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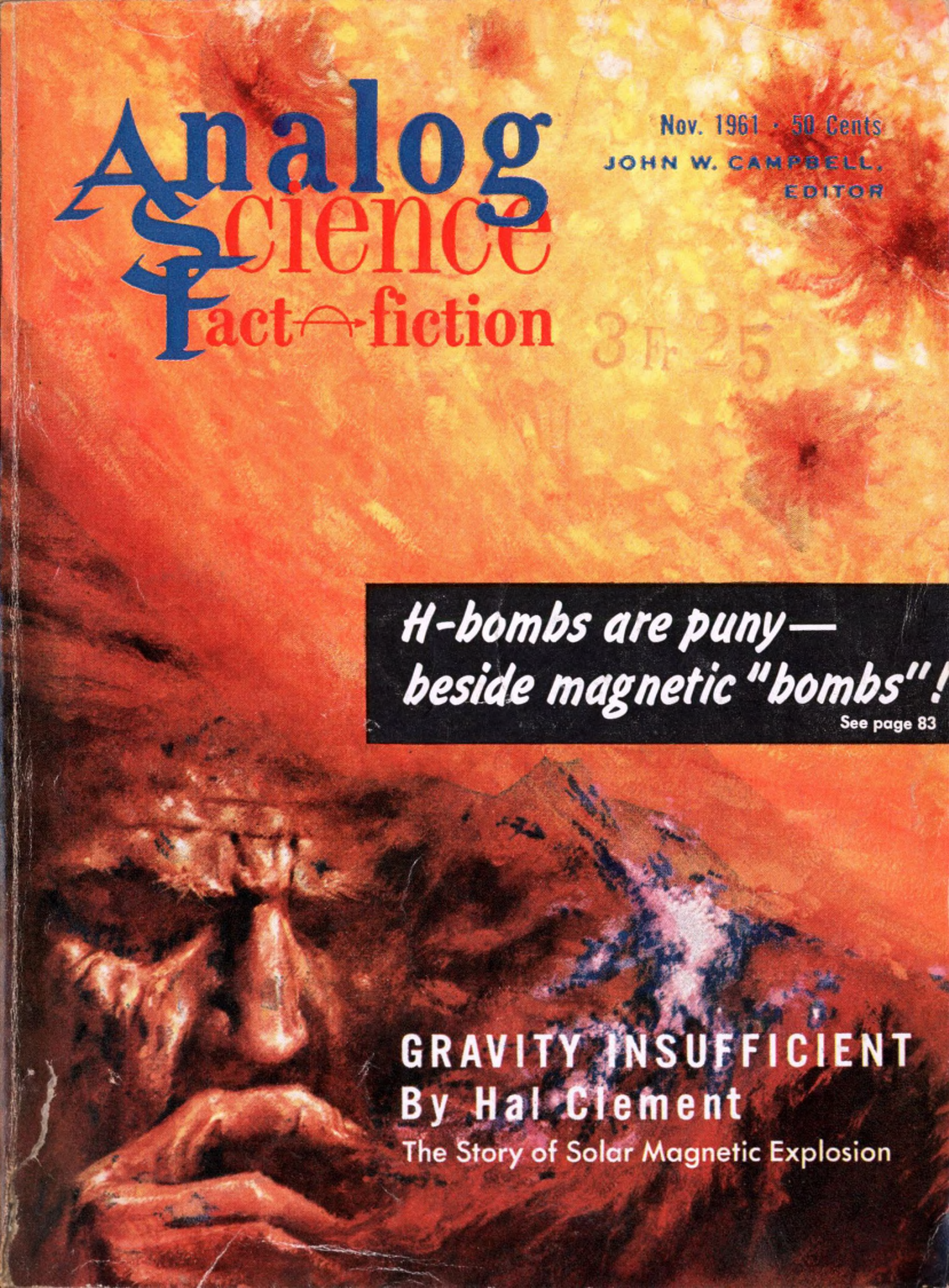
JOHN W. CAMPBELL, EDITOR

H-bombs are puny— beside magnetic "bombs"!

See page 83



GRAVITY INSUFFICIENT

By Hal Clement

The Story of Solar Magnetic Explosion

Analog Science Fact-fiction

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EDITORIAL

THE ORIGINS OF SCIENCE

SCIENCE, as the term is used in modern discussion, is strictly a product of Western Culture. The Mystic approach of the Orient is very distinctly and characteristically different —and the quasi-mystics who refer to the "science of astral walking" or the like, miss the basic point of what makes Science.

Pure thought, pure contemplation, and pure logic are essential ingredients of both the real, high-order Mystic, and of the Scientist; both Mysticism and Science require them. But Science entails a "feedback circuit" that Mysticism dispenses with. After thought and reasoning have reached a conclusion . . . Science has to try the conclusion experimentally. And if the trial and the conclusion don't check, the conclusion, the product of thought, not the experimental result, gets modified.

Without real-world, objective experiment, Science is trimmed down to Mysticism. Basically, it would be valid to say that the Greek logicians were Mystics rather than Scientists, because, like the Oriental Mystics, they discussed, thought, argued, logicked . . . but didn't use or accept the experimental method.

However, once you insist on the experimental method, there is, immediately, another extremely important difference between Mysticism and Science—a derivative difference, so to speak.

Science costs money; Mysticism doesn't.

A Mystic can be a full, practicing Mystic, so long as he himself has about twelve hundred calories of food a day; he doesn't *need* anything more. He can be a practicing and effective Mystic sitting naked in the public square, or in a mountain cave. Since the Truths he studies are Universal and Eternal, it makes no difference whatever when or where he is, so he has no need to travel. Unlike an anthropologist, or marine biologist, he need not go to his subject to study it, because it is everywhere.

The *man* has to have economic support, he has to eat. But the *study* requires no wealth whatever; it costs nothing but time and thought.

In this respect, it is like pure mathematical theory; a pure mathematician needs only food enough to stay alive, and he, too, can operate with perfect success in a desert cave. He doesn't need pencil and paper—he can use a stick in the sand. Pure mathematics, be it remembered, was highly developed by the Oriental Mystics, and by the Greeks, before Science was started. The Hindu thinkers were far ahead of the Greeks in mathematical development. Mathematics *per se* is *not* a Science in the modern meaning of "experimental Science," though mathematics certainly is a major constituent of Science. (As a brain is not a man, though there is not much of a man without a brain.)

Because Mysticism can be practiced without cost, without economic support, it is a far older field of study. A man who felt that learning was worth spending his life-efforts on could do so freely . . . as a Mystic. But *not* as a Scientist. A Scientist has to support not only himself, which can take very little, but his experiments—and if that involves anything much beyond simple levers and pulleys, that is going to take a lot of effort. He's either going to have to spend a lot of his time and energy earning economic wealth to buy his apparatus—time and energy "wasted" from his intended purpose—or he's going to have to spend time and effort being a salesman, inducing someone who already has the requisite wealth to invest it in his beloved experiments.

Science, because it is objective, is inherently tied to the problems of economics, whether it likes it or not. And it doesn't, of course!

Pure Science, moreover, is like a baby in being a pure consumer of economic goods, producing nothing, except more of itself. A baby spends three years or so consuming food, clothing, furniture, toys, and producing nothing except a larger baby that consumes more food and more expensive clothes and toys.

A baby never produces economic values. Never . . . so long as it is a baby. It has to stop being a baby before it starts to produce as much as it consumes.

Pure Science never has, and never will, be able to support itself; it always was and always will be a pure economic drain. It produces nothing but more and bigger Pure Science, that requires more expensive food, housing and toys. A chemistry lab used to be satisfied with simple things like ordinary mineral acids, bases and salts . . . but now they demand rarities in quantity lots. How can we study the corrosion inhibiting powers of chromate salts, if you don't give us some technetium atoms to study—so make us some in your nuclear reactor! A few hundred grams will do . . .

The baby grows up and becomes an income producer . . . and, therefore, ceases to be called "a baby". A

Pure Science grows up, becomes an income-producer, and, therefore, ceases to be called a Pure Science, but instead is called Engineering.

Science got started in the West, when the Islamic philosophers combined the Greco-Hindu concepts of mathematical logic, with Roman pragmatic engineering, and invented the experimental system. (At the time, it appeared to pure philosophers to be as abhorrent, as improper, as settling a logical debate by using a club. Instead of arguing the point to a proper logical conclusion, these barbarians insisted on physical methods of argument—clubbing a gentleman-philosopher over the head with an experiment!)

The technique spread to Europe during the Renaissance—but it was still pure Science, a baby that, indulgent people hoped would some day grow up to produce economic value. (Mysticism, because it doesn't consume wealth, has never been required to produce wealth.) Early Western Science was supported by noble—or wealthy—patrons in hopes that, some day, it would produce gold, or, in the case of astrology, predictions that could be relied on economically. (Astrologers are still trying to make the system work on the stock market.)

Through several rather dismal centuries of failure, the baby showed signs of being a Mongolian idiot that would continue to consume forever, and produce nothing. A few useful things dribbled out—gunpowder, for one—but the noble patrons continued to invest in the support of artists who dabbled with paints, and scientists who dabbled with stinks, with about the same level of non-economic satisfaction.

Then, about the end of the eighteenth century, the first of the real engineering sciences began to start earning its own way—chemical engineering began to change the face of European economy. And fairly rapidly afterwards, the various other sciences began to start getting out of infancy into adolescence; they at least began getting summer jobs and earning a little money.

Throughout the early centuries of Science, the bills were—and had to be—paid by patrons. Copernicus is one example of a scientist who patronized himself; there were others. Cavendish could experiment to his heart's content, because he had inherited wealth. Copernicus was a highly successful merchant, administrator, and a number of other things, who spent some of his commercially earned wealth on his hobby.

This first, Patron stage of Science gradually changed into the second, self-supporting stage. As Engineering science developed into successful commercial businesses it was able to support and pay for more Science. At first, Engineering ventures supported simply engineering research work, but fairly rapidly the engineering companies recognized and supported the pure-consumer stage, Pure or Basic Research.

(*Continued on page 175*)

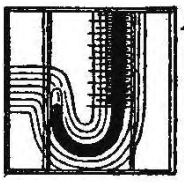
NO

SMALL ENEMY

By CHRISTOPHER ANVIL

The size of an enemy must never be rated in dimensions . . . but in effectiveness! After all, elephants are small enemies, beside the virus molecule of rabies . . .

Illustrated by Krenkel



AMES CARDAN saw the flash as he rounded the last horseshoe curve of his short cut on the way to the company plant near Milford.

