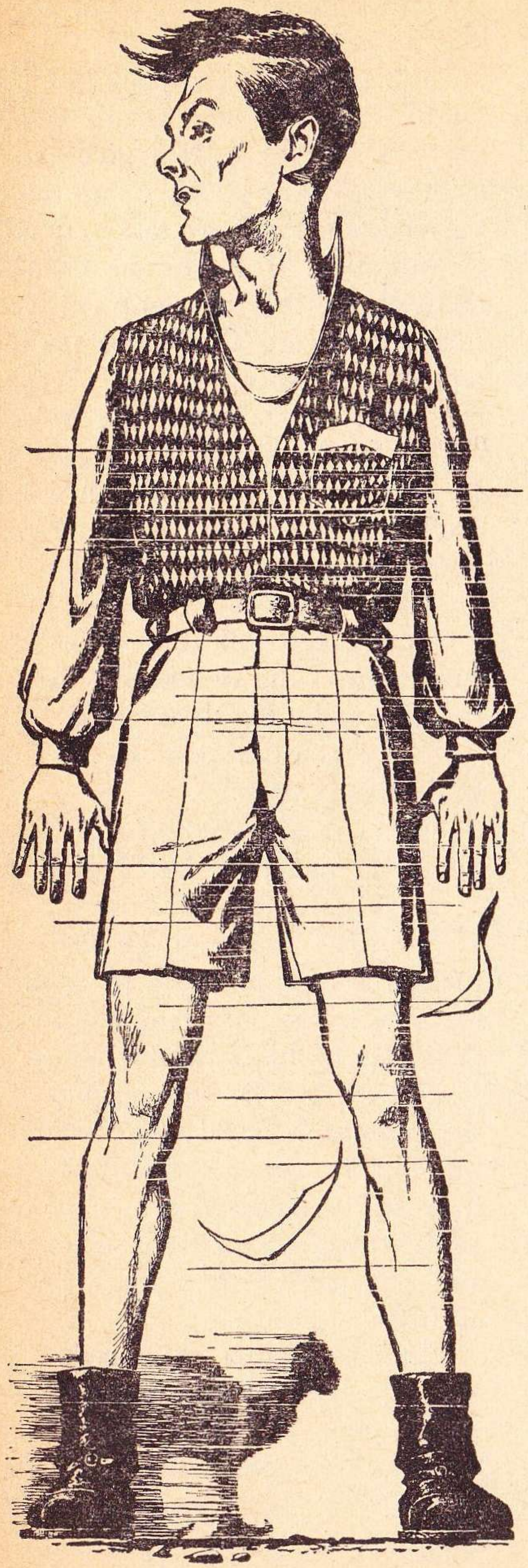
"Didn't Jeri tell you? You must have noticed the switch; it's the big red one, under my right hand."

"Uh, I've never been in the Control Room, Father."

"Eh? I must correct that; it might belong to you some day. Remind me . . . right after we go irrational."

"I will, Father." Thorby was pleased at the prospect of entering the mysterious shrine—he was sure that half of his relatives had never visited it—but he was surprised at the comment. Could a former fraki be eligible for command? It was legal for an adopted son to succeed to the worry seat; sometimes captains had no sons of their own. But an ex-fraki?

Captain Krausa was saying, "I haven't given you the attention I should, Son . . . not the care I should give Baslim's son. But it's a big family and my time is so taken up. Are they treating you all right?"



"Why, sure, Father!"

"Mmm . . . glad to hear it. It's . . . well, you weren't born among the People, you know."

"I know. But everybody has treated me fine."

"Good. I've had good reports about you. You seem to learn fast, for a . . . you learn fast."

Thorby sourly finished the phrase in his mind. The captain went on, "Have you been in the Power Room?"

"No, sir. Just the practice room once."

"Now is a good time, while we're grounded. It's safer and the prayers and cleansing aren't so lengthy." Krausa paused. "No, we'll wait until your status is clear—the chief is hinting that you are material for his department. He has some silly idea that you will never have children anyway and he might regard a visit as an opportunity to snag you. Engineers!"

Thorby understood this speech, even the last word. Engineers were regarded as slightly balmy; it was commonly believed that radiations from the artificial star that gave *Sisu* her life ionized their brain tissues. True or not, engineers could get away with outrageous breaches of etiquette—"not guilty by reason of insanity" was an unspoken defense for them once they had been repeatedly exposed to the hazards of their trade. The Chief Engineer even talked back to Grandmother.

But junior engineers were not allowed to stand power-room watches

until they no longer expected to have children; they took care of auxiliary machinery and stood training watches in a dummy power-room. The People were cautious about harmful mutations, because they were more exposed to radiation hazards than were planet dwellers. One never saw overt mutation among them; what happened to babies distorted at birth was a mystery so taboo that Thorby was not even aware of it; he simply knew that power watchstanders were old men.

Nor was he interested in progeny; he simply saw in the captain's remarks a hint that the Chief Engineer considered that Thorby could reach the exalted status of power watchstander quickly. The idea dazzled him. The men who wrestled with the mad gods of nuclear physics held status just below astrogators—and, in their own opinion, higher. Their opinion was closer to fact than was the official one; even a deputy captain who attempted to pull rank on a man standing power-room watches was likely to wind up counting stores while the engineer rested in sick bay, then went back to doing as he pleased. Was it possible that an ex-fraki could aspire to such heights? Perhaps some day be Chief Engineer and sass the Chief Officer with impunity?

"Father," Thorby said eagerly, "the Chief Engineer thinks I can learn power-room rituals?"

"Wasn't that what I said?"

"Yes, sir. Uh . . . I wonder why he thought so?"

"Are you dense? Or unusually modest? Any man who can handle fire-control mathematics can learn nuclear engineering. But he can learn astrogation, too, which is just as important."

Engineers never handled cargo; the only work they did in port was to load tritium and deuterium, or other tasks strictly theirs. They did no housekeeping. They . . . "Father? I think I might like to be an engineer."

"So? Well, now that you've thought so, forget it."

"But—"

" 'But' what?"

"Nothing, sir. Yes, sir."

Krausa sighed. "Son, I have obligations toward you; I'm carrying them out as best I can." Krausa thought over what he could tell the lad. Mother had pointed out that if Baslim had wanted the boy to know the message he had carried, Baslim would have put it in Interlingua. On the other hand, since the boy now knew the Family language perhaps he had translated it himself. No, more likely he had forgotten it. "Thorby, do you know who your family is?"

Thorby was startled. "Sir? My family is *Sisu*."

"Certainly! I mean your family before that."

"You mean Pop? Baslim the cripple?"

"No, no! He was your foster father, just as I am now. Do you know what family you were born in?"

Thorby said bleakly, "I don't think I had one."

Krausa realized that he had poked a scar, said hastily, "Now, Son, you don't have to copy all the attitudes of your messmates. Why, if it weren't for fraki, with whom would we trade? How would the People live? A man is fortunate to be born People, but there is nothing to be ashamed of in being born fraki. Every atom has its purpose."

"I'm not ashamed!"

"Take it easy!"

"Sorry, sir. I'm not ashamed of my ancestors. I simply don't know who they were. Why, for all I know, they may have been People."

Krausa was startled. "Why, so they could have been," he said slowly. Most slaves were purchased on planets that respectable traders never visited, or were born on estates of their owners . . . but a tragic percentage were *People,* stolen by raiders. This lad— Had any ship of the People been lost around the necessary time? He wondered if, at the next Gathering, he might dig up identification from the Commodore's files?

But even that would not exhaust the possibilities; some chief officers were sloppy about sending in identifications at birth, some waited until a Gathering. Mother, now, never grudged the expense of a long n-space message; she wanted her children on record at once—*Sisu* was never slack.

Suppose the boy were born People and his record had never reached the Commodore? How unfair to lose his birthright!

A thought tiptoed through his brain: a slip could be corrected in more ways than one. If any Free Ship had been lost— He could not remember.

Nor could he talk about it. But what a wonderful thing to give the lad an ancestry! If he could—

He changed the subject. "In a way, lad, you were always of the People."

"Huh? Excuse me, Father?"

"Son, Baslim the Cripple was an honorary member of the People."

"*What?* How, Father? What ship?"

"All ships. He was elected at a Gathering. Son, a long time ago a shameful thing happened. Baslim corrected it. It put all the People in debt to him. I have said enough. Tell me, have you thought of getting married?"

Marriage was the last thing on Thorby's mind; he was blazingly anxious to hear more about what Pop had done that had made him incredibly one of the People. But he recognized the warning with which an elder closed a taboo subject.

"Why, no, Father."

"Your Grandmother thinks that you have begun to notice girls seriously."

"Well, sir, Grandmother is never wrong . . . but I hadn't been aware of it."

"A man isn't complete without a wife. But I don't think you're old enough. Laugh with all the girls and

cry with none—and remember our customs." Krausa was thinking that he was bound by Baslim's injunction to seek aid of the Hegemony in finding where the lad had come from. It would be awkard if Thorby married before the opportunity arose. Yet the boy had grown taller in the months he had been in *Sisu*. Adding to Krausa's fret was an uneasy feeling that his half-conceived notion of finding—or faking—an ancestry for Thorby conflicted with his unbreakable obligations to Baslim.

Then he had a cheerful idea. "Tell you what, Son! It's possible that the girl for you isn't aboard. After all, there are only a few in port side purdah—and picking a wife is a serious matter. She can gain you status or ruin you. So why not take it easy? At the Great Gathering you will meet hundreds of eligible girls. If you find one you like and who likes you, I'll discuss it with your Grandmother and if she approves, we'll dicker for her exchange. You can be sure we won't be stingy either. How does that sound?"

It put the problem comfortably in the distance. "It sounds fine, Father!"

"I have said enough." Krausa thought happily that he would check the files while Thorby was meeting those "hundreds of girls"—and he need not review his obligation to Baslim until he had done so. The lad might be a born member of the People—in fact his obvious merits made fraki ancestry almost unthinkable. If so, Baslim's wishes would be carried out in the spirit more than if followed to the letter. In the meantime —forget it!

They completed the mile to the edge of the Losian community. Thorby stared at sleek Losian ships and thought uneasily that he had tried to burn one of those pretty things out of space. Then he reminded himself that Father had said it was not a fire-controlman's business to worry about what target was handed him.

When they got into city traffic he had no time to worry. Losians do not use passenger cars, nor do they favor anything as stately as a sedan chair. On foot, they scurry twice as fast as a man can run; in a hurry, they put on a vehicle which makes one think of jet propulsion. Four and sometimes six limbs are encased in sleeves which end in something like skates. A framework fits the body and carries a bulge for the power plant—what sort Thorby could not imagine. Encased in this mechanical clown suit, each becomes a guided missile, accelerating with careless abandon, showering sparks, filling the air with ear-splitting noises, cornering in defiance of friction, inertia, and gravity, cutting in and out, never braking until the last instant.

Pedestrians and powered speed maniacs mix democratically, with no perceptible rules. There seems to be no age limit for driver's licenses and the smallest Losians are simply more reckless editions of their elders.

Thorby wondered if he would ever get out into space alive.

A Losian would come zipping toward Thorby on the wrong side of the street—there was no right side—squeal to a stop almost on Thorby's toes, zig aside while snatching breath off his face and heart out of his mouth—and never touch him. Thorby would jump. After a dozen escapes he tried to pattern himself after his foster father. Captain Krausa ploughed stolidly ahead, apparently sure that the wild drivers would treat him as a stationary object. Thorby found it hard to live by that faith, but it seemed to work.

Thorby could not make out how the city was organized. Powered traffic and pedestrians poured through any opening and the convention of private land and public street did not seem to hold. At first they proceeded along an area which Thorby classified as a plaza, then they went up a ramp, through a building which had no clear limits—no vertical walls, no defined roof—out again and down, through an arch which skirted a hole. Thorby was lost.

Once he thought they must be going through a private home—they pushed through what must have been a dinner party. But the guests merely pulled in their feet.

Krausa stopped. "We're almost there. Son, we're visiting the fraki who bought our load. This meeting heals the trouble between us caused by buying and selling. He has offended me by offering payment; now we have to become friends again."

"We don't get paid?"

"What would your Grandmother say? We've already been paid—but now I'll give it to him free and he'll give me the thorium just because he likes my pretty blue eyes. Their customs don't allow anything as crass as selling."

"They don't trade with each other?"

"Of course they do. But the theory is that one fraki gives another anything he needs. It's sheer accident that the other happens to have money that he is anxious to press on the other as a gift—and that the two gifts balance. They are shrewd merchants, Son; we never pick up an extra credit here."

"Then why this nonsense?"

"Son, if you worry about why fraki do what they do, you'll drive yourself crazy. When you're on their planet, do it their way . . . it's good business. Now listen. We'll have a meal of friendship . . . only they can't, or they'll lose face. So there will be a screen between us. You have to be present, because the Losian's son will be there—only it's a daughter. And the fraki I'm going to see is the mother, not the father. Their males live in purdah . . . I think. But notice that when I speak through the interpreter, I'll use masculine gender."

"Why?"

"Because they know enough about our customs to know that masculine gender means the head of the house. It's logical if you look at it correctly."

Thorby wondered. Who was head of the Family? Father? Or Grandmother? Of course, when the Chief

Officer issued order, she signed it "By Order of the Captain," but that was just because . . . no. Well, anyhow—

Thorby suddenly suspected that the customs of the Family might be illogical in spots. But the captain was speaking. "We don't actually eat with them; that's another fiction. You'll be served a green slimy liquid. Just raise it to your lips; it would burn out your gullet. Otherwise—" Captain Krausa paused while a Losian scorcher avoided the end of his nose. "Otherwise listen so that you will know how to behave next time. Oh yes!—after I ask how old my host's son is, you'll be asked how old you are. You answer 'forty.'"

"Why?"

"Because that is a respectable age, in their years, for a son who is assisting his father."

They arrived and seemed still to be in public. But they squatted down opposite two Losians while a third crouched nearby. The screen between them was the size of a kerchief; Thorby could see over it. Thorby tried to look, listen, and learn, but the traffic never let up. It shot around and cut between them, with happy, shrill racket.

Their host started by accusing Captain Krausa of having lured him into a misdeed. The interpreter was almost impossible to understand, but he showed surprising command of scurrilous Interlingua. Thorby could not believe his ears and expected that Father would either walk out, or start trouble.

But Captain Krausa listened quietly, then answered with real poetry—he accused the Losian of every crime from barratry to mopery and dopery in the spaceways.

This put the meeting on a friendly footing. The Losian made them a present of the thorium he had already paid, then offered to throw in his sons and everything he possessed.

Captain Krausa accepted and gave away *Sisu,* with all contents.

Both parties generously gave back the gifts. They ended at status-quo, each to retain as a symbol of friendship what each now had: the Losian many hundredweight of verga leaf, the Trader slugs of thorium. Both agreed that the gifts were worthless but valuable for reasons of sentiment. In a burst of emotion the Losian gave away his son and Krausa made him (her) a present of Thorby. Inquiries followed and it was discovered that each was too young to leave the nest.

They got out of this dilemma by having the sons exchange names and Thorby found himself owner of a name he did not want and could not pronounce. Then they "ate."

The horrid green stuff was not only not fit to drink, but when Thorby inhaled, he burned his nostrils and choked. The captain gave him a reproving glance.

After that they left. No good-bys, they just walked off. Captain Krausa said meditatively while proceeding like a sleepwalker through the riot of traffic, "Nice people, for fraki. Never any sharp dealing and abso-

lutely honest. I often wonder what one of them would do if I took him up on one of those offers. Pay up, probably."

"Not really!"

"Don't be sure. I might hand you in on that half-grown Losian."

Thorby shut up.

Business concluded, Captain Krausa helped Thorby shop and sight-see which relieved Thorby, because he did not know what to buy, nor even how to get home. His foster father took him to a shop where Interlingua was understood. Losians manufacture all sorts of things of extreme complexity, none of which Thorby recognized. On Krausa's advice Thorby selected a small polished cube which, when shaken, showed endless Losian scenes in its depths. Thorby offered the shopkeeper his tokens; the Losian selected one and gave him change from a necklace of money. Then he made Thorby a present of shop and contents.

Thorby, speaking through Krausa, regretted that he had nothing to offer save his own services the rest of his life. They backed out of the predicament with courteous insults.

Thorby felt relieved when they reached the spaceport and he saw the homely, familiar lines of old *Sisu.*

When Thorby reached his bunkie, Jeri was there, feet up and hands back of his head. He looked up and did not smile.

"Hi, Jeri!"

"Hello, Thorby."

"Hit dirt?"

"No."

"I did. Look what I bought!" Thorby showed him the magic cube. "You shake it and every picture is different."

Jeri looked at one picture and handed it back. "Very nice."

"Jeri, what are you glum about? Something you ate?"

"No."

"Spill it."

Jeri dropped his feet to the deck, looked at Thorby. "I'm back in the computer room."

"Huh?"

"Oh, I don't lose status. It's just while I train somebody else."

Thorby felt a cold wind. "You mean I've ben busted?"

"No."

"Then what *do* you mean?"

"Mata has been swapped."

XI.

Mata swapped? Gone forever? Little Mattie with the grave eyes and merry giggle? Thorby felt a burst of sorrow and realized to his surprise that it mattered.

"I don't believe it!"

"Don't be a fool."

"When? Where has she gone? Why didn't you tell me?"

"To *El Nido,* obviously; it's the only ship of the People in port. About an hour ago. I didn't tell you because I had no idea it was coming . . . until I was summoned to Grandmother's cabin to say good-by." Jeri frowned. "It had to come some day . . . but I thought Grandmother

would let her stay as long as she kept her skill as a tracker."

"Why, Jeri? *Why?*"

Jeri stood up, said woodenly, "Foster Ortho-Uncle, I have said enough."

Thorby pushed him back into his chair. "You can't get away with that, Jeri. I'm your 'uncle' only because they said I was. But I'm still the exfraki you taught to use a tracker and we both know it. Now talk man to man. Spill it!"

"You won't like it."

"I don't like it now! Mattie gone . . . Look, Jeri, there is nobody here but us. Whatever it is, tell me. I promise you, on *Sisu's* steel, that I won't make an uncle-and-nephew matter of it. Whatever you say, the family will never know."

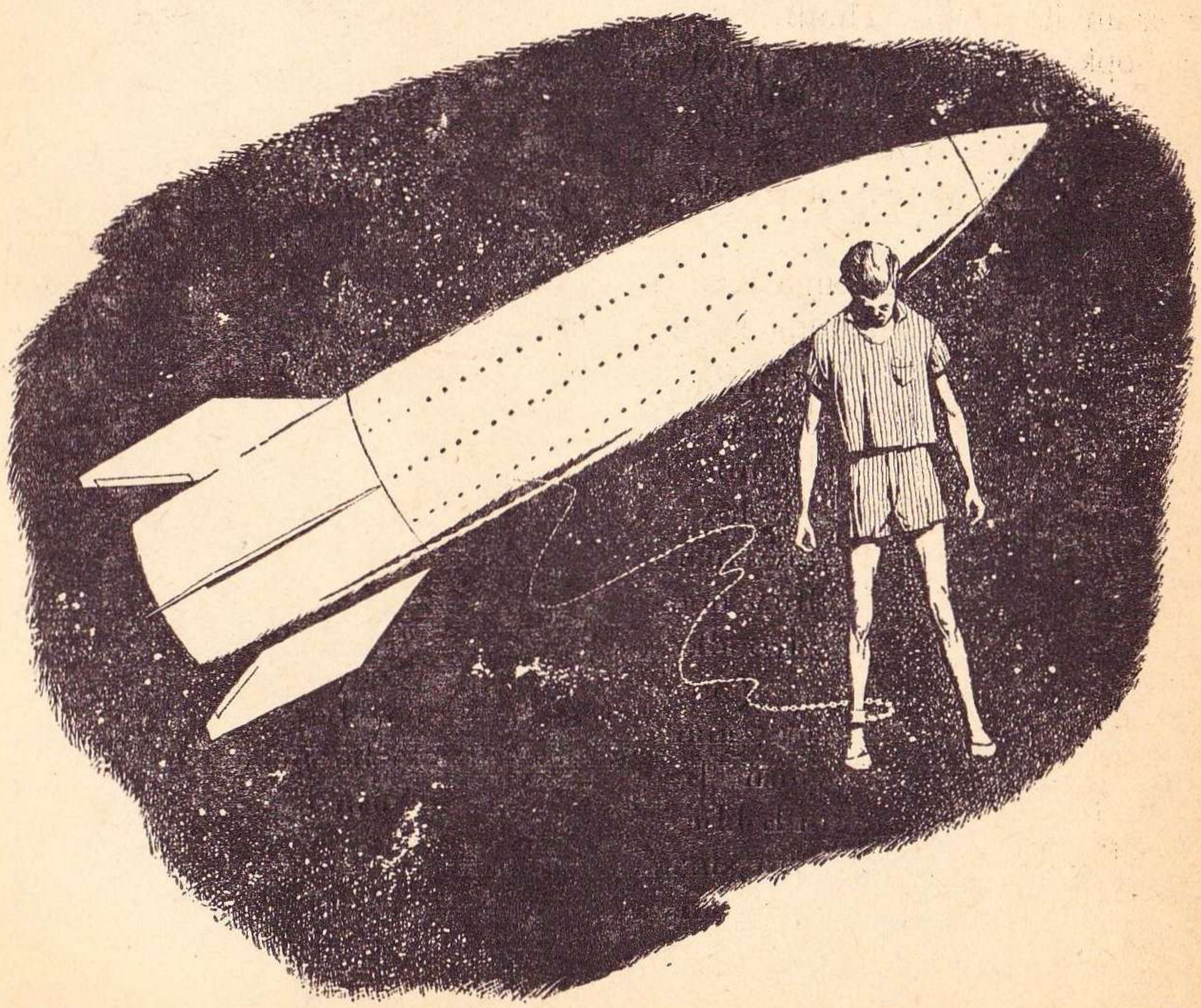
"Grandmother might be listening."