Ahead of him, the gray morning sky lit up in a blue-white glare that outlined the bare trees of the forest, and reflected dazzlingly from the snowbanks melting by the roadside.

Cardan brought the car to a quick stop, set the parking brake, and glanced at his watch. He rapped the button that in this car rolled down the windows, then reached forward to snap on the radio. As the windows slid down, he could hear the diffuse roar of snow water rushing down a nearby ravine.

Ahead of him, the glow faded, to reveal a bright, slightly jagged line, like a stationary lightning bolt. Cardan located the bright center of the glow in the same direction as a large oak and a tall slender maple. Then the glow faded out, and abruptly the bright line was gone. Cardan glanced again at his watch, then turned down the radio, which had come on loudly and with a crackling of static. He twisted in his seat to see no other part of the sky lit by a glow like that he'd seen ahead.

There was a crash, as of heavy distant thunder, and Cardan looked at his watch. A little over thirty-one seconds had passed. Whatever had happened, it must have happened about six miles away.

The radio was now free of static, and playing dance music. Cardan switched from station to station, to find only music, local news, and road and weather reports. He frowned, shoved in the cigar lighter, and glanced out to study the oak and maple he'd lined up in the direction of the brightest part of the glow. What he wanted now was a compass, to find the direction of the bright glow.

The lighter popped out, and Cardan thoughtfully puffed his cigar alight. In his own car, he carried a compass and some other emergency supplies that he'd found useful on hunting trips. Unfortunately, this wasn't his own car, but an experimental car converted to steam propulsion by several enthusiasts among his men. Cardan had driven it home over the week end to see how it worked, and had put in chains and a few tools, but nothing else. He glanced in the glove compartment, saw a collection of odd nuts, fittings, and lock washers, shut the compartment, and got out of the car.

Overhead, the sky was gray, but in one part of the sky, a relatively bright spot offered hope that the sun would come out. Cardan broke a thin straight stick off a fallen branch, lined up the oak and maple he'd used to fix the direction of the flash, and traced their direction on the muddy road. He glanced up to see the sun fade out, then start to rapidly grow brighter. He held the stick vertically, traced the direction of its momentary shadow, and held his watch so that the hour hand was lined up in the same direction, its

point toward the place where the stick had stood to cast the shadow. Cardan considered his location within the time zone, decided he could neglect the difference between standard time and local sun time, and took half the angle between the hour hand and the numeral twelve on his watch as the direction of south. That meant that the flash had taken place roughly to the northeast.

Cardan frowned and straightened up. If he was right, the flash had happened on or over a stretch of low-lying farmland about two miles to the right of the highway, on his way into town. He shifted his cigar as he mentally checked his calculations. Then he cleaned the worst of the mud off his shoes with the stick, and got back into the car. He released the parking brake, and changed stations on the radio as he guided the car around a slight curve. The radio switched from dance music to an announcer's voice:

". . . Widespread calls from rural families. No, folks, there has been no plane crash, to the best of our knowledge, and authorities contacted by this station assure us that the 'light in the sky' was just a momentary bright reflection of the sun on the snow. It's a dark day, and when the sun does come out, it can be unusually dazzling. Now, we have a popular ballad by . . ."

Cardan tried a variety of other stations, one after the other, found nothing about the flash, and switched back to the local station. He turned down the volume, and drove swiftly but carefully toward the highway.

He puffed his cigar alight once more as the car came down the last steep hill toward the highway. He judged the speed of the oncoming cars, swung out into the traffic, and settled down for the run to Milford, keeping to the right-hand lane so he could pull over to the side if he saw anything unusual near the site of the flash.

Soon the hum of the tires, and the soft *whoosh* of traffic passing to his left, formed a background to Cardan's thoughts, and for a moment the cars gliding smoothly by made him think of all the changes that had come about in the past fifty years. This in turn led him to wonder briefly about the coming fifty years. Then he puffed thoughtfully on his cigar, and he was thinking of that last meeting at the plant, and of what was waiting for him there today. As Donovan had remarked at the end of that last meeting, while squinting over Cardan's shoulder, "You know, Chief, if you rush too fast into untraveled country, you're likely to wind up all of a sudden at the bottom of a sinkhole, or inside a bear's den."

"Sure," said Cardan. "If your legs outrun your eyes and your mind, that may happen. But," he added, studying the layout of wires, resistors, condensers, and other circuit elements mounted on a board, "if you refuse to travel unfamiliar country, you aren't likely to find anything new."

"You won't be so likely to break a

leg Or to electrocute yourself, either."

Maclane, a sharp-featured, slender man sitting on the other side of the table, said, "Nobody is going to electrocute himself with this, Don. That's the whole business, right on that board."

"No power source?" said Donovan. He walked around the table, a tall, athletic, blond-haired man, and stood looking down at the circuit.

"Nothing but what you see," said Maclane.

Cardan said, "And you got the diagram for this by sending for a patent?"

Maclane shook his head. "I got the *idea* there. It struck me that if I made a change here and a change there, the circuit would look better. It would be . . . well, better balanced. So I made the changes. And there's the result."

"Let's see if I understand you," said Cardan. "You say that if you put your hands on these contacts, and adjust this variable condenser, you get a *sensation?*"

"Right. In the original, I understand it was a tactual sensation. With this adaptation, it's visual."

Donovan said roughly, "In my opinion, this sounds like a lot of bunk."

Maclane looked up sharply. "Why?"

"Because, with no power source, there's no current flow, and with no current flow, the circuit can't operate. Therefore, you can't feel anything, or have any other effect."

"There's no power source in a crystal radio set, either," said Maclane. "Are you going to say that there is, therefore, no current flow in the circuit, and therefore you can't hear anything, or have any other effect?"

"Well, that's different. The crystal set picks up man-made signals sent out to it on purpose."

"You think it won't pick up *natural* signals that aren't sent out to it on purpose? How about a flash of lightning? The crystal set has no optical components to pick up the flash. It has no megaphone device to magnify the sound of the thunder. Therefore, how could it possibly detect a flash of lightning? The idea is too ridiculous to consider, isn't it?"

Donovan frowned. "What you're saying is, we've got something new here, and we're in about the same position as the original experimenters with static electricity?"

"I touch those contacts, and I get a visual impression. That's all I say. But I *do* say that."

"How could you explain a thing like that?"

"Let's work the textbook out later," said Maclane. "Right now all I want anyone to do is to touch these contacts."

Cardan said, "Turn it over and let's see the other side."

Maclane picked up the board and held it up. There was nothing on the back but a faint smear of what looked like grease.

"All right," said Cardan, putting

his cigar in a tray. "The worst we should get out of this is a jolt from a charged condenser."

"Let me do this first, Chief," said Donovan.

"Go ahead," said Cardan.

Donovan put his hands on the contacts. Maclane turned the variable condenser. Donovan said, "Heck, Mac, I don't get any effect at all. I might as well—" Abruptly he cut off, and frowned.

"Well?" said Maclane.

"Go back a little. Do that over again."

Maclane eased back on the variable condenser.

Donovan said sharply, "Hold it. Right around there. Stop. That's it."

"What is it?"

"I don't know." Donovan had his eyes shut tightly. "I don't know what it is. But I see *something*."

Maclane nodded. "In color?"

"No. There's no color. For that matter, there's no form." Donovan scowled. "I mean, the form doesn't —" His voice trailed off.

Maclane said, "It's not in focus?"

"I guess that's it. It's not in focus."

Cardan glanced at Maclane, then at Donovan. Donovan let go of the contacts, turned the condenser a trifle, took hold, and let go again. He shook his head, and glanced at Cardan. "It's a funny effect."

Cardan got up, slid the device over, and took hold. He had no more awareness of any unusual sensation from it than if he had just taken hold of a doorknob.

Maclane turned the knob of the variable condenser. Cardan, his eyes shut, suddenly seemed to be looking at a light through a gray blanket. He raised his hands as if to brush away an obstruction. The sensation was gone instantly. He took hold of the contacts again and now there was nothing unusual.

"Go back," said Cardan. "Try that once more."

Abruptly he had the sensation again. He seemed to be looking through a gray blanket, or through an unfocused microscope in a bad light.

Cardan let go of the contacts and opened his eyes. "You've got something."

Maclane smiled. "Thanks."

Donovan said, "What are you going to do now, Mac?"

Maclane said, "I'm going to get a record of the temperature, humidity, weather conditions, and everything else I can think of. This may not work tomorrow."

Cardan puffed his cigar alight. "Suppose you were to replace a few more constants in that circuit with variables? Now here, for instance, you've got a resistor. Suppose you put in a rheostat? Why not use this circuit as a model, and build another like it with more variable circuit elements? It might not work, but then again—"

Maclane nodded. "It's worth a try, all right. I can do that over the week end."

"Good idea."

The three men looked at each other.

"Well," said Maclane with a grin. "I have to get home on time for dinner tonight, or my wife will have a fit. But I don't think I'll be there a heck of a long time."

Now, as Cardan sped along the highway on Monday morning, he was wondering what Maclane had done over the week end. Ahead, he saw he was coming to a spot on the highway about opposite the site of the flash. A quick glance showed him nothing unusual. Then he was swinging around a wide, well-banked curve to the left, and abruptly he slammed on the brakes.

Straight ahead was a massive pile-up of traffic. One State police car was pulled off on the shoulder of the road, and two more were parked on the partly snow-covered grassy strip in the center. A patrolman was on the road ahead of Cardan, waving the oncoming traffic across the grass and back into the southbound lanes on the other side. The stopped cars in the traffic jam ahead of Cardan were unlike cars he'd seen in traffic jams before; a great number of these cars had their hoods up. At some of the cars, the owners were bent down looking into the engine compartment. Other cars were apparently deserted, the owners trying for rides in the cars now being sent back toward the south.

Directly in front of Cardan, the State policeman thrust his right arm out to his side, gesturing urgently for Cardan to cross the mall and head back. Cardan obediently crossed the grass, then swung over onto the shoulder of the southbound side of the road, stopped, backed out of the stream of traffic crossing the grass, and swung the car around so it was headed north.

A shout, followed by the blast of a whistle, reached him, and he glanced around to see a police officer striding toward him angrily from the right. Cardan glanced at the other cars, all apparently stalled, thrust his cigar at a belligerent angle, set the brake, slid under the wheel and was out of the car on the right-hand side, pointing angrily at the stalled cars, before the policeman had time to reach him.

The officer was shouting and pointing at the southbound lanes. At the fender of a parked police car, several other patrolmen turned around, and looked on alertly.

Cardan ignored the others, and concentrated on the patrolman before him. Some switch in Cardan's brain seemed to mute the function of hearing, so that he was aware only of a generalized noise. With his mind concentrated on the other man's eyes, Cardan hurled words at him like a warship slamming rockets and shells at its target. As the police officer angrily gestured to the south, Cardan remorselessly pointed to the stalled cars. There was an interval like a combined earthquake and hurricane, and at the end of it Cardan was still pointing at the cars. The policeman, looking dazed, glanced over his shoulder for support. The other officers had moved off to help direct traffic.

"Now," Cardan demanded, "what is this? Why are these cars stuck? How long has this been going on? And wasn't there a bright flash about two miles to the northeast, in that direction?"

The policeman said uncertainly, "Are you investigating that?"

"That's right. I want to know if there's any connection between that flash and this tie-up. How long have these cars been here?"

"It started about fifteen minutes ago. One of our cars was in the middle of it and radioed the news. We were already on the way, so we managed to straighten things out and get traffic turned around and moving south."

"These cars with the hoods up are stalled?"

"That's right, sir. They're *all* stalled."

"What happened?"

"Their engines just sputtered and quit."

"They can't be started again?"

"No, sir. The starting motors will turn the engines over, but the engines won't fire."

"How about that flash? Wasn't that right over there?"

"I've heard about that, but I don't know anything about it. Anyway, that was before this happened."

"But it was near here?"

"Yes, it was. It was out on the flats there, somewhere. But I don't know where."

"What's at the north end of this jam? Are there police there, turning the southbound traffic around and heading it back north?"

"Yes, sir. Just the same as we're doing here."

Cardan nodded. He looked at the stalled cars, glanced out over the low flat land to the right of the road, then looked back at his car.

The police officer said, "If I were you, sir, I'd investigate this on foot. If you go in there, you're likely to get stranded."

"The engine would sputter and then quit?"

"That's right. If you were going slowly enough, you could probably back up and get out. But if you roll too far, you're stuck, and we'd have to use a tow cable to get you out."

Cardan thought a moment, then said, "I'll go slowly. This car has an experimental engine, and it may be important to know if it can get through."

The patrolman's eyes widened.

Cardan got back into the car, leaving the door open. "You want to ride down with me?"

"I'd better stay here. Thanks, anyway."

"Thanks for your help."

"That's all right, sir. I hope you get through." The policeman shut the door, and Cardan drove the car slowly ahead. When he'd gone about a hundred feet, Cardan stopped and called back, "Am I in it, yet?"

"You're right in it! Your engine should have stalled by now!"

"It's O.K., so far!" Cardan waved, and started ahead.

Gliding steadily up the grass, Cardan rolled along between cars stalled

on both sides, with people thronging back along the sides of the road and up the mall in the center. He tapped his horn gently, and they jumped out of the way, staring and shouting questions. The pile-up lasted for a good half mile. Somewhere in the middle of it, Cardan spotted a young woman in a little red sports car, a look of furious determination on her face, her hands gripping the wheel as she went nowhere. Cardan glanced around. At this point, most of the cars were deserted. Cardan stopped, and rolled down a window.

"Are you planning to stay here?"

"I've just finished paying for this car, and if I leave it, I don't know *what* will happen to it." She stared at him. "Your car's moving!"

Cardan nodded. "I'd pull you out if I had a chain."

"I've got a tow strap."

"Fine. Now, tell me what happened. I take it you've been in this from the beginning."

She nodded. "I was going about fifty when the engine coughed and quit. I put on the brake, then for just an instant I thought I must be mistaken about the engine, because I wasn't falling behind the rest of the traffic. We all rolled to a stop more or less at the same time. I tried to start the car, but I couldn't do it."

"Did you see a flash?"

"Not then. Earlier."

"About how much earlier?"

"Oh, I'd say five to ten minutes."

Cardan nodded. He got out of the car and looked thoughtfully in the direction from which he thought the flash had come. He could see nothing unusual but only flat land with brown strips where the ground showed through a layer of snow. To the other side of the road here, the ground rose in a long hill that grew steep and was cut away by the road ahead. But nowhere did he see anything unusual.

"O.K.," he said. "Let's have that tow strap."

He towed the girl out, and down a slight downgrade at the head of the traffic jam, then watched as the engine of her little sports car caught with a bang. She jumped out, ran back, threw her arms around him and gave him a big hug and a kiss. The police grinned as Cardan wiped off the lipstick, and the sports car buzzed off into the northbound traffic. A few minutes later, Cardan followed, having parried questions as to whether he was working for the Defense Department or the Atomic Energy Commission. When he pulled into the parking lot of the Milford plant, he noticed that it was less than half-full.

He parked, went up to his office, and found a small crowd packed around Donovan and Maclane, who were seated at the long table, wearing headsets with one wire at each earphone cut, bent back, and taped. Somebody glanced up, and murmured, "Morning, Chief," and Cardan grunted a greeting. The crowd momentarily broke into individuals, who looked around to say a brief "good morning," and then went back to watching Maclane and Donovan,

both of whom were leaning forward, their elbows on the table, their hands at their temples and their eyes tightly shut.

Cardan looked at the crowd, and wondered exactly what Maclane and Donovan had found. No one seemed anxious to let him in on it, but Cardan, studying their tense expressions, felt an uneasy premonition.

"Gray," said Maclane in a low voice. "Taller and more strongly built than usual. Dressed in a kind of coverall, with what I guess are insignia pinned on the chest. They're apparently working some kind of launcher. There goes another one. Can't

judge direction at all because the sun isn't visible, and I'm not familiar with the place."

Cardan scowled, took out a fresh cigar, and worked his way around behind his desk. He pulled open a drawer, got out a match, and puffed the cigar alight.

"Listen," said somebody in the crowd around Maclane. "I don't quite get that. Does it slide on rails, or what? Is there a rocket blast? Is it catapulted out by steam? How *is* the thing launched?"

Donovan said, "When the thing—missile—whatever you want to call it—is dropped into the launcher, it travels up a half-cylinder shaped like a . . . oh . . . a piece of half-round guttering about a foot across at the top."

"You mean, this launcher is like half of a cylinder that's a foot in diameter?"

"Yes. A cylinder split lengthwise, so as to form a sort of trough. The whole thing looks about six feet long, and it's mounted on a tripod. There are a couple of wheels on the side, I suppose to set azimuth and elevation, there's a set of graduated scales, and several locking levers. The missile is set in at the lower end, and slides up the cylinder with no means of propulsion *I* can see."

Maclane said, "You may think I'm nuts, Don, but I can influence this picture."

A plaintive voice said, "How about another look, Don?"

"It's Mike's turn," said Donovan.

Maclane said, "If you think I'm going to let go of it at this point after two days and a night wrestling with the circuit, you're crazy."

Cardan, his curiosity growing by the minute, stepped forward, said "Excuse me," and "Let me through, please," and got no result from the tier of intent backs between him and the table. He grunted, puffed his cigar to a red glow, and angled it so that it heated the back of first one neck and then another. In a few seconds he was at Maclane's shoulder. He studied what was visible of the circuit, and noted that the modified headphones had wires that ran to two contacts like those he'd touched when Maclane had demonstrated the device on Saturday. Cautiously Cardan touched the contacts.

His view of the room vanished, and he was looking at the back of what seemed to be a powerfully-built man in coveralls, who bent at a kind of half-round guide tube mounted on a heavy tripod. The man spun two small wheels on the mount, yanked a cylinder about a foot long out of an almost empty case, nearby, and put the cylinder down at the base of the guide tube. The cylinder slid up the tube, picked up speed like a falling stone, and streaked out into the distance. Cardan tried to follow its path over the snow-covered lowland, but without success. Then the man was again spinning the wheel on the side of the tripod, and someone else came over carrying a fresh case of cylinders. When this second individual set the case down, Cardan's gaze was riveted on his face.

Two eyes, a nose, and a mouth were present on this face, but the overall effect was that of a bobcat. The face seemed to be no shade of brown, tan, or pink, but a dull gray.

Cardan shifted his cigar in his mouth, and Maclane sucked in his breath.

"Chief," said Maclane, "look out with the torch, will you?"

"What have we got here?" growled Cardan.

"That's what I'm trying to figure out."

"Somebody get me a chair. Then I won't be dropping ashes down anybody's neck."

There was the sound of a chair being slid around, and Cardan, watching the two muscular figures drop another cylinder onto the guide tube, felt the edge of the chair press against his legs. He sat down, slid the chair closer to the table, and saw another cylinder streak out over the snow.

"Where is this place?"

"I don't know. I worked all day Sunday on the circuit, and part of last night. I thought I hadn't gotten anywhere, because I couldn't see a thing. When I touched the contacts, they just cut off my vision. This morning, I came in, tried it, shifted some of the settings, and got a flash that blinded me, as if I'd looked into a searchlight. I waited a few minutes, tried again, and got blinded again, though the light didn't seem quite so intense. I tried again, and this time all I saw was a thick dazzling line in the foreground. That faded out, and—"

"Where was this dazzling line?"

"It seemed to hang right in the air in front of me—like an incandescent rope or hose."

"It faded out?"

"No, it was just—it was *gone* all of a sudden."

"Was there any noise—a sound like an explosion?"

"Sorry, Chief, there's no sound with this thing."

"I mean, did you hear any explosion later—as you hear me talking now?"

"Oh, I see what you mean. Did I see it with the circuit, then hear it independently of the circuit? No, I—Now, wait a minute. I think I did hear a sort of low roar some time afterwards. But that could have been anything."

"Then what?"

"Nothing particular. At first I thought the flash was some fault in the circuit. Then I wrestled with the focus a little, got it clearer, and noticed that some of the snow in front of me had a glazed look, as if the top layers had melted and settled to form a shallow trough. But I didn't know what to make of it. Then something blurred across my field of vision from left to right. A little later it happened again. I changed the focus on this thing, and after backing and filling for quite a while, I got this scene you see now."

"Is it hard to change the focus?"

"It's an awful job. It isn't enough to just . . . say . . . change the re-

sistance in one branch of the circuit. You've got to change inductance and capacitance, too. And then if you don't change them just right you get some kind of fantastic picture like a surrealist's nightmare. The patterns are almost familiar and three-dimensional, but they just don't add up. Then when you've almost got the scene, everything's fuzzy, and it slops back and forth between the scene you're after, and this other scene I mention, and it's enough to drive you nuts. The actual scene is unstable unless everything is just right. That's why you don't see me trying to change the focus to find out where this scene is located. In the process, we'd miss whatever is going on here. I think what we've got here is the filming of some kind of monster picture, but I don't see how those things get slung out of that half-cylinder."