"If she is, I've ordered you to talk and it's my responsibility. But she won't be; it's time for her nap. So talk."

"O. K." Jeri looked at him sourly. "You asked for it. You mean to say you haven't the dimmest idea why Grandmother hustled my Sis out of the ship?"

"Huh? None . . . or I wouldn't ask."

Jeri made an impatient noise. "Thorby, I knew you were thick-witted. I didn't know you were deaf, dumb, and blind."



"Never mind the compliments! Tell me the score."

"You're the reason Mata got swapped. *You.*" Jeri looked at Thorby with disgust.

"Me?"

"Who else? Who pairs off at spat ball? Who sits together at story films? What new relative is always seen with a girl from his own moiety? I'll give you a hint—the name starts with 'T.' "

Thorby turned white. "Jeri, I never had the slightest idea."

"You're the only one in the ship who didn't." Jeri shrugged. "I'm not blaming you. It was her fault. She was chasing you, you stupid clown! What I can't figure out is why you didn't know. I tried to give you hints."

Thorby was as innocent of such things as a bird is of ballistics. "I don't believe it."

"It doesn't matter whether you do or don't . . . everybody else saw it. But you both could have gotten away with it, as long as you kept it open and harmless—and I was watching too closely for anything else—if Sis hadn't lost her head."

"Huh? How?"

"Sis did something that made Grandmother willing to part with a crack fire-controlman. She went to Grandmother and asked to be adopted across moiety line. In her simple, addle-pated way she figured that since you were adopted in the first place, it didn't really matter that she was your niece—just shift things around and she could marry you." Jeri grunted. "If you had been adopted on the other side, she could have wangled it. But she must have been clean off her head to think that Grandmother — *Grandmother!* — would agree to anything so scandalous."

"But . . . well, I'm not actually any relation to her. Not that I had any idea of marrying her."

"Oh, beat it! You make me tired."

Thorby moped around, unwilling to go back and face Jeri. He felt lost and alone and confused; the Family seemed as strange, their ways as difficult to understand, as the Losians.

He missed Mata. He had never missed her before. She had been something pleasant but routine—like three meals a day and the other comforts he had learned to expect in *Sisu.* Now he missed her.

Well, if that was what she wanted, why hadn't they let her? Not that he had thought about it . . . but as long as you had to get married some day, Mata would be as tolerable as any. He liked her.

Finally he remembered that there was one person with whom he could talk. He took his troubles to Dr. Mader.

He scratched at her door, received a hurried, "Come in!" He found her down on her knees, surrounded by possessions. She had a smudge on her nose and her neat hair was mussed. "Oh. Thorby. I'm glad you showed up. They told me you were dirtside and I was afraid I would miss you."

She spoke System English; he answered in it. "You wanted to see me?"

"To say good-by. I'm going home."

"Oh." Thorby felt again the sick twinge he had felt when Jeri had told about Mata. Suddenly he was wrenched with sorrow that Pop was gone. He pulled himself together and said, "I'm sorry. I'll miss you."

"I'll miss you, Thorby. You're the only one in this big ship that I felt at home with . . . which is odd, as your background and mine are about as far apart as possible. I'll miss our talks."

"So will I," Thorby agreed miserably. "When are you leaving?"

"*El Nido* jumps tomorrow. But I should transfer tonight; I don't dare miss jump, or I might not get home for years."

"*El Nido* is going to your planet?" A fantastic scheme began to shape in his mind.

"Oh, no! She's going to Thaf Beta VI. But a Hegemonic mail ship calls there and I can get home. It is too wonderful a chance to miss." The scheme died in Thorby's brain; it was preposterous, anyhow—he might be willing to chance a strange planet, but Mata was no fraki.

Dr. Mader went on, "The Chief Officer arranged it." She smiled wryly. "She's glad to get rid of me. I hadn't had any hope that she could put it over, in view of the difficulty in getting me aboard *Sisu*; I think your grandmother must have some bargaining point that she did not mention. In any case I'm to go . . . with the understanding that I remain in strict purdah. I shan't mind; I'll use the time on my data."

Mention of purdah reminded Thorby that Margaret would see Mata. He started with stumbling embarrassment to explain what he had come to talk about. Dr. Mader listened gravely, her fingers busy with packing. "I know, Thorby. I probably heard the sad details sooner than you did."

"Margaret, did you ever hear of anything so silly?"

She hesitated. "Many things . . . much sillier."

"But there wasn't anything to it! And if that was what Mata wanted, why didn't Grandmother let her . . . instead of shipping her out among strangers. I . . . well, I wouldn't have minded. After I got used to it."

The fraki woman smiled. "That's the oddest gallant speech I ever heard, Thorby."

Thorby said, "Could you get a message to her for me?"

"Thorby, if you want to send her your undying love or something, then don't. Your Grandmother did the best thing for her great granddaughter, did it quickly with kindness and wisdom. Did it in Mata's interests against the immediate interests of *Sisu,* since Mata was a valuable fighting man. But your Grandmother measured up to the high standards expected of a Chief Officer; she considered the long-range interests of everyone and found them

weightier than the loss of one fire-controlman. I admire her at last—between ourselves, I've always detested the old girl." She smiled suddenly. "And fifty years from now Mata will make the same sort of wise decisions; the sept of *Sisu* is sound."

"I'll be flogged if I understand it!"

"Because you are almost as much fraki as I am . . . and haven't had my training. Thorby, most things are right or wrong only in their backgrounds; few things are good or evil in themselves. But things that are right or wrong according to their culture, really are so. This exogamy rule the People live by, you probably think it's just a way to outsmart mutations—in fact that's the way it is taught in the ship's school."

"Of course. That's why I can't see—"

"Just a second. So you can't see why your Grandmother should object. But it's essential that the People marry back and forth among ships, not just because of genes—that's a side issue—but because a ship is too small to be a stable culture. Ideas and attitudes have to be cross-germinated, too, or *Sisu* and the whole culture will die. So the custom is protected by strongest possible taboo. A 'minor' break in this taboo is like a 'minor' break in the ship, diastrous unless drastic steps are taken. Now . . . do you understand that?"

"Well . . . no, I don't think so."

"I doubt if your Grandmother understands it; she just knows what's right for her family and acts with forthrightness and courage. Do you still want to send a message?"

"Uh, well, could you tell Mata that I'm sorry I didn't get to say good-by?"

"Yes. I may wait a while."

"All right."

"Feeling better yourself?"

"Uh, I guess so . . . since you say it's best for Mata." Thorby suddenly burst out, "But, Margaret, I don't know what is the matter with me! I thought I was getting the hang of things. Now it's all gone to pieces. I feel like a fraki and I doubt if I'll ever learn to be a Trader."

Her face was suddenly sad. "You were free once. It's a hard habit to get over."

"Huh?"

"You've had violent dislocations, Thorby. Your foster father—your first one, Baslim the Wise—bought you as a slave and made you his son, as free as he was. Now your second foster father, with the best of intentions, adopted you as his son, and thereby made you a slave."

"Why, Margaret!" Thorby protested. "How can you say such a thing?"

"If you aren't a slave, what are you?"

"Why, I'm a Free Trader. At least that's what Father intended, if I can ever get over my fraki habits. But I'm not a slave. The People are *free*. All of us."

"All of you . . . but not each of you."

"What do you mean?"

"The People are free. It's their proudest boast. Any of them can tell you that freedom is what makes them People and not fraki. The People are free to roam the stars, never rooted to any soil. So free that each ship is a sovereign state, asking nothing of anyone, going anywhere, fighting against any odds, asking no quarter, not even co-operating except as it suits them. Oh, the People are free; this old galaxy has never seen such freedom. A culture of less than a hundred thousand people spread through a quarter of a billion cubic light-years and utterly free to move anywhere at any time. There has never been a culture like it and there may never be again. Free as the sky . . . more free than the stars, for the stars go where they must. Ah, yes, the People are free." She paused. "But at what price was this freedom really purchased?"

Thorby blinked.

"I'll tell you. Not with poverty. The People enjoy the highest average wealth in history. The profits of your trading are fantastic. Nor has it been with cost to health or sanity. I've never seen a community with less illness. Nor have you paid in happiness or self-respect. You're a smugly happy lot, and your pride is something sinful—of course you do have a lot to be proud of. But what you *have* paid for your unparalleled freedom . . . is freedom itself. No, I'm not talking riddles. The People are free . . . at the cost of loss of individual freedom for each of you—and I don't except the Chief Officer or Captain; they are the least free of any."

Her words sounded outrageous. "How can we be both free and not free?" he protested.

"Ask Mata. Thorby, you live in a steel prison; you are allowed out perhaps a few hours every few months. You live by rules more stringent than any prison. That those rules are intended to make you all happy—and do—is beside the point; they are orders you have to obey. You sleep where you are told, you eat when you are told and what you are offered—it's unimportant that it is lavish and tasty; the point is you have no choice. You are told what to do ninety per cent of the time. You are so bound by rules that much of what you say is not free speech but required ritual; you could go through a day and not utter a phrase not found in the Laws of *Sisu*. Right?"

"Yes, but—"

"Yes, with no 'buts.' Thorby, what sort of people have so little freedom? Slaves? Can you think of a better word?"

"But we can't be sold!"

"Slavery has often existed where slaves were never bought and sold, but simply inherited. As in *Sisu*. Thorby, being a slave means having someone as your master, with no hope of changing it. You slaves who call for yourselves the 'People' can't even hope for manumission."