Cardan, his hands still on the contacts, watched the powerfully-built figure in coveralls shoot out another cylinder. Cardan grunted, let go of the contacts and looked up at his men crowded around the table.

Cardan puffed his cigar back to life, and said, "Smitty, go out and see if you can get any news. Try all the stations, and listen particularly for anything about highway trouble, big traffic jams, car engines quitting, lights in the sky, or unidentified flying objects being sighted."

Smitty, a wiry figure with black hair combed straight back, nodded and went out.

Cardan glanced at a pugnacious-looking towheaded six-footer, noted his habitual combative look, and grinned. The towhead hesitated, then grinned back. Cardan said, "Consider the mess you got into this morning. You were taking a trip south to finish up a business deal. You tried to drive out on Route 27 and the State police turned you back. You've been thinking it over, and you want to know how there could be a traffic jam on a weekday on both sides of a four-lane highway. You've got a right to know. You're a taxpayer. And if they tell you the cars all stalled, you tell them you know that's not so because you saw a late-model car drive up the mall towing a sports car. How come *that* car could run if the others couldn't. Give 'em hell. And then demand to know just how you *can* get out of this place before the middle of next week."

The towhead grinned and went out.

Cardan said, "Now, as long as we're dependent on just one of these circuits, we never dare vary the focus, because we'll miss what's going on while we fight with the various adjustments. Mac, why don't we make up a batch of these circuits?"

Maclane nodded. "Good idea."

"O.K.," said Cardan. Half-a-dozen of the men around the table eagerly volunteered for this job, and Cardan was sending them out when the door opened and a shapely brunette stepped in. "Mr. Cardan, there's a General Whitely on the line. I told him you were in conference, but he

insists he has to speak to you right away. And Dr. Crawford was due to get here early this afternoon. He called up and said all flights coming into Milford have been cancelled. I came in to tell you about Dr. Crawford a minute ago, but you were busy and I didn't want to interrupt."

Cardan nodded. "Put Whitely on the line. If Crawford calls back, tell him to keep out of here till things clear up. He'd particularly better not come by car unless he's got a Stanley Steamer or the equivalent."

Cardan's secretary looked perplexed. But she nodded. "Yes, sir, I'll tell him that. And I'll put General Whitely on right away."

"Good."

Someone handed Cardan a phone, and he heard a voice say loudly, "Hello, Bugs?"

Cardan winced. He and Whitely had been boyhood friends, but Cardan didn't care for this nickname.

"Bugs?" The voice jumped out at him.

Out of the corner of his eye, Cardan could see several of his men glance at each other. Cardan blew out a cloud of smoke, set his cigar on the edge of the table, and growled, "Right here, Tarface. What do you want?"

"Listen," said the voice loudly, "what's going on up your way? Fill me in."

Cardan squinted at the phone. "I thought you had an Intelligence section."

"Never mind all that secondhand stuff, Bugs. I've got an idea you know what's going on. You're right in the middle of it."

"All right," said Cardan, "I'll trade you item-for-item. About an hour ago, Route 27 was blocked with half-a-mile of cars stalled on the curve about four-and-a-half miles toward Milford from the shortcut over the ridge. You remember how I drove you out last time?"

"I remember. Now I'll tell you something. About three quarters of an hour ago, a man in a late-model car drove smack through the middle of that jam. The police in charge think he was an official of the Atomic Energy Commission, driving a car with a nuclear engine. I notice, Bugs, their description is such that he was about your height and build, conservatively dressed, smoked a cigar, and had your manner. Also, he looked a little younger than you are, but you look a little young for your age, so I suppose that's natural. Now what is going on up there?"

Whitely's voice jumped out of the phone like a whiplash, and Cardan grinned. "What you just told me is something I already knew, Tarface, so it doesn't count. Now I believe there were one or two trucks stuck in that traffic jam, but I have no way to be sure whether their engines stopped, or they just got trapped amongst all the stalled cars and couldn't get out. Now some trucks have gas engines and some trucks have Diesel engines. You see what I'm getting at?"

"It hits gas and Diesel engines both. But there's a kind of engine it

doesn't hit, and I want to know about it."

"There are at least *two* other kinds of engines it doesn't hit. The starters in the cars worked, so low-voltage electrical motors aren't stopped."

"That's right. What's the other kind?"

"My turn, Tarface. Is Route 27 the only place this has happened?"

"Until about an hour ago, yes. But this thing, whatever it is, has also begun moving out along an arc, like a crayon on the end of a forty-mile string. Rail, truck, and highway travel are stopped dead, along a quarter-circle with this forty-mile radius, and the arc is still spreading out with mathematical accuracy. We've had three plane crashes so far, but some planes at high altitudes have gotten over all right."

"O.K. Where's this forty-mile string centered?"

"Wait a minute. How about that nuclear car?"

"Not nuclear. Steam."

"Steam-propelled, eh? What heats the boiler?"

"A main burner fired by kerosene, and pilot burner run on gasoline. Where's the center of this forty-mile arc?"

"Smack in the middle of the industrial district north of Milford."

Cardan stiffened.

Whitely said, "You hear me, Bugs?"

"Yes, and I think that's a blind. Take a look at the low land opposite that traffic jam I mentioned on Route 27."

Cardan could hear faint voices as if someone had covered the mouthpiece. "All right, Bugs," came Whitely's voice suddenly. "You got anything more? I'm in a rush here."

"Nothing more yet," said Cardan.

"O.K. You know how to reach me. Keep away from that traffic jam on 27."

Cardan heard a click, and he was holding a dead phone.

Smitty was standing on the other side of the desk, and the belligerent towhead was just coming in the door.

Cardan glanced at Smitty. "What did you find out?"

Smitty said, "Pretty straightforward coverage on radio and TV. Motorists are warned to keep off the out-of-town highways, because some unknown effect causes car engines to stall. Travel within town, and between specified points on a map shown on TV, is O.K. The airport is closed, but travel out-of-town by train is all right for now, and emergency travel on Route 34 is permitted, subject to cancellation any time if the trouble spreads. They call it the 'stalling effect.'"

"What explanation do they give?"

"They've got some professor from the local college at a blackboard showing how ionized air around the spark plugs can short a high-voltage spark from the plug to the cylinder head. The professor has a very cultured voice, and treats the whole thing as if it were a trivial matter."

"What causes the ionized air around the spark plugs?"

"He's a little vague about the exact connection, but bears down heavy on the fact that cosmic rays cause ionization in a cloud chamber. When I left he was saying something about sunspots."

"What's the conclusion?"

Smitty grinned, "It would be premature at this time to attempt a definitive characterization of the precise nature of this disturbance. There is, however, no cause for alarm. This is nothing more serious than the slightly irritating situation encountered when the porcelain insulating material of the automobile's spark plugs becomes moist due to fog or mist."

One of the men at the table snorted. "Some of those spark plugs are buried under valve covers bolted down on waterproof gaskets. You could run those engines under Niagara Falls if you had the air intakes clear."

"Well," said Smitty, "it's an explanation, anyway, and to see this authority sneer at the whole business certainly has a calming effect."

Donovan said, "I heard you ask about Diesel trucks, Chief. Any information on that?"

"They get stopped, too."

"Then there goes the spark-plug argument. A Diesel fires by compression, not by spark plugs."

Cardan glanced at the towhead, who shook his head, and said, "All I could get was the same stuff. The police say they aren't responsible for sunspots and to keep off the highways except in case of emergency. Apparently the trains are still running, and Route 34 is still clear. About the car that went through the traffic jam, they say they're sorry, but for security reasons, they can't give any information on it. The government is investigating the tie-up, and that was a new experimental kind of car. I'm not supposed to repeat that, and if anybody asks me about seeing the car, I'm supposed to say 'no comment,' or deny any knowledge of it."

Cardan laughed.

Somebody said, "What's this about a secret governmental car?"

Cardan said, "I had to give some explanation for that steam car. I didn't *say* it was a secret government car. But if they want to think so, that's *their* business."

Maclane said, "Excuse me, Chief. I'd better see how those circuits are coming along. You want to watch this?"

Cardan said, "Sure," and Maclane handed him the headset. Maclane went out, and Cardan sent everyone but Donovan out of the room to keep watch on the radio and TV news coverage, to go down to the local supermarkets and bring back some meat and fresh grocery orders, and to drop in at nearby sporting goods and Army-Navy stores to pick up weapons and ammunition.

Cardan put on the headset for a moment to study the tripod, then took the headset off, and, frowning, fired up his cigar.

Donovan said, "I wish we could change the focus on this thing. I'm

sitting here watching nothing while there's no telling what may be going on just twenty feet away."

"When Mac gets the other sets ready," said Cardan, "we ought to be a lot better off."

"I keep hoping that when we can see more of this, we'll find out it's just a big flap over nothing. Maybe, say, the filming of a motion picture. But this trough on a tripod just isn't dramatic enough for that. And they acted too casual when they used it."

"It's no flap over nothing," said Cardan. He described his phone conversation with Whitely.

Donovan shook his head. "You'd think a race that *could* do this would have gotten past the point where it *would* do it."

"Why?"

"It seems to me to be a basic truth that when you set out to injure someone else, you may succeed. But, in due time, the thing will curve around in such a way that you get your own teeth rammed down your throat. I'd think an interstellar race would have had enough experience to have learned that."

Cardan blew out a cloud of smoke. "You're talking about how it *ought* to be. But what if this interstellar race isn't perfect? What if they have competition from *another* interstellar race? For that matter, by the time *we* can travel from star to star, will the whole human race have turned into saints?"

Donovan hesitated. "Maybe not the *whole* human race."

"There's another catch."

"Why?" Donovan asked abruptly.

"The bulk of our own people are law-abiding. But how does that help you if you run into a gang of murderers? How do we know your wise interstellar race won't have a band of fanatics, or frustrated adventurers, who will get a ship, go off to some planet out in the hinterlands, take the planet over and run things *their* way?"

Donovan frowned. "Kind of a rough situation. They'd have the advanced technology, but not the restraints that went with it."

"Which would be our tough luck."

"Yeah."

A cold, hard expression passed over Donovan's face, then he said, "I don't know if you're watching this or not, Chief. If you aren't, you'd better take a look."

Cardan put on the headset. Directly before him sat the tripod, still deserted, and with its half-cylinder pointed at the horizon. For a moment there was nothing else nearby but tracks in the snow. Then a thing like a huge, pale gray oil drum rolled from the left into Cardan's field of view, wheeled, and swung back in the opposite direction, the long snout of a gun showing momentarily in outline against the sky.

Cardan looked at the snow, where there were two broad tracks, each of which appeared to be about four feet wide, with roughly a two-and-a-half foot space between them.

A moment later, another of the gray drums rolled into view, and Cardan glanced rapidly from point-to-

point on this drum, noting the non-rotating central part, the wide treads turning on either end, the slit between these two treads, and the long gun that thrust out, canted slightly skyward, below the right end of the slit.

Then the vehicle wheeled, and Cardan had a brief glimpse of a tube like a short length of fifty caliber machine gun, thrust out the rear of the cylinder and aimed straight at him. Then the thing was out of his range of vision.

Cardan slipped off the headset, and snapped on the intercom. "Miss Bowen, see if you can get General Whitely for me."

"Yes, Mr. Cardan."

Donovan said, "Those guns *could* be for self-defense."

"Sure. Which is why they try to paralyze traffic along a circle eighty miles across."

"Yeah," said Donovan slowly.

"A circle eighty miles across takes in about five thousand square miles," said Cardan. "That's about the size of the state of Connecticut. What's going to happen to all the people inside the circle when neither trucks nor trains can get through with food?"

"They'll have to get out."

"How? On foot?"

"They'll drive to the place where their cars stall. Then they'll walk."

"What happens to the cars they leave behind when they get out to walk?"

"They—" Donovan stopped.

"Say the cars average sixteen feet in length," said Cardan. "If half a dozen drivers, with or without their families, just stop their cars one behind the other, there's a hundred feet of road blocked up. Five hundred and twenty of these cars will block a mile of a single-lane road. If you stand on a highway, with the cars going past fifty feet apart and at sixty miles an hour, it will only take about four minutes for that number of cars to go by."

"But can't the police—"

Cardan snorted. "The police can operate for two reasons. First, their own organization and discipline. Second, the fact that the great bulk of the people are on their side, actively or passively. Now, what's going to happen when everybody, including the police, realizes that the only way to get food for themselves and their families is to get on the other side of this eighty-mile circle?"

Donovan was silently thinking that over when the door opened up and Maclane stepped in. He grinned at Cardan, and said, "Anything new?"

Cardan described the cylindrical vehicles, with their guns fore and aft.

Maclane whistled and put on the headset. "Nothing in sight now but the tripod and a lot of packed snow. What do you mean, this vehicle is like a big thick axle with a wheel on each end?"

"More like an overgrown oil drum, with broad treads turning on each end."

"Does the drum itself rotate?"

"Not while I was looking at it. How about you, Don?"

"The drum rotates a little, but not much, just the way a car dips a little in the front when you stop suddenly."

Maclane said, "How much clearance between the underside of this drum and the ground?"

"Oh, I'd guess about a foot."

The door opened, and Cardan's secretary said, "I have General Whitely on the phone, sir. And Mr. Farrell—he's working on the circuits—said to tell Mr. Maclane they're having an 'h' of a time focusing the circuits."

Cardan grinned. "You'd better get back down there, Mac. When you get them focused, send one up here, and take another down to the subbasement and see if it works down there."

Maclane nodded and went out.

Cardan picked up the phone, and held it cautiously a little way from his ear. The general's voice jumped out at him. "What are we up against here, Bugs? Have you got any inside dope on this?"

Cardan said cautiously, "I've got a kind of long-range viewer with a very narrow fixed field of view, overlook-

ing what I think is the spot where the trouble is. How about you?"

"I've got aerial TV and blown-up aerial photographs."

"What do you see?"

The general snorted. "There's a big cylinder piled into the snow, with one end open, and things like pale blue fuel drums dropping out and rolling away."

"Rolling away toward what?"

"The highway. Where that traffic jam is, on the curve south of Milford."

"What are you doing about it?"

"I managed to get a couple of helicopters around this arc of interference to take a close look. Their engines quit before they could get close. I've got some special jets high overhead."

"How about their engines?"

"They give out, too. Whether because of what hits the others, or because of a kind of drifting fluff or fuzz we've run into, I don't know."

"What does the fuzz do?"

"It gets sucked into the air intakes, and apparently knocks out the engines. I've told you something. How about something in return?"

"Well," said Cardan, "this thing I'm looking through has a narrow fixed field of view, but I'm trying to get that fixed. Meantime, those drums you saw are a pale blue, is that right?"

"Right. What about them?"

"I got a close view of them but without color, and it didn't last very long. The drums seem to be about twelve feet long, the center section fitted with a view slit and a gun in front, a gun behind, and broad treads mounted on either side of the center with about a foot ground clearance. The treads look about four feet wide. They may actually be several treads mounted side-by-side. The whole drum doesn't roll over, but just the treads. Directly in my field of view, there's a heavy tripod mounting a half-cylinder that looks about a foot through and six feet long. This half-cylinder is something like a big bazooka split lengthwise and mounted on a tripod with two adjusting wheels, graduated circles—apparently for elevation and azimuth, and several locking levers. About an hour ago, a big brawny individual in coveralls was dropping cylinders a foot or so long in his end of this split bazooka, and the cylinders streaked up the trough and shot out for the horizon. I don't know what the means of propulsion is."

The general said tensely, "See the face of the individual, Bugs?"

Cardan hesitated.

Whitely's voice sprang out at him. "Did this individual look human, Bugs?"

Cardan said, "Depends on what you mean by human. All the features were there, and the body looked human, but the overall effect was that of a lynx or a bobcat. Why?"

"You know why. Either this is Orson Welles' shocker come to life, or it all started out on Earth. If so, I think we know the foreign power responsible."

Cardan thought of the vivid streak across the sky, the intense bluish glare of the explosion, the tripod with its half-cylindrical launcher, and the drum-shaped vehicles churning toward the highway jammed with stalled cars. Cardan tossed his dead cigar into the ashtray. "Nuts," he said irritatedly. "If the Russians had this stuff, they could put it into production and crowd us right off the map into the Pacific Ocean. They wouldn't tip their hand like this. You're going off the deep end, Tarface."

"Hell, it could be a test. To see if we've got the stuff ourselves. *Then* they spring the main attack."

"And what if we happen to be jumpy and the minute this 'test' of theirs starts, we hit them with everything we've got?"

Whitely was silent a moment, then he laughed. "I just wanted to see how it sounded to you."

"It sounds lousy. Suppose in the course of this test we should turn out to have the devices ourselves. Then we overpower the 'aliens,' tear off their Halloween masks, and they turn out to talk Russian. Next we put on a big propaganda exhibition featuring the 'alien spaceship,' plus vehicles, guns, and alien invaders complete

with masks. The Russians would look foolish for the next five years."

"It doesn't sound too good, does it?"

"They just aren't stupid, that's all. They'd have their neck stuck out a mile, and no way to pull it in."

"You got any more information?"

"Not yet. Maybe later."

"O.K., Bugs. If you can get any more close views, it will be a big help. Keep me in touch. And keep away from the highway."

Cardan frowned at the dead phone. That was the second time Whitely had told him to stay away from the road. He put the phone on its cradle, and looked up to see Maclane holding another circuit, and looking serious. "Was that the general?"

Cardan nodded.

Maclane said, "You don't look too disturbed, Chief."

Cardan frowned. "Why? Have you got a better view on that set?"

"We've got a ringside seat."

"Let's see."

Cardan put the headset on, and got a view across the northern end of the traffic jam out over the lowland to the east, and to the southeast along the bend of the highway. Several of the big cylindrical vehicles were on the highway above the traffic jam, and others were spread out, approaching across the low snow-covered ground. About five hundred feet from the highway a helicopter was burning. Another plane was burning about a thousand yards away. Still further back, he could see a line of towers that carried power lines across the low-lying farmland. In the foreground, a parachute was caught in some brush, billowing in the wind near the foot of the embankment below the highway.

Cardan glanced at the stalled and deserted cars, then back at the big cylindrical drums, rolling northward on the road. They seemed to be moving only about fifteen or twenty miles an hour, but they were moving steadily. More of them were working along a slanting cable up the bank and onto the road. As Cardan watched, one of the cylinders wheeled toward the jammed cars. There was a blur at the forward gun of the vehicle, and a puff of rolling black smoke burst amongst the nearest cars which lifted up and smashed heavily back and sidewise. There was another blast. A figure in airman's uniform jumped up to dart back amongst the cars. There was a third puff of smoke and the figure disintegrated.

The cylinder rolled down the grass strip toward the south, followed by another cylinder, and then another. Far out across the lowland, a blast of smoke billowed at the base of a tower supporting the power lines. The tower tilted and leaned out. There was a dazzling display of arcing sparks, then the power line came down.

Nearby, several of the cylinders crossed the highway, spread out, and started up the hill on the other side, passing out of Cardan's field of vision.

Several powerfully-built figures,

carrying crates, walked onto the shoulder of the northbound side of the highway, and began setting up a half-cylinder on a tripod.

Maclane's voice reached Cardan. "I'm watching this thing, Chief, with my hands on the contacts. I want you to notice something."

Donovan's voice cut in, "I don't know if you can see this. There's a big Marine Corps helicopter coming in fast, to the right of this view. There —Boy, it hit like a rock! Wait a minute. Here come parachutists! They're drifting down all over the place. Can you see that, Chief?"

Cardan could now see in the sky well beyond the fallen power lines the parachutes blossoming out in what appeared to be different shades of gray and drifting to the south. Big planes were gliding down fast overhead.

Maclane said urgently, "This is important, Chief. You see that mess of burning trash blown out of the cars over there?"

Cardan tore his gaze from the parachutes, and looked at the overturned cars. "You mean the front seat cushion, and some upholstery ripped half-off a door? What of it, Mac?"

"Watch it."

Cardan briefly glanced up at a plane that was banking steeply, toward the road. The plane blew up in a blast of black smoke, and Cardan looked back at the burning car, and growled. "What's the point of this, Mac?"

"Just watch."

A small piece of blazing upholstery flapped sharply, then tore away, and blew along the road in the wind, twisting and tumbling. It stopped, and momentarily seemed to lean against the wind, then rolled away, and stopped again, on an empty stretch of road.

Cardan frowned as the strip of cloth flapped in the air, rising slowly above the roadway, *but remained stationary and did not blow back with the wind.*

Cardan watched intently.

The cloth flapped in the air, as if held on an invisible pin.

Maclane said, "I've been trying to tell Don, I can influence this picture."

Donovan suddenly groaned, then cursed in a low voice. Cardan snapped his attention back to the scene in the distance, beyond the power line, but could see only a confused whirl of motion. He handed the headset he was using to Maclane, and put on the second headset of the circuit Donovan was using.