Thorby scowled. "You figure that's what's wrong with me?"

"I think your slave's collar is chafing you, in a fashion that does

not trouble your shipmates—because they were born with theirs and you were once free." She looked at her belongings. "I've got to get this stuff into *El Nido*. Will you help me?"

"I'd be glad to."

"Don't expect to see Mata."

"I wasn't," Thorby fibbed. "I want to help you. I hate to see you leave."

"Truthfully, I don't hate to leave . . . but I hate to say good-by to you." She hesitated. "I want to help you, too. Thorby, an anthropolgist should never interfere. But I'm leaving and you aren't really part of the culture I was studying. Could you use a hint from an old woman?"

"Why, you aren't old!"

"That's two gallant speeches. I'm a grandmother, though the Chief Officer might be startled to hear me claim that status. Thorby, I thought you would become adjusted to this jail. Now I'm not sure. Freedom is a hard habit to break. Dear, if you decide that you can't stand it, wait until the ship calls at a planet that is democratic and free and human—then hit dirt and run! But, Thorby, do this before Grandmother decides to marry you to someone, because if you wait that long—you're lost!"

TO BE CONTINUED

INSOLUBLE PROBLEM

One type of supernova, after the cataclysmic explosion, continues to radiate at a fantastic rate for months, even years, afterward, the radiation output declining by one half every fifty-five days. The mechanism has long been a mystery.

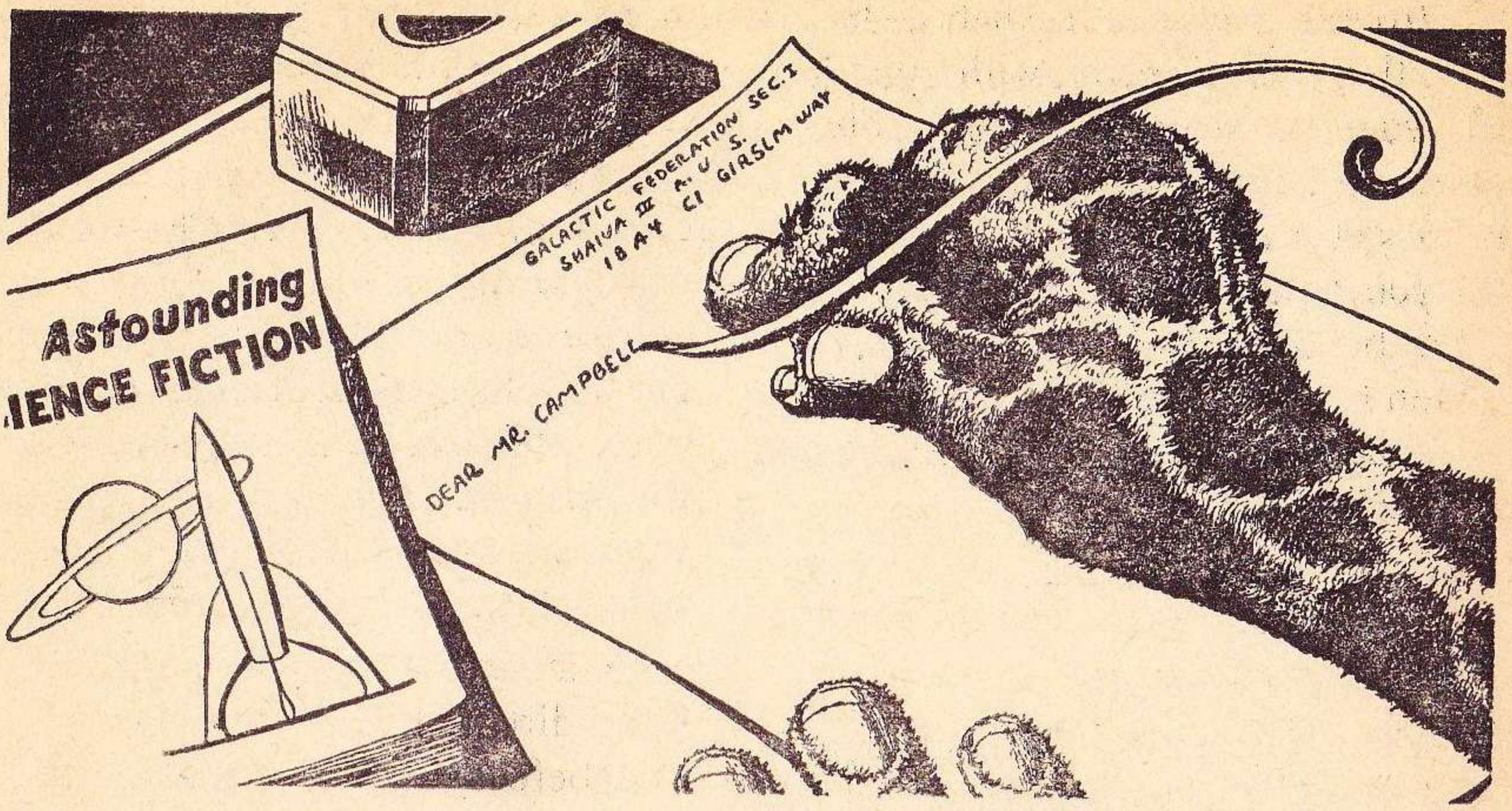
Since the synthesis of Californium, and other trans-plutonic elements, it has been found that these super-heavy elements tend to decay by spontaneous fission—not only by the more common alpha and beta particle emission. Californium-254, for instance, has a spontaneous-fission half-life of fifty-five days.

Recent studies strongly indicate that the Type I supernova explosion process itself entails processes that produce Cf-254—and that the radiation of the supernova after the explosion is due to the fission-decay of this Cf-254.

Now it takes a brilliant mind to see the pattern, the meaning, in a mass of data. But while a brilliant mind doesn't have to have *all* the data to reach a valid conclusion—it does have to have all the crucial data.

No planet anywhere in the Universe can contain both intelligent life and natural Californium. Assume that the Cf-254 fission reaction is the correct explanation of the radiation output of Type I supernovas. Then no intelligent animal can ever find in nature the data necessary to explain the observation. It's essential that they synthesize the non-existent Cf-254.

Is this a case of making up the data to fit a theory?



BRASS TACKS

Dear Mr. Campbell:

The July editorial concerned itself with the "intelligence amplifier." Your arguments against the amplifier are completely invalid, mainly because your basic tenet is invalid.

Your mistake is that you blandly assume that because the intelligence amplifier amplifies intelligence, it must have an intelligence of its own. This is untrue.

In the second paragraph of your article you compare the amplifier to a "device that amplifies a man's muscle power." This being the case, the intelligence amplifier could no more accurately predict what would happen if its solution of India's "social, economic, and political problems" was given to mankind, than a pair of pliers could do push-ups.

For the intelligence amplifier is simply a tool, and could not, under any circumstances, become a separate entity unto itself, as you suggest.

I'd like to see you keep the serials coming, especially after "Under Pressure" and "Call Him Dead." And keep the Asimov articles coming too, I really enjoy them.

My ratings for the July issue are, "Profession," "Divine Right," "Hot Potato," "The Best Policy," "Run of the Mill" in that order.—John Caiazza, 30 Kalda Avenue, New Hyde Park, New York.

Whoa back, friend! Sure the intel-

ligence amplifier is just a tool—but a tool of a different level. The essential function of intelligence is to make choices between alternatives on the basis of probable future consequences. Pliers can't do push-ups—but electronic devices can shut themselves off if dangerous overloads threaten them!

Dear Mr. Campbell:

Your interesting brain teaser in the Brass Tacks department of the July issue brings up several points to be considered. First, although the chemical energy of the fuel is invariant to changes of frame of reference, the total energy of the fuel is not invariant, since it includes both the chemical and kinetic energy of the fuel. This kinetic energy, at least in part, is available to increase the energy of the rocketship and must be taken into consideration. If it is taken into account, no efficiencies of greater than one hundred per cent will result.

Second, there are several different expressions for efficiency which should be distinguished from one another. The most important may be referred to as the "conversion efficiency." This is the fraction of the chemical energy of the fuel which is converted into kinetic energy, including the kinetic energy of both the rocketship and the exhaust gases,

$$N_c = \frac{dE}{Q\ dM}$$

(1) where N is the conversion efficiency, dE is the increase in kinetic energy of the system, Q is the chemical energy per unit mass of fuel and dM is the mass of fuel consumed.

The conversion efficiency is invariant to changes of frame of reference. This can be seen by computing the increase in energy dE resulting when a mass of fuel dM is ejected with relative velocity C from a rocket with mass M at initial velocity V and final velocity V + dV.

$$dE = \tfrac{1}{2}M(V + dV)^2 + \tfrac{1}{2}dM(V - C)^2 - \tfrac{1}{2}(M + dM)V^2$$

(2) $dE = \tfrac{1}{2}\ dM\ C^2 + MVdV - CVdM$

(3) (neglecting second order infinitesimals).

By the law of conservation of momentum:

$$M(V + dV) + dM(V - C) = (M + dM)V$$

(4) and

$$MdV = dMC$$

(5) so

$$dE = \tfrac{1}{2}dM\ C^2$$

(6) therefore

$$N_c = \frac{C^2}{2Q}$$

(7) Equation (7) is independent of V and thus is independent of frame of reference. From equations (5) and (7) it can be seen that the conversion efficiency determines the amount of fuel necessary to produce a given increase in velocity

$$dM = \frac{MdV}{\sqrt{2QN_c}}$$

(8) Thus this is the efficiency of most interest to the captain and chief engineer and equation (8) solved for efficiency

$$N_c = \frac{M^2 dV^2}{2Q dM^2}$$

(9) is the one they should use (in integrated form for large changes of velocity since M decreases as the fuel is discharged). Equation (9) does not involve any absolute velocities so the captain and chief engineer will get the same answer.

Another kind of efficiency, the "propulsion efficiency," does depend on choice of frame of reference and thus loses much of its significance when applied to non-earthbound rockets. The propulsion efficiency is the fraction of the available (after conversion) energy of the fuel, $dE + \frac{1}{2}dMV^2$ or $\frac{1}{2}dM(V^2 + C^2)$, which contributes to increasing the kinetic energy of the rocketship. This will obviously be less than one hundred per cent unless the fuel loses *all* of its energy to the rocket, in which case the velocity of the exhaust must be zero with respect to the frame of reference chosen. The expression for propulsion efficiency can easily be found to be

$$N_p = \frac{2VC}{V^2 + C^2}$$

(10) which is zero for $V = 0$, increases with increasing V until it becomes one hundred per cent when $V = C$—and exhaust velocity is zero with respect to frame of reference—and then decreases as V becomes greater than C.