The confused whirl Cardan had seen beyond the power lines now sprang into clear view. Men in battle dress were running forward, then dropping to the ground to take aim at a line of cylinders rolling toward them. Cardan could see mortars, machine guns, 3.5-inch rocket launchers, and some weapon or device that he didn't recognize. At first glance, he felt a grim sense of pleasure. Then he looked again.

The men were struggling with their weapons. There was no sign of rifle, mortar, or machine-gun fire, and

the rockets were falling short and failing to explode. The men glanced up at each other, then looked out over the lowland.

The cylinders were closer now, and faint blurs flickered at the snouts of their guns.

Close by, directly in Cardan's field of view, chunks of dirt and snow flew up. Then the smoke blew away, and he could see endless puffs of black erupt across his field of view in a continuous churning that stopped thought, and left him looking on blankly as men, guns, and equipment blew into fragments.

Then the cylinders were rolling by.

Behind them walked coveralled individuals seven or eight feet in apparent height, carrying like tommy-guns large-breeched, long-muzzled weapons, with which they methodically shot the wounded.

Then they had passed by, too, and there was nothing left but fragments, motionless figures, torn uniform cloth lifting in the wind that swept across the lowland, and dirt falling down the sides of shellholes.

Cardan took off the headphones, snapped on the intercom, and said, "Miss Bowen, see if you can get General Whitely for me."

"Yes, Mr. Cardan."

Donovan got to his feet, and put his headphones on the table, "I can't watch that any more."

"Somebody has to keep an eye on it," said Cardan, "so we'll know if anything new develops."

"I'm going to watch it from a little closer range," said Donovan.

Cardan opened his mouth. Donovan went out, slamming the door.

Cardan got out a fresh cigar, stuck it in his mouth, and lit it. He blew out a cloud of smoke. "That's the trouble with having a bunch of individualists around. When the crisis comes, they all boil off in their own direction."

Maclane took off his headset. "The only one to boil off in his own direction so far is Donovan."

"Wait a while," said Cardan.

The intercom buzzed. Miss Bowen said, "Mr. Cardan, the men are back with the groceries."

"Have them put the stuff down in the subbasement. How about the men who went out to the sporting goods stores?"

"They aren't back yet, sir."

"O.K. Keep trying to get Whitely."

"Yes, sir."

Maclane, holding the headset in one hand, was squinting at the wall. "I wonder, Chief," he murmured, "what Donovan's planning to do?"

Cardan glanced at Maclane, and took a fresh grip on his cigar.

Maclane said thoughtfully, "No ordinary car will get him near that place by now, I suppose. But our steam car can do it. And they'll be *sure* nothing we have can move."

Cardan looked at Maclane sourly. "Mac, listen a—"

Maclane abruptly tossed the headset on the table and jumped up.

"Stay at that set!" Cardan ordered.

The door slammed as Maclane went out.

"Lousy individualists!" roared Cardan. He now had two circuits giving a close-range view of the action, and no one to do the watching but himself.

The intercom buzzed. Miss Bowen said, "The men with the sporting goods are back, Mr. Cardan."

"Good. Have them put them down in the subbasement, and leave a few men to keep an eye on things."

"They're on the way up here right now, sir."

"Oh," said Cardan coldly. "Well, when they get here, send them in."

"Yes, sir."

"And keep trying for Whitely."

"Yes, sir."

Cardan picked up the headset Maclane had dropped, and studied the remaining wisps of smoking upholstery from the wrecked car. He eyed them thoughtfully, and adjusted the cigar in his mouth. Watching one particular bit of upholstery intently, he willed it to move to the left. A puff of wind blew it to the right and backwards. Cardan's teeth tightened on the cigar. Drawing all his conscious awareness into a tight focus centered on the wisp of blackened cloth, he commanded it to move forward, toward him. A puff of wind carried it farther away. Cardan absently took out his cigar. Then he centered his entire consciousness on that little bit of cloth, till he was aware of nothing else. The view seemed to waver and enlarge as Cardan focused his mind on the cloth, seeing each separate fiber, taking hold of it as he became fully aware of its every visible characteristic, and lifted it up and forward, toward him, against the wind, and held it in the air. He turned it from side-to-side before him, over and over, winding it into a tight ball and spreading it out flat almost as if it were a finger on a hand that he controlled through the direct action of nerves on muscles.

Somewhere in the background, Cardan could hear voices. He drew a deep breath, and carefully took off the headset. He felt somewhat like a man awakening from anesthesia, or from a vivid dream. But his last glimpse with the headset on showed him the bit of cloth fluttering down from a position well upwind of the smoldering wreckage of the cars.

Miss Bowen was saying urgently, "Mr. Cardan, I have General Whitely on the line. And the men are back from the sporting goods stores, and they're quite insistent—"

Cardan picked up his cigar. "Put Whitely on, then let them in but tell them to be quiet."

Miss Bowen put the phone in Cardan's hand, then stepped outside to quiet angry voices.

"Hello?" said Cardan into the phone.

The door opened, and Cardan's men shoved in, rifles and shotguns thrust out in all directions.

"Bugs?" Whitely's voice jumped out of the phone.

"Right here," said Cardan, holding up his hand to quiet his men.

"Listen," said the general, "they've stepped up the power of that circle. We can't get anything through or over, and what we had inside is used up."

"What about missiles?"

"We attacked them hand-to-hand a little bit ago, Bugs. Not a gun would fire. As a last resort, we had a nuclear device in there, and if nothing else worked, we intended to set it off. We set it off. Nothing happened."

Cardan frowned. "How about missiles?"

"We've tried missiles. They seem to get through, but they don't explode —unless you want us to beat them to death with war heads."

Cardan set his cigar in the tray. "What are you going to do?"

"So far we've been fighting blind and off-balance. There are too many unknowns. We don't know who we're fighting, what they've got, or what they'll spring on us next. They've knocked us into a kind of punch-drunk stupor, and the only way out of it I can see is to get in there fast, smash their airhead while it's still little, and grab enough material and prisoners so we can start to figure out what's going on."

"What are you going to fight them with?"

"We're going to try to get at them close-range with gas and anything else that's not based on explosives. But, Bugs, how do we get close enough to do it in time? You drove through that barrier. How many of those steam cars do you have?"

"Just one, and I'm pretty sure someone just took off in it. The devil with that. Listen, Tarface."

"I'm listening."

"What you want is steam locomotives. Get after every roundhouse and railroad repair yard for one that isn't torn down yet. Get in touch with the Canadians. I think they're still using them, and theirs will be in good shape. There's a track that runs only a few miles to the east of that landing site, and—"

The general's voice cut in abruptly. "I've got the picture, Bugs. Thanks."

There was a click at Cardan's ear. He set the dead phone in its cradle and looked up at the men across the desk, bristling with guns. The powerfully-built, belligerent towhead stood directly in front of Cardan, and seemed to be the spokesman.

The door opened up, and Maclane came in, looking furious.

Cardan glanced at Maclane. "Don went off in the steam car, did he?"

"He whizzed right out of the parking lot as I was yelling to him to wait a minute."

"So you could run out with him, eh?"

"It's a free country," blazed Maclane. "You don't own me!"

There was a mutter of sympathy from the rest. Cardan was on his feet and had Maclane by the collar before he knew what had happened. "You fool, do you think I *want* to own you?" He gave him a shake, and let go. "Get out! Beat it, the lot of you!" He sat down, threw his dead

cigar into the wastebasket, and pulled out a fresh one. When he looked up, they were all standing there, watching him pugnaciously.

He paused with the cigar in his hand and eyed them one-by-one. They looked back unflinchingly. "All right," he snarled. "Donovan has gone roaring off on his own, and you want to, too. Do you think *I* don't? But we've got something better here." He jerked a thumb at the circuits. "Mac was telling me he could influence the picture! When he left a minute ago, I discovered *I* could influence the picture. Do you know what that 'influencing the picture' means? What's the only way to move the image of an object on an ordinary TV screen without distorting the rest of the picture?"

Maclane, his eyes glinting, said, "Move the object itself in the studio."

"Right. And it seems to me exactly what happens here."

Smitty scowled. "So therefore, what?"

Cardan lit the cigar. "So therefore Mac can move a small light object down on that highway. So can I."

The big towhead said, "We'll never beat them by moving 'small light objects'! We've got to go down there and smash them!"

"What with?" said Cardan contemptuously.

"With what we've got. We can figure out what to do when we get there."

Cardan blew out a cloud of cigar smoke. "If you think you're a one-man armored division, go ahead and try it. Maybe you can succeed where a paratroop battalion and nuclear missiles fail."

"All right, then, what *do* we do?"

"If you'll shut up for a minute, I'll tell you."

The towhead was watching him as if he had a bonfire lit behind each eye. Cardan blew a cloud of cigar smoke in his face, eyed the rest of the men, noted that all of them looked tense, and some appeared so keyed up as to be ready to spring at his throat any time. Cardan knocked the ash off his cigar and growled, "I don't know if you realize it or not, but one basic principle of either war or business competition is to hit your opponent's weak point. If you go charging out there with those guns, you're going to run up against him where he's strong. Another basic principle is to do what your opponent doesn't expect, and isn't ready for, and get him off-balance. If you go after him head-on, you'll be doing exactly what he *does* expect, and he'll polish you off by simple routine. Now, if you want to go, go ahead."

The men glanced at each other uneasily. There was a brief silence. Smitty said, "What's your idea, Chief?"

Cardan glanced at their faces, saw they were all listening intently, and said, "It isn't just how much power a man has that counts. A lot depends on how he uses it, and where he brings it to bear. The armed forces

have the power to flatten the opposition down at that highway, but they can't bring their power to bear. They're tied up. They've been hit by devices they can't strike back at. Now, what do you think that circuit there represents for our side?"

"Sure, but you said yourself, all you can do is move a little light object with it."

Cardan grinned. "That's all."