Other efficiencies are possible, such as a "trip efficiency" which would be the ratio of the minimum energy required to complete a specified journey to the energy actually used. This efficiency would be invariant with respect to choice of frame of reference, if proper account is taken of kinetic as well as chemical energy. No properly defined efficiency will give results greater than one hundred per cent.

I was unable to figure out the basis for computing efficiency used by the captain and chief engineer in your example. If a simple ratio of increased kinetic energy of the rocketship to chemical energy of the consumed fuel were used, one would expect the "efficiencies" to be in the ratio of

$$\frac{30^2 - 29^2}{10^2 - 9^2} = \frac{3.105}{1}$$

instead of about 5/1.

In any event, the change of kinetic energy resulting from a change of frame of reference should not introduce any real difficulties into space navigation other than a slight increase in the confusion coefficient. —James C. Wilcox, Sperry Gyroscope Co., Great Neck, New York.

One solution, anyway!

Dear Mr. Campbell:

I am very interested in the subject of your editorial, "Intelligence Amplifier." As I understand this term,

it means equipment which a man can communicate to and which communicates back to him so that the pair of them can perform with greater ability than can the man alone. That is, the two of them form a man-machine team. Furthermore, I read into the term that the machine has no intelligence of its own; the intelligence is furnished by the man and then amplified by the machine. Ashby introduced this concept as a variant on a machine able to think for itself, one which might be easier to achieve, and which might arouse less resentment or skepticism among those who do not believe that machines can think. The word "ability" here has a limited meaning, that of "mental ability." Improvements in perception or in ways of responding do not seem to qualify, although it is difficult to exclude them completely. A man may be able to improve his performance considerably with a new pair of spectacles, yet this hardly seems spectacular enough to justify the magnificent term of "amplification of intelligence."

Yet as we turn this concept around in our minds and look at it from all sides the spectacles may not be far from what we need. An author composing at a typewriter may have his performance enhanced by being able to dispose quickly of his ideas. In this way his intelligence is amplified, although the machine does not contribute directly to his performance but only permits him to exercise his abilities with less hindrance. As I see it an intelligence amplifier would have no ability of its own, but would do drudgery for its master.

There are numerous examples of such "intelligence amplifiers." A writer with a thesaurus is one. An engineer with a handbook or a logarithm table is another. A modern computer is another, for all of the thinking must be done or at least anticipated by the programmer. A scientist with a library is a good example, for by means of books the man extends his memory and improves its accuracy; memory is an important component of all tests of intelligence. A research director with a research staff may be counted as an example; the staff is there to extend the abilities and conserve the energies of the director. This last case might be disallowed, for the amplifier has ability of its own and is not strictly a machine, although the Russians might call it an "apparatus."

These examples are not very satisfying however, for in each case the amplification is of specialized abilities, and we think of intelligence as a general ability. It is not surprising that such a difficulty should arise, because the very same trouble has presented itself to the measurers of intelligence; they can only measure specific abilities and skills. Because these specific abilities are correlated, tending to be all high or low together, the concept of "intelligence" has been invented.

Looked at in this way the amplification of intelligence is not very promising. Can we make a gadget which will assist a man to do what-

ever he undertakes, no matter what its nature? This is a tall order indeed. If we drop back to the less demanding requirement of a device to assist him do some things better, then those devices already exist. Maybe a more clear-cut victory could be achieved against the original problem, to make a machine that can think.

Maybe, but some of the same difficulties are also inherent in this problem. Thinking consists of not one but of many activities, including weighing, calculating, deduction, induction, recognizing, categorizing, and recalling. If we are content to make a machine to do just one of these, why it has already been done for all of those I have listed except induction. If we should try to make a single machine able to do all of them I think we could—except again induction—but it might be an uncoordinated, unbalanced, unwieldy, or even useless monster, if built only from our present knowledge. The requirement to do all of these in a co-ordinated, balanced, workable machine will take a little longer.

My point is that we are closer to achieving some of these goals than we realize. Perhaps some of the things we dream of are not consistent, one with another. An intelligence amplifier the size of a hearing aid which will enable an individual of I.Q. 50 to compete with a man with I.Q. 150 is still a very long way in the future. The thinking machine which answers questions like a Delphic oracle may be just as remote as it was in 350 BC. Nevertheless, each of the components of brain work is in itself a simple operation, and each of them can be done mechanically—with the possible exception of jumping to conclusions, which is the only one which has not yet been demonstrated. Putting them all together is an engineering task similar in difficulty to that of making a flying submarine, but it will eventually be done. It may even be done in the volume of an old-fashioned hearing-aid, although that may take some special servicing such as keeping it well supplied with liquid helium.

The hard part will be in deciding what our goal actually is.—Howard Campaigne.

A machine can be built as soon as you can define exactly what it is you want done. If you could define exactly what the process of intuitive thinking was, then an intuitive machine could be built. But we cannot define that crucial process!

Dear John:

Two years ago, I wrote an article called "The Sound of Panting" which described the difficulties of keeping up with the scientific literature. In the article I mentioned *Chemical Abstracts* as an invaluable aid to keeping track of the papers being published. At the time I said that a year of *Chemical Abstracts* listed 14,000 columns of papers as

compared with 10,000, ten years earlier. This year's *Abstracts* shows every sign of reaching the 17,000 mark.

Each year, *Chemical Abstracts* puts out an index of all the papers it mentions, both by author and by subject matter. This index increases in size each year, too, partly because of the increasing number of papers and partly because the desperate needs of the chemists require more and more intricate subdivision and more and more elaborate cross-referencing. The index for the year 1955 took up 4,000 pages. (The complete index for 1956 is not yet available; they take a long time to prepare.)

Now every ten years, *Chemical Abstracts* puts out a "decennial index" which is an overall index for the decade.

The 1927-1936 decennial index (author and subject matter) comes in five fat volumes, totaling 8,000 pages.

The 1937-1946 decennial index comes in six fatter volumes, totaling 10,000 pages.

The 1947-1956 decennial index, now in preparation, will consist, it is reported, of about *nineteen* still fatter volumes, totaling some 45,000 pages.

It is further predicted that the 1957-1966 decennial index will have to consist of nearly a *hundred* volumes with a total of at least a quarter of a million pages.

There are also predictions that the 1947-1956 decennial index will be the last to be prepared by the present system. I do not know what other system will be used next time around —micro-filming? Feeding all data to a computer?

Maybe they'll just forget the whole thing. I'm tempted to.—Isaac Asimov.

That's an exponential system, busily approaching infinity as an unlimit!

Dear John:

The following is addressed—with gestures—to Dr. Isaac Asimov, author of "Planets Have Atmospheres" published some months ago.

Ikey, Ikey—I'm ashamed of you! As a biochemist you're tops (he says, courteously,) but as a physical chemist—pfui!

You have described the atmosphere of the earth at an early stage as consisting of H_2 (in large excess) H_2O, NH_3, and CO_2. Ugh! CO_2 can *not* exist in such an atmosphere. It will go first to CO and then to methane, CH_4, the total reaction being $CO_2 + 4H_2 = CH_4 + 2H_2O$, the equilibrium being to Hell and gone over to the right at any temperature much below 1000° K. Under the conditions you describe, damned near anything will show up as a hydride—oxides are going to be rare items. We're cursed with that reaction on some rocket exhausts.

Second item. You mention, or suggest, a system with a reducing (H_2) atmosphere and oxidizing foods and

what have you, and remark that it has not been described in SF. Correction, please. Consider an antediluvian story, "The Black Star Passes," by the person who later became the editor of this esteemed journal.

Third Item. If you want a description of a fluorine planet, try the introduction to "The Petrified Planet," a trilogy published by Twayne. Such a planet is described in detail —I ought to know. Incidentally, the low intensity of high energy radiation that is necessary for the planet —the low intensity to keep the temperature within bounds, the high energy to break the H-F bond—does not make it unworkable. It just slows down the rate at which free fluorine is produced.

In the meantime, your series is fun—keep it up.—Doc Clark.

Your turn, Ike!

Dear Mr. Campbell:

Replying to your Earth-Mars rocketship problem, the frame of reference you use depends on what you want to do. If the engineer wants to figure out rocket efficiency and fuel efficiency, he uses a frame of reference relative to earth, but the skipper should use a frame of reference relative to Mars if he is concerned about settling gently on the sand.

However, the skipper can use the Earth frame just as well providing he takes into consideration the fact that Mars, in the problem, is moving toward the Earth at 20 mps.

And the engineer, in computing his fuel efficiency, must remember that each pound of fuel he has left carries with it not only the latent chemical energy of the fuel, but also the kinetic energy it has taken from the fuel already used to accelerate the ship to 10 mps. In other words, if the chemical energy only were considered, it very well might seem as if the rockets are delivering 500% efficiency.—Peter B. Horsley, 1831 - 24th Ave. N. W., Calgary, Canada.

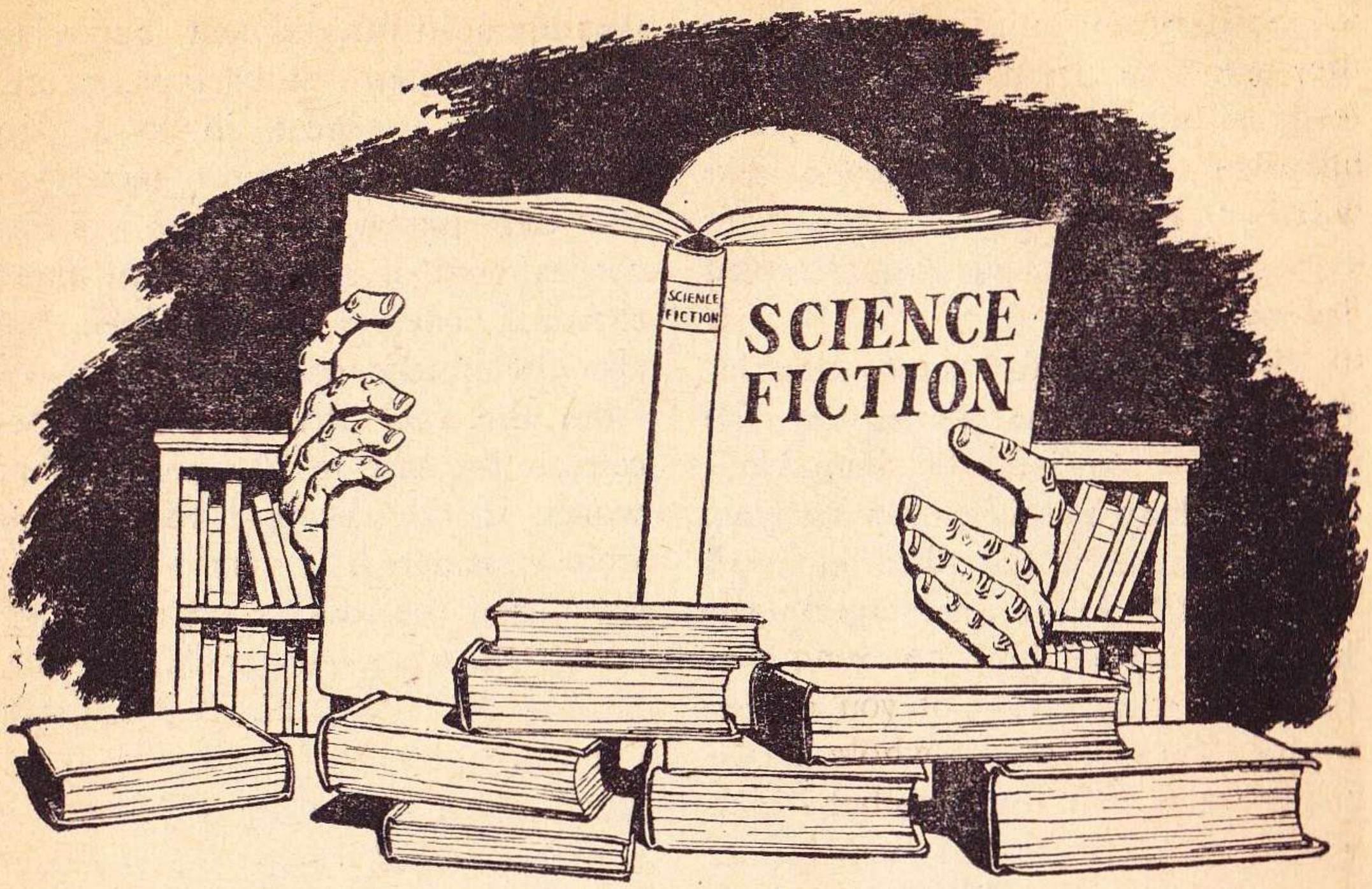
But—which frame of reference is the chemical energy of the fuel to be related to?

Dear Mr. Campbell:

It is with great pride I write to ask how many other readers noted the symbolism in the Freas drawing on pages 8-9 of July.

Starting on the left we have RICHMAN (be-jeweled); POORMAN (wrinkled clothes); BEGGARMAN (begging); THIEF (pickpocket); DOCTOR (bag); LAWYER (briefcase); MERCHANT (selling jewels); CHIEF (Chief Warrant Officer stripes). So now we know where artists, at least, get their ideas. Freas is great and the subtlety of this proves it. Give *him* 2¢ an inch more.—Rick Sneary, 2962 Santa Ana Street, South Gate, California.

Wonder how many spotted Kelly's fun on that?



THE REFERENCE LIBRARY

BY P. SCHUYLER MILLER

...WHAT DO THEY SAY?

Last month I called your attention to an article in last February's *Bulletin of the Atomic Scientists,* in which sociologist Arthur S. Barron gave his reasons why scientists—as he supposes—make up the majority of science-fiction readers. He believes that it is because they can identify themselves with science fiction, as the suppressed sadist in us leaps at a Micky Spillane guts-and-gals yarn (this simile is getting pretty ragged: there's been no Spillane book in a long time), or the ten-year-old who never grew up — me — glories in a Hollywood Western. SF glamorizes its scientists, Barron says; it protests against regimentation and unreason in a way that scientists no longer dare do themselves; and it affirms various social and ethical values, *as the values of the scientist heroes,* which make them out to be pretty good and noble folk after all. He thinks that if scientists ever feel glamorous

in their own right, feel safe when they come out from behind their lead walls, and can again read the historical novels of Howard Fast, SF will be a dead duck.

At about the same time, one Robert Plank, otherwise unknown to this non-intellectual, was writing about "Space Travel and Psychotic Fantasy" in the Winter *Partisan Review*. Like Barron, he knowingly or unknowingly selects the kind of science fiction for which this magazine is noted, and the kind of readership which most of you represent, as typical of the whole field. Like Barron and many another "outside" critic, he shows that he is slumming and has merely sampled the field without understanding it very clearly. Although he is studying the space-travel motif in science fiction, he rambles around, making offhand comments which rather detract from the main line of his argument.

For example, he cites as typical—and typically ridiculous—Kenneth Heuer's "estimates" of the populations of Mars (624,800,000) and Jupiter (267,805,925,000) without ever realizing that these came out of Victorian and medieval fantasy, and that most SF fans greeted them with guffaws and something like disgust that the book should be published as non-fiction.

In a discussion of flying, he completely misses the distinction between physical man and cultural man: flying may be "secondary" in that I can *physically* get anywhere on Earth by walking or rowing a boat, but as a member of our culture there are many places I can't get to at all *except* by flying. Time—money—vacations—expense accounts—these are things Plank ignores, but they govern a man's behavior as much as his muscles and appetite.

What Robert Plank seems to be saying is that in science fiction writers and readers are seeking an almost psychopathic release from the world they are in. Space flight, to him, is literally flight from the realities we don't like—and in this, he acknowledges that science fiction is a part of the mainstream literature of our times.

"The contact points between psychopathology and the imaginative writing about space travel are . . . not too scarce," Plank says. "The motive of space travel can be used as a potent release: once it is postulated, the rest can be left to free-flowing imagination; in a world from which we are separated by the formidable barrier of space, neither the physical laws of our universe nor our moral laws have to be accorded validity. Both the psychotics . . . and the science-fiction writers . . . have made use of that liberty." Yet, he complains, we "have carried the soil of the Earth on their soles to the most distant parts of the heavens" and faithfully preserved our allegiance to the laws and prohibitions of our society and our times.

On the level of much science fiction that is intended as pure enter-

tainment, or as conceptual gymnastics, perhaps this can be applied. But presumably this writer is analyzing "serious" science fiction—if he can recognize it—and here he is right out of the ball park, for it is one of the tenets of science and science fiction that physical laws *are* basically universal, and it is an anthropological and historical truism, which SF authors have used intelligently and thoughtfully, that far-wandering man *does* invariably carry his prejudices and his "soil" with him. To expect otherwise is "wish-fulfillment"!

The "adventurous hero who strikes out alone, who has freedom of action within the natural law and responsibility to none but himself . . . is for all practical purposes unknown," he complains. He should read more space opera—but again, he is showing ignorance both of science and science fiction. The lone hero just cannot leap into his trusty sports-model rocket, without bothering to check the gas tank, the algae beds, or the analogue computer, and go cavorting off among the stars. But Plank is treating science fiction about space travel as unrelated to reality—or he does not understand the basic facts about that reality. He just does not know that space travel is a complicated and costly social operation — a "gigantic military-administrative machine."

Plank comments on the same guilt-feeling that Barron considered a factor in scientists' identification with SF—but he comes up with a rather different, and perhaps plausible, conclusion:

"For people who are sincerely concerned about the fate of mankind—as many of these writers, for all their antics, certainly are—science has changed its role. . . . (It) is again, as in the day of the alchemists and the necromancers, awesome, threatening, uncanny, sinister. . . . A potentially hostile power, never again to be trusted." Science fiction, he says, has turned from this grim field of the physical sciences to the blameless and innocent social sciences, but it has done so without concerning itself realistically with the basic human drives. These—following Schiller—he says are hunger and love. But since science fiction is an American expression, and Americans aren't hungry, the first of these is ignored . . . while we replace love with hate.

"The way current science fiction reads sociology and psychology, the world is kept going round by satiety and hate. . . . Science fiction has abandoned its former interest in what is conventionally known as science, and has taken root directly in that hot and ugly subsoil in which there is no grace, no smile, no justice, and no reason—nothing but vitality. . . . Hostility unrestrained by love; brash young men in the service of super-imperial schemes; devouring clashes of incompatible civilizations—these are the laws and the prophets."

Yet there's a positive note at the end of all this, for Plank recognizes the unparalleled freedom which sci-

ence fiction has to play with ideas—except that he simply does not understand the discipline of science; he would be one of the many who have complained of "The Cold Equations." "It is hard to see how we can advance human society unless we experiment in thought with the various possibilities of its development," he says. What he ignores is the practical limitation that SF *is* fiction, and must by and large work within a framework which includes hostility, schemes, BEMs, and other familiar plot elements.

Poul Anderson, in the April 27th *Saturday Review,* isn't talking about science fiction at all: he is talking about science, and why it is a phenomenon of our time and our society, and not of one of the great ages of the past. There are elements in our Western society, he feels, which may have weakened our understanding of ourselves, but which have made our advance in the physical sciences possible. Why didn't modern science spring up in the Hellenistic age? . . . among the Arabs or Hindus? . . . during the Renaissance?

What we have had—and these earlier civilizations lacked—is a partnership of intellectual curiosity and the "try it" attitude of hard-headed backwoods pragmatists, building on an essential foundation of technology borrowed from all over the world:

"The scientific method appears to have been born in the later European Renaissance after a gestation extending well back into the Middle Ages," Poul points out. "Its ancestry is obscure, but may to a large degree be the triad: accumulated technology, Christian respect for order and theory, and a vigorous practical-minded capitalism. Whether this be right or wrong, it seems clear that science was not a matter of inevitable progress, but of the accidentally right combination of social circumstances."

But something else—something important for our own times—follows: ". . . Scientific enterprise is a social enterprise: . . . the discoveries we make—even the kind of discoveries, or whether we are to make any discoveries at all—depend on the society in which we live. If so, we might well take a little thought before changing the conditions of that society too much. It is all too possible that we may improve and organize our science out of existence."

Does actual space travel depend on our living in a psychotic society of the kind Robert Plank discusses, in which we are driven off the Earth because we can't stand it here? If the scientists lose interest in science fiction, as Arthur Barron suggests, will it be because their society has first lost interest in science? Poul Anderson, as a student of history and science, is doing a good deal more than making another plea for a Christian, capitalistic, technological society based on the status quo.

EDGAR RICE BURROUGHS BIBLIO, by Bradford M. Day.

TALBOT MUNDY BIBLIO, by Bradford

M. Day. Science Fiction & Fantasy Publications, 127-01 116th Avenue, South Ozone Park 20, N. Y. Mimeographed. 28 pp. 50¢ each.