"But look, Chief—"

"Benjamin Franklin said, a couple of hundred years ago, 'There is no *little* enemy.' "

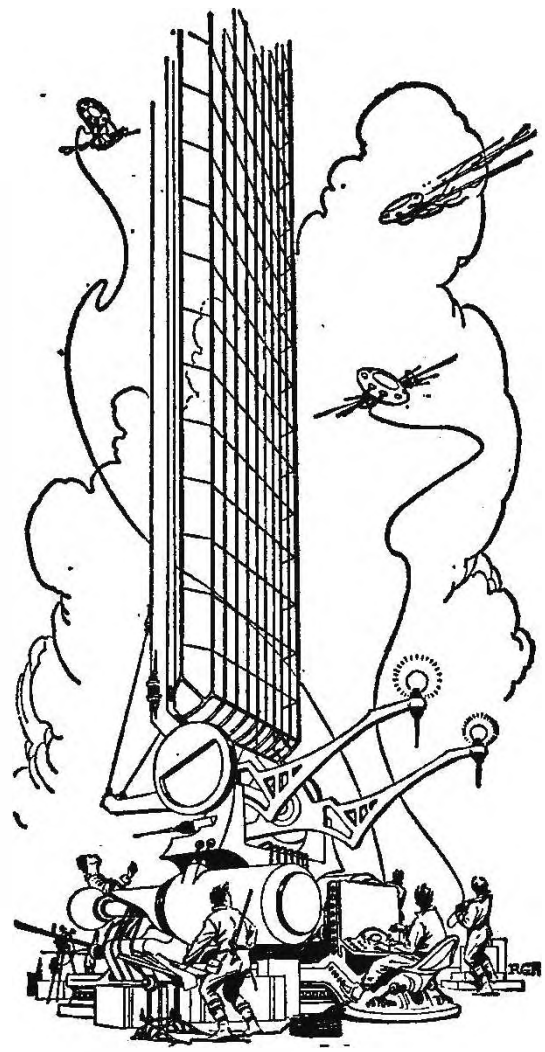
The men were squinting from Cardan to the circuit. Maclane scowled, and put his hands on the contacts.

Cardan said, "In the first world war, the British outnumbered the Turks in Palestine. But the Turks were dug into a system of trenches. The British couldn't bring their superiority to bear. Then Lawrence of Arabia went to work on the Turkish communications. Once he had these worn to a thread, the British threatened an attack in one direction, secretly switched their forces, and smashed through elsewhere. The British Army won the actual victory. But first Lawrence and the Arabs wore the opposition down and drove them to distraction."

The men all looked thoughtful. Smitty was massaging his chin with his hand. "We're like Lawrence, and the Armed Forces are like the British?"

"Exactly."

The towhead said curiously, "But



if we can only move small light stuff, how does that help?"

Cardan said, "A pin is a very small light object. Do you know any man who can do efficient work with a little light pin stuck in him? And yet—he'd better do efficient work, with the Armed Forces closing in on him."

"Hm-m-m," said the towhead.

Maclane, his hands on the contacts of one of the sets, said, "Whatever we're going to do, Chief, we'd better hurry up and do it. They're setting up some kind of framework of long shiny rods on the highway.

They're working as if they want to get it set up in a hurry."

Cardan snapped on the intercom.

"Miss Bowen, we're going to move down into subbasement. There's a switchboard down there, so we can keep in touch with the outside. The telephone lines are underground, so if worst comes to worst, we should be able to keep in touch with the outside for quite a while. Are you willing?"

"Yes, sir."

Cardan looked up. "Let's go."

They went out the door in a rush, and headed downstairs.

The "subbasement," Cardan was thinking, was the reason for one of the worst squabbles he'd ever had with the major stockholders of the company. Every feature of it had infuriated them, from the massive, heavily-reinforced ceiling, to the small production facilities and self-contained water, sewage, and power supply. Why, the big stockholders demanded, should the profits of the company be sunk into this slab of masonry instead of turned back into useful production, or distributed in dividends?

In reply, Cardan mobilized the small stockholders, played the national anthem, waved the flag, puffed the Cold War into an imminent threat of missile and bombing attack, and scattered smoke, dust, and confusion in all directions. He squeezed through a violent stockholders meeting with a narrow margin of control and well-heeled opponents breathing fire and brimstone down his neck.

Cardan knew the subbasement was still spoken of acidly.

About the kindest name for it was "Cardan's Folly."

And Cardan knew that there were still a few diehards who automatically voted against everything they thought he wanted, just in commemoration of that subbasement fight. But he also knew that the majority of the big stockholders were again behind him, with one reservation: "So long as he doesn't want *another* bomb shelter."

As the massive doors slid back, Cardan eyed the subbasement approvingly, then walked in with the rest of the men.

Smitty, carrying one of the sets, said curiously, "Chief, why did you build this?"

"I thought we might need it."

"But why?"

"With people waving H-bombs and missiles around, what's wrong with having a hole to crawl into?"

"*I* think you had some kind of hunch."

Cardan shifted the cigar in his mouth, and blew out a noncommittal cloud of smoke. Overhead, the lights faded out, then snapped on more dimly. Someone called, "Power's been knocked out!"

Underfoot, there was a faint vibration as the subbasement generators began to turn over.

Cardan glanced around. Canned goods were regularly kept stored away down here, and now he noted a large pile of fresh groceries. "Good," he said approvingly, and gave directions for putting the food away.

Maclane, he saw, was at a table with a group of men huddled around a number of sets.

The towhead said, "What about these guns, Chief? We got the whole assortment—shotguns, rifles, air guns, CO_2 guns. You ask for it, and we've got it. We even picked up a few of these slingshots that shoot ball bearings."

Cardan nodded approvingly. "Sort 'em out, with the right ammunition by each weapon. I think the CO_2 guns and those slingshots are going to be the handiest."

"You figure we've got a siege coming up?"

"Not if I can help it," said Cardan. "But you never know."

The lights had now come on brightly once more, and Cardan again glanced at Maclane huddled with a little group at the sets. Everything seemed under control, so Cardan spent several minutes seeing that everyone was inside, and that the subbasement was sealed off from the rest of the building, then he activated the TV pickups that enabled the men inside to see what was going on outside the building. He set some men to watch the screens, had others practicing with the weapons, and made arrangements for them to change off later on. Miss Bowen told him that most phone lines out of Milford had been knocked out, but a roundabout route was apparently still in operation for emergency use. Cardan nodded, and put her to work with the groceries and canned goods, in a corner fitted with a large, awkwardly-arranged collection of outdated cooking appliances that struck Cardan as the ideal kitchen.

"Hey, Barbara," shouted Smitty, with a grin, "suppose we're marooned down here—the last woman on Earth, plus umpteen men."

Barbara Bowen grinned and picked up a can. "There won't be too many left after I serve my first meal. How do you open this, anyway?"

Smitty winced, and then Cardan saw Maclane gesturing to him frantically.

"Look at this," said Maclane, and Cardan put on one of the headsets. Around the table were other circuits and other men wearing the headsets, but they vanished as Cardan abruptly saw a view down the highway from the north, the traffic jam of cars in front of him in the background, a large lattice of bright metal bars growing up on the highway directly in front of him, between his point of view and the jammed traffic, and large gray-faced men pacing back and forth holding the ends of cables that looped skyward to where floating pieces of machinery edged long bright rods into the growing lattice.

Maclane said, "It's now or never, Chief. That Lawrence of Arabia stuff sounded good upstairs, but we're up against trouble now. I've got an awful hunch that if they once get that grid completed, we aren't going to stop them, ever."

Cardan looked over the grid. To him, it appeared to be just a big metal framework. That it was being fitted

together with great precision seemed clear enough, but what could it *do?* Then he noted the cables running out to the framework, and paused to consider. The thing *looked* harmless. But so did a live wire, or a stick of dynamite with the fuse burning short. He studied the tense concentrated expressions of the workers operating the control cables that ran up to the overhead machines that handled the long rods. Some of these creatures had a look that appeared to Cardan like barely-suppressed jubilation.

Maclane's voice said tensely, "I can't even budge one of those rods. I've tried to swing it when it's being lowered into place. But I can't move it at all."

Cardan growled, "You can get a good grip on something light, can't you?"

"Sure, but how will that stop them?"

"You see that cat-faced clod just guiding a beam into place?"

"I see him."

"He's got a good thick head of hair. Take hold of a few strands, fasten your attention on them, and *pull.*"

"Yes," said Maclane thoughtfully. "Yes, now I get it."

Cardan glanced around at the hill sloping up to one side of the highway, the ditch carrying run-off water at the base of the hillside, and on the other side of the road, the flat lowland with the wrecked planes and downed power lines. Not finding just what he wanted, he continued to look around, and his gaze passed across the traffic jam of deserted cars, some overturned and still smoking, and one with its transmission smashed, and gears and roller bearings strewn over the pavement beside it.

Cardan centered his attention on this smashed transmission, and his viewpoint seemed to slide forward as he studied the roller bearings, and then dwelt minutely and exclusively on each one in turn. After a while he had much the feeling of a man who has examined the operation of a complex machine, one element at a time, and now sees the thing as a whole, and has a good idea what he can do with it. Then as Cardan focused his attention on them, one-by-one, the bearings began to roll.

For an instant, he felt the same startled sensation he had had years ago, when he first pressed the accelerator of a car, and it abruptly moved forward with him. Then he was no longer thinking of the uneasy unfamiliar sensation, but was concentrating wholly on what he wanted to do.

The bearings rolled together in a small heap. Then, like wasps rising from an underground nest, they began to lift into the air. Cardan sent them, fast and low, down the highway toward the huge grid.

Beside the grid, one of the cat-faced machine-operators abruptly slapped at the back of his head. Beside Cardan, Maclane made a low noise in his throat. The operator jerked again, and twisted around angrily. Several of the other operators opened their mouths to shout as

the rod overhead began to teeter dangerously.

Cardan's bearings were approaching rapidly.

The operator spread one hand over the top of his head, and with the other on the controls steadied the rod-shaped beam. A small fistful of hair visible between his spread fingers straightened out abruptly. This time the alien did not jump, but quickly moved his hand further over to ease the pain. Overhead, the beam paused, then started down again. Several more strands of hair straightened out painfully. The beam overhead stopped again. The operator, obviously fighting to keep himself under control, moved his hand again, then once more carefully began to lower the beam. Apparently to get a better view of it as it lowered, he took a step backward.

Cardan slid the bearings in under the raised foot as it came down.

The foot slipped, and shot back.

The alien took a lightning hop backwards with his other foot.

Cardan shot the roller bearings forward.

The other foot slipped.

The powerful figure of the alien landed on its knees, braced on one hand, with the other hand still gripping the controls at the end of the long cable that looped down from the machine.

Cardan looked up. Overhead, the machine had tilted and twisted sidewise, in such a way that the rod it held should have whipped forward and struck the grid. But another handling machine, controlled by one of the other operators, had taken hold of the end of the rod and held it back. The rod was bent, but the grid itself wasn't damaged.

Maclane's voice said, "They've apparently got that thing finished except for one last beam."

Cardan was studying the controls that worked the handling machine. The operator had five fingers and a thumb, and each one of them disappeared into a hole in a thing like a partially flattened bowling ball on the end of the cable that dangled from the machine. Cardan brought up several of his bearings and rapped them sharply against the knuckle of the alien's index finger.