I owe bibliographer Brad Day an apology for having lost these two booklets in the shuffle for several months. By the time you see this, they'll be about a year old, but I trust you can still get them from him at the address listed.

The Burroughs bibliography will probably be of greatest interest to the rank-and-file collector. You get, first, an alphabetical list of his published books—then a chronological listing of his published magazine stories—and some biographical notes. The book listing also tells you what the original magazine versions were called, and where and when they appeared. What I miss, principally, is an arrangement of the main sequences in chronological order, as they are supposed to have happened. I'm not sure, for example, that all the "Tarzan" stories fit end to end as they appeared. I know Tarzan became involved with the Pellucidar series, but are there any other cross-connections?

You do get some of this kind of information with the Talbot Mundy bibliography, and it's more important here, for some of the episodes in the sagas of Jimgrim, Ramsden, and the others have never been put between hard covers. You need not only rare books but rare magazines, British and American, to work out all the adventures of these heirs of Kipling's India. As some of you know, many of the stories have a strong science fiction or occult element. And the flavor is something rare.

THE WINDS OF TIME, by Chad Oliver. Doubleday & Co., Garden City. 1957. 192 pp. $2.95

Maybe it's me, but this novelization of an anthropological theme doesn't quite seem to come off. The reason, I think, is that it does too many things.

The book starts as an adventure. Wes Chase, vacationing M.D., is caught in a storm high in the Rockies and holes up in a convenient cave to wait it out. But there's a door in the back of the cave, and through the door comes an alien from the stars, who has been sleeping there for fifteen thousand years . . .

Then, on page 44, the focus shifts to this starman—Arvon of Lortas—and the crew of the ship in which they have been searching the Universe for other men like themselves. The Lortans, alone among the human kind who teem among the worlds, have reached an ultimate technological world-civilization without first destroying themselves in atomic or bacterial war. But they have reached a dead end; to rise higher they need the cross-fertilization of ideas shared with another human race as advanced and stable as their own. And they can't find one.

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The Lortan ship is wrecked on Earth, somewhere in Siberia, late in the Wisconsin glacial period when the first roving hunters are crossing to America. There's a nice and regrettably brief bit devoted to the nameless, pragmatically friendly folk among whom they fall, but five of the ship's company decide to put themselves into a fifteen thousand-year sleep in the hope that when they emerge, Man will be ready to build them a new star-ship. Instead, they awake in our time, with the atomic issue still unsettled and human technology still too crude for a space-drive.

So far we've had two story lines, and from here it becomes a problem yarn with a gimmicked solution. How *can* Wes Chase save the Lortans?

I'd like to see Chad Oliver, who has used his field of anthropology so well before, really go to town on this question of the cultural explosion when two civilizations meet and mesh. Would Egypt and Sumeria have risen so far, so fast, if they had been isolated on opposite sides of the world, or does the kind of fellowship of peers that the Lortans sought account for the thousands of years between parallel stages in America and the Old World? Try again.

NO BLADE OF GRASS, by John Christopher. Simon and Schuster, New York. 1957. 218 pp. $2.95

This is the kind of book that English writers seem to do exceptionally well: catastrophe underplayed and underwritten, but spelled out with the meticulous detail of personal experience that makes the effect cumulatively horrible. "John Christopher," under his own and other names, is also busy with detective and serious novels, and the skills that have gone into them are also apparent here. They have also been apparent to the *Saturday Evening Post*, where the book was serialized.

On the surface, this is a counterpart of John Wyndham's triffids and krakens—a kind of reverse twist to Ward Moore's neglected "Greener Than You Think." A virus, appearing in China, attacks and kills all the grasses of the world, and step by step the civilizations that have been erected on these grasses come crashing down in horror and brutality. To the West, the starvation and cannibalism of Asia are tsk-tsk misfortunes: of course, it could never happen to us. Presently, the governments reach the conclusion that the basic problem and the only solutions are political—persuade people that (a) there is no problem, (b) we have it solved, and (c) if we haven't, we will. And in the end a ruthless Prime Minister decides that the only quick solution is to destroy the urban population of Britain with H-bombs and thus bring the bellies and the root crops into balance.

There is more than enough in all this for the wildest kind of melodrama and save-the-world scientific heroics, and not too many years ago the book would have been written that way. We are introduced, in the

beginning, to a locked-away valley in the North Country, and it would have been all too easy to have this the one place in the world where, for convenient and "scientific" reasons, the blight never comes—but science fiction has outgrown that, too, or John Christopher has.

Instead, this is a novel of character: the slow, inevitable growth of hardness and ruthlessness in John Custance, the soft white-collar Londoner, as he tries to get through with his family and his friends to the haven of that hidden valley, where his farmer-brother has barricaded himself against the world. At first, he kills with qualms, to break through the road blocks thrown up around London. Soon he is killing for revenge against the gang who have raped his wife and daughter. Very soon he is killing to get food and weapons, then for strategy, finally to hold the power he is coming to enjoy and need. In the John Custance of the last pages, we see the kind of man who can survive and lead in a world forced back to savagery—and we see that this kind of savage is in us all.

It's quietly savage and ruthless in every page, once the grim trek north is under way. A lot of people won't like it. But it's certainly one of the best books of the year.

THE FROZEN YEAR, by James Blish. Ballantine Books, New York. 1957. 155 pp. $2.75; 35¢

I haven't seen any of the recent

hard-back Ballantine editions, so I don't know whether they have forsaken their execrable format of a year or so ago and gone back to something more like their first publications. This is one that is well worth the hard-shell price, and it is by a long way the best that the author has done—even by his own tough standards.

Only technically is this science fiction—because it is a story of next year, the current International Geophysical Year, and the off-this-world element that comes into the last third isn't really necessary.

The narrator is a bystanding science writer who goes along on a polar expedition run by a flamboyant Halliburton-Phillips style explorer with a pneumatically glamorous wife and a staff of unpaid minor scientists. The expedition has been adopted, with misgivings, by the IGY; it is supported by industrial handouts, to be paid for in publicity and testimonials; and its real purpose is the leader's intention of proving that only a little while ago an inhabited planet in the present asteroid belt blew up and plunged into the hole now occupied by the Arctic Ocean.

If you've read between the lines in the official chronicles of similar expeditions, you'll realize what a wonderful piece of genre writing Blish has done here. The story of the assembling and first tottering steps of this misbegotten hegira is terrific, and for me it would have been enough to see them do what came naturally, without the melodrama of the fallen planet and the Alien Among Us. A Hollywood director stupid enough or smart enough to film this straight would have an arty success on his hands, no matter what kind of phosphorescent, leering monster he dreamed up for the finale.

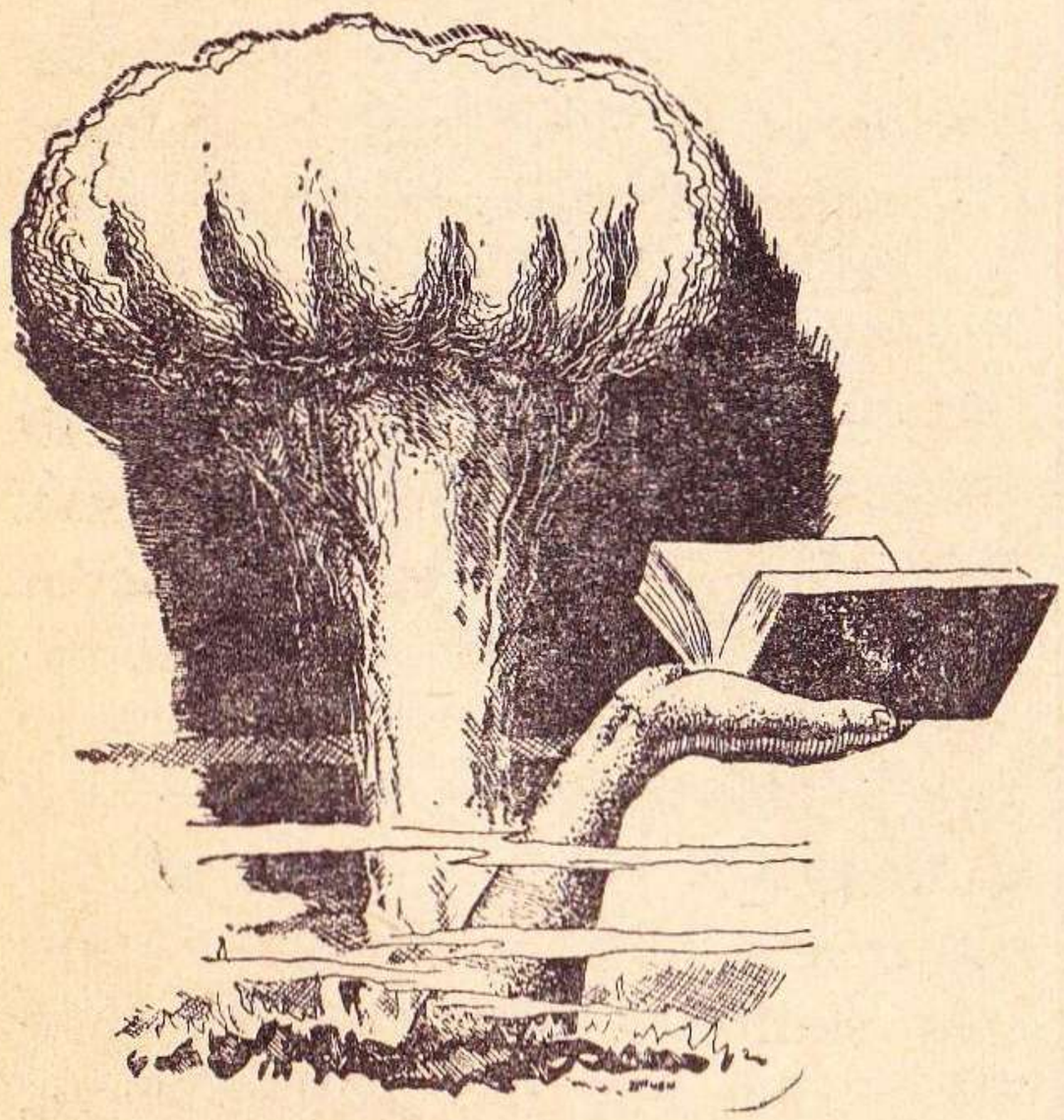
More, please.

ONE HALF OF THE WORLD, by James Barlow. Harper & Brothers, New York. 1957. 277 pp. $3.50

No regular reader of science fiction needs to be told how differently two authors may treat a basically similar theme. One may tear at it with the harshness and drive of George Orwell's "1984," while another, like James Barlow, will write subtly and almost gently. Probably they will appeal to and move quite different groups of readers.

This is a story of the Soviet occupation of England, not in an overdramatized 1984—which many readers found not gadgety enough—but in 1960. Like Orwell's hero, Trevor Baxter is a servant of the new State —in his case, one of the Internal Security Police. He gets satisfaction and takes pride in his work, keeping the machinery of the new order moving smoothly in spite of occasional outbursts of violence presumably instigated by American agents. He is very skillful at tracking down those responsible for such acts against the State, even when one is a friend and co-worker.

Then Trevor Baxter falls in love, and because the girl is from a religious family, he begins to explore the meaning of religion and to sense the contradictions between what it, and his own reason, teach about human relations, and what the Occupation State holds true. Just when his newfound faith becomes more important than Jill Smallwood we are never quite sure, but in the inevitable end, when they are all in flight from a charge of treason, he makes his choice almost automatically, and in doing so wins more from the Occupiers than he would have by escaping to Portugal and America. Where "1984" was a novel of despair, "One Half of the World" preaches the inevitability of hope where faith remains.



(*Continued from page 7*)

human population, in its interactions, is a very complex system of information relay units. The "grapevine" communication system is a tremendously powerful force in shaping the reaction of any population—and grapevine communication involves multiple-parallel information relaying, with an almost indescribably complex system of feedbacks, cross-checkings, shunts, filtering systems, distorting forces, damping forces, and what not. An individual unit in the interacting complex may have a personal bias that causes him to block passage of information of type 1, while strongly amplifying and reinforcing information of type 2. For information of type 1 he acts as a damping filter; for type 2 he's a resonant amplifier.

Due to his interconnections, with type 2 information, he'll excite (transmit to) twenty contacts, and reinforce the input information strongly in transmitting it. Perhaps for type 3, or type 17 information, he's an inverter-amplifier—he actively denies and suppresses any such information. He will spend time and effort seeking out individuals who have the information, and seeking to destroy their belief in its validity. Other individuals may organize to establish blocks in the system seeking to make the entire system non-conductive for information of a specific type. In our current culture, information on sex and various other subjects is actively blocked by organized groups, for example.

All in all, the complex interactions of human individuals in a culture constitutes an enormously complex information filtering and relaying system, with both positive and negative feedback at all stages, complex shunts around blocks, and altogether constituting an unanalyzably involved system.

However some of the general characteristics of such very complex systems have been solved in a quite different area—in the field of nucleonics!

A standard nuclear reactor represents a complex population of different components, having different characteristics with respect to two critical phenomena; neutrons and fission reactions. Present in a nuclear reactor there will be U-235, U-238, a moderator such as graphite or heavy water, and various impurities, plus control rods, which are simply controllable impurities having neutron-absorbing characteristics.

If a neutron reaches a U-235 nucleus, it normally causes fission; the U-235 nucleus can, for our purposes, be considered a neutron-amplifier, since it gives off 2-plus neutrons for each neutron absorbed. All the other substances present are neutron-absorbers, tending to damp out the neutron-signals released by the U-235 neutron-amplifiers. Some neutrons will be lost by escape through the boundaries of the reactor.

If the net gain due to the U-235 "neutron amplifiers" is exactly equal to the total loss of neutrons to all other components, the intensity of the nuclear reaction will be constant at whatever level it happens to be. The overall situation is, under this condition, that, on the average, the birth rate of neutrons in the system equals exactly the death rate, so that the neutron population is constant. The net neutron reproduction constant is, then, 1.000000. This neutron reproduction rate is referred to as the k-factor of the reactor.

However, if the k-factor is 1,0000001, each succeeding generation of neutrons is slightly more numerous; the neutron population is rising, and the level of activity of the reactor going up. In a reactor, the time per generation of neutrons is exceedingly short; the rate of rise of activity will be decidedly notice-

able, even with so minute an excess over 1.000. . . .

On the inverse side, if k = 0.9999999 . . . , the rate of reaction is falling, the system is being damped, and will eventually settle down to zero reaction.

In such a system then, if k departs from exactly 1.000 . . . by even a minute degree, the system, as a whole, heads either for zero, or infinity. In the atomic bomb, we have a nuclear reactor with a high k factor, and the system heads for an infinite rate of reaction at a spectacularly high rate. Yet the bomb is perfectly safe and stable until triggered, because the system has been so designed that, until triggered, the k factor is held below 1.0000, and the reaction rate is, therefore, practically zero.

Now herein lies the peculiarity of this type of system-reaction; a minute difference in degree—the k-factor—produces, because of the chain interaction system, *a difference of kind*. If k is less than 1.0000, the reactor *does not* react; if k exceeds 1.0000, the reactor *does* react. A tiny difference of degree becomes, in a complexly ineracting system of this type, an Aristotelian difference of Yes or No.

In a nuclear reactor, the k-factor is controlled usually by inserting or withdrawing the neutron-absorbing material of the control rods. The reactor system, as a whole, is highly sensitive to very small changes in the amount of neutron-absorbing material present; a little too much neutron-absorption, and the nuclear reaction damps out completely. A little too little . . . and things get frantic rather suddenly; the safety rods drive home, alarm bells sound off, various automatic damping devices shut down everything, and start yelling for somebody to find out what in blazes went wrong.

But any human culture is a complexly interacting group. There are individuals who will amplify and transmit certain classes of information—and others who damp it out.

Who wants to bet that a very slight shift in the peak of the population's distribution curve can't make the whole system suddenly become highly reactive to a type of idea that, theretofore, it was totally unreactive to?

Just a few less idea-dampers, or a few more idea-amplifiers—and the system may "go critical" with respect to that idea.

Sure—it's just a matter of degree, not of kind, at the level of individual characteristics.

But it's a matter of *kind* at the level of system response!

The Editor.

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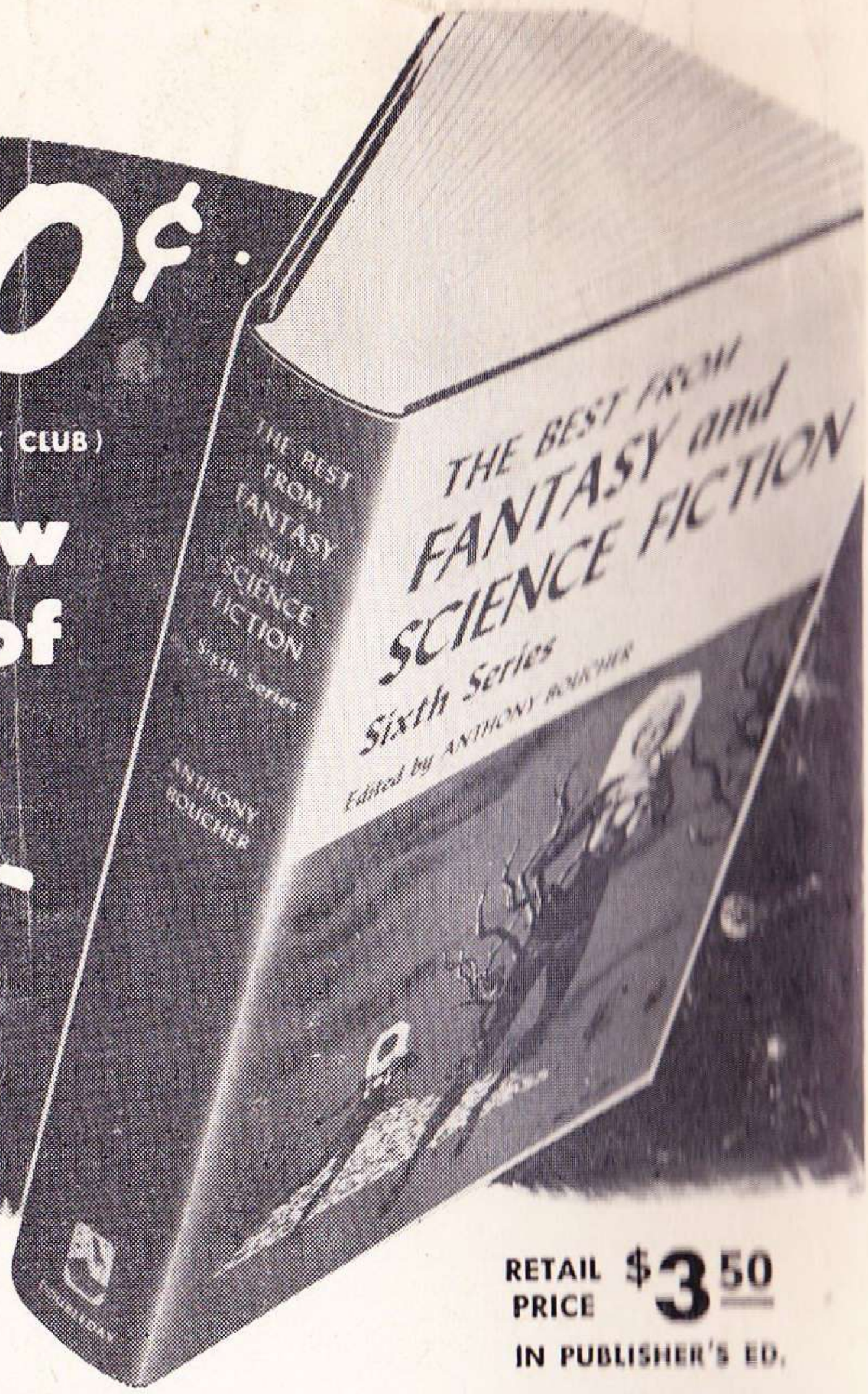

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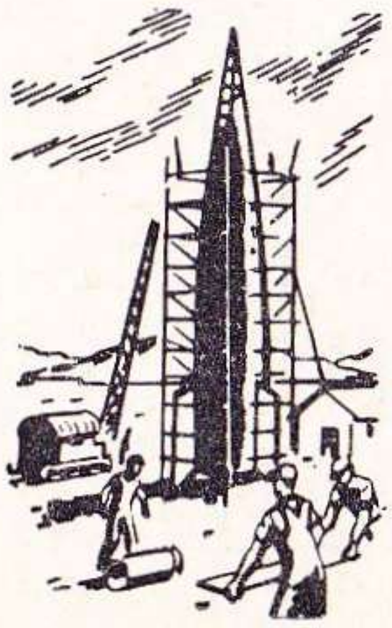

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