The handling machine jerked sharply upward.

The machine operator, in a display of vigor and resiliency, sprang back to his feet, glanced at his hand, and began to shout a warning to the others.

Cardan changed direction on the roller bearings, and shot about half of them in the open mouth.

A succession of spasms passed across the catlike face. The creature clapped a hand over its mouth, and suddenly dropped to the ground.

The control cable dangled free.

Cardan slammed a bearing in the index-finger hole of the control box.

The handling machine shot skyward.

Using his remaining roller-bearings like so many fingers, Cardan experimented with the control box.

The various studs at the bottoms of the finger holes respectively raised the machine, moved it forward, moved it to the right, rotated the whole machine counterclockwise, or tilted it forward. The harder the pressure, the more rapid the motion. The thumbhole had two separate studs, one of which, Cardan found, reversed the action of the finger-controls. That was all he wanted to know.

Maclane gave a low exclamation. "They've finished it!"

Cardan, swinging the handling machine back and down, had the impression of a dull flash from below. When he had the machine well back and at about the height of the grid, he glanced forward.

Rolling out from under the raised grid, was a thing like a heavy tank blown up to several times its natural size, and fitted with an assortment of unconventional antennae atop its massive turret. Around the grid, the machine operators were grinning widely.

Cardan pressed one of the studs of the control box. The handling machine began to move forward. Cardan pressed harder.

Beneath the grid, a kind of fog sprang into existence as the monstrous tank rolled clear. A vague shape began to loom through the fog.

Cardan lifted the machine slightly as it gathered speed.

Below, someone was running, and waving his arms. Somewhere, someone raised a weapon. One of the antennae atop the tank began to swing around.

Cardan pressed harder on the control stud.

The machine slammed headlong into the grid. There was a sense of rending vibration, then a blinding flash.

For several seconds, Cardan couldn't see. Then he could make out the warped structure of the grid, tilted and bent. Around it, a number of figures were lying motionless. Several handling machines drifted nearby, their control cables untended. The foglike appearance that had been under the grid was gone now, and so was whatever had been looming through it. But the monster tank was swinging its turret around and slowly elevating what looked like an enormous gun. The turret stopped moving. At the mouth of the gun, there was a blur.

Miss Bowen's voice reached Cardan. "Sir, General Whitely is on the line and wants to talk to you right away."

"Take a message if he wants to leave one. I can't talk to him now."

Somewhere there was a thud, and a heavy, dull boom. Cardan felt the concrete floor beneath him move perceptibly.

The turret of the huge tank began to move again.

Cardan looked around, saw where the first machine operator had been violently ill, and recovered several of his roller bearings.

There was another blur at the gun mounted on the turret of the tank.

Maclane said, "Look. On the mall."

Behind the tank, creeping up the grassy strip between the double lanes of stalled traffic, came Cardan's steam-powered car, with Donovan crouched at the wheel. As Cardan stared, the steam car glided closer, steadily closing the distance between itself and the monster tank.

There was a heavy boom, and the earth jumped beneath Cardan.

The turret of the tank began to move again.

Cardan had the controls of one of the handling machines, and was gently easing it to the side, and up.

One of the antennae atop the tank turret moved around. There was a faint shimmer in the air around it. The handling machine glowed near the spot where the control cable entered it, and suddenly blew apart.

Cardan immediately got control of another machine, and jerked it fast to the side.

The antennae turned slightly, and the machine blew up.

Cardan got another, and dropped it fast, to put it directly in line with a group of aliens running toward the grid. Keeping right in line with them, so the tank could not fire at him without having them in the line of fire, too, he sent it hurtling with increasing speed straight at the antennae.

The handling machine blew apart, as did a gun carried by one of the running figures. The remaining figures dove for cover.

Cardan was left with two handling machines, neither one of which, he was sure, could get anywhere near the tank. Nevertheless, he took control of one, and without moving it, looked around.

From somewhere around him, there was another dull boom, and the floor moved slightly underfoot.

The turret of the tank was swinging slowly around again.

At the rear of the tank, a figure dragged itself up.

Cardan blinked. Moving out on the slanting plate over the huge tread, Donovan hauled up on a rope a five-gallon can of gasoline.

Far down the grassy strip in the center of the highway, one of the big cylindrical vehicles came rolling around the bend.

"Mac," said Cardan, "see if you can do anything to that cylinder down at the bend."

Donovan, oblivious to the cylinder, pulled out a big wrench, and studied the tank. Nearby, a short pipe was thrust up, with a U-shaped piece at the top. Donovan methodically unscrewed the U-shaped piece, then started to empty the can of gasoline down the pipe.

The various antennae atop the tank swiveled around.

Cardan experimented briefly with the controls, then sent the handling machine straight back toward the grid, seized one of the rods, and wrenched and twisted at it like a dog tearing at a stick.

The motion of the tank's antennae wavered, and Cardan could guess the frame of mind of those inside. They

had to protect the grid, but if they blew the machine up while it was at the grid, that would damage the grid. And while this new problem confronted them, Donovan was still pouring in gas.

Down the grassy strip, the cylindrical vehicle came to a sudden stop, then jockeyed around to bring its forward gun to bear on Donovan.

From a snowbank near the cylinder, a small chunk of dirty white flew out, and went in through the cylinder's view slit.

Atop the tank, Donovan threw a lighted match down the pipe after the gas, and jumped over the side.

A streamer of flame shot up out of the pipe, puffed out in a flash around the base of the turret, and was followed by black smoke.

Cardan jerked one of the rods loose from the grid, gripped the end like a flail, and went for a cluster of armed figures running up the highway. Spinning the machine, he whipped the long rod in a circle, and scattered powerfully-built, heavily-armed figures in all directions. After a few minutes of this, he had the highway completely to himself.

He glanced down at the far curve, where the front of the cylindrical vehicle suddenly dropped open, and a massive, feline-faced figure sprang out, and jumped down the bank at the edge of the road.

"What happened to him?" said Cardan.

Maclane said, "He's tired of getting gritty snow ground in his eyes, ears, nose, and mouth."

"Good work. Where's Don?"

"He's disappeared amongst those cars, somewhere."

Cardan looked around. In front of him sat the large tank, with smoke rolling out of it. Nearby, the grid was bent badly out of shape, but still standing. Beside it hung one handling machine, its control-cable dangling. Cardan still had control of another one of the machines. Neither on the hill above the road, nor on the flat land below it, was there any sign of opposition. The sun was just setting, and long shadows were reaching across the road. Far to the south, a plume of black smoke was just coming into view on the horizon.

Maclane said wonderingly, "Just a little bit ago, they had us almost licked—and now they're finished?"

"Don't count on it," said Cardan. "This is like one of those fights where one side wins the first few rounds, and the other side wins the next few, and the whole thing is still in doubt." Cardan got out a fresh cigar, and stripped off the wrapper. He stuck the cigar in his mouth unlit, and growled, "There's something funny here. Where are the others?"

From down the table, one of the men spoke up. "Chief, these sets are focused on different places. Mac figured it was better to leave them that way than go nuts trying to focus them all over again. There's a lot of action going on here. You want us to fill you in?"

Cardan said, "Good idea. What places can you see?"

"Their ship, the road about two miles north of the traffic jam, the hill above the road, and a stretch of flat farmland below the road."

"What's going on at their ship?"

"A bunch of them have just come out wearing spacesuits, apparently to keep us from getting at them. They've got some crates and a long low machine—it looks like a metal-working machine of some kind—on a frame mounted between two of these cylinders they travel around in. The side bars of the frame attach to fittings on the sides of the cylinder, and at the front there's a movable plate that allows for a limited turn in either direction."

"Which way are they headed?"

"Toward the road."

"Are they armed?"

"Yes. And the spacesuits will make it harder to hit them with small stuff."

"How about on the hill, above the road?"

A different voice said, "They're busy here, Chief. It looks to me like they're getting set in case there's a counterattack. They've laid out two parallel cables, about six feet apart, along the forward slope of the hill, for as far as I can get a view of it. Above the cables, and well spread out, they've got the cylinders partly dug in, covered with brush and moss, and so located that they can sweep the face of the hill with crossfire if anyone starts up. I don't know what the function of the cables is, but you can't get at the cylinders without crossing them. And if there's a pause at those cables—well, the cylinders have a nice clear field of fire."

"How about up the road?"

"Nothing doing right now, Chief. Some cars tried to get through here about half-an-hour ago, though. There are a couple of cylinders lying in wait here, and they blew the cars to bits."

"Is the road blocked?"

"The northbound side is. One lane of the southbound side, and about two-thirds of the grass strip, are unblocked."

"The cylinders haven't tried to completely block the road?"

"No, I think they may want to keep it partly open for their own purposes."

"How about the flat farmland below the road?"

The pugnacious towhead spoke up. "Chief, that crew from their ship are crossing it right now. What do you say I let the acid out of their batteries?"

Cardan blinked. "Do what?"

"I got a good look into one of these cylinders a little bit ago. The power to run them comes from some place. It looks to me as if the bottom third or fourth of the cylinder, at least in the center, is some kind of storage battery. If I let the fluid out, they'll be stranded."

"How are you going to do that?"

There was a silence, then the towhead said hesitantly, "I know how this sounds, but I can get through the metal."

Cardan removed his cigar.

The towhead said earnestly,

"Sure, Chief, all you do is loosen a tiny bit at a time, then another and another, and when you get the rhythm of it, you can eat right through the metal. It's not a *big* hole, to start with, but you can enlarge it the same way."

Maclane muttered, as if the thought had just hit him, "Boy, we really let the genie out of the bottle this trip. Listen, Chief, how are we going to keep all this quiet afterward?"

Cardan shook his head, "One mess at a time." He took a fresh grip on his cigar.

The towhead said urgently, "What do you want me to do? They aren't going to wait while we argue over it."

"Let them through," said Cardan. "But if they try to go back, ruin them."

"Does that hold for just these, or for all of them?"

"If you see something really unusual, let me know. If you have to act fast, do what you think best. Otherwise, let them all go through without too much trouble *toward* the highway. But tie them in knots if they try to get back to their ship."

"Why?"

"So we can cut them off from their ship. The more of them out in the open, the better."

"I get it."

Maclane said, "Chief, that machine is just coming into view. I don't know if I like the looks of it."

From beside Cardan's shoulder, Miss Bowen said apologetically, "General Whitely left a message, Mr. Cardan. Would you like me to read it to you later?"

Cardan looked at the machine being hauled up on a frame carried between two of the cylindrical vehi-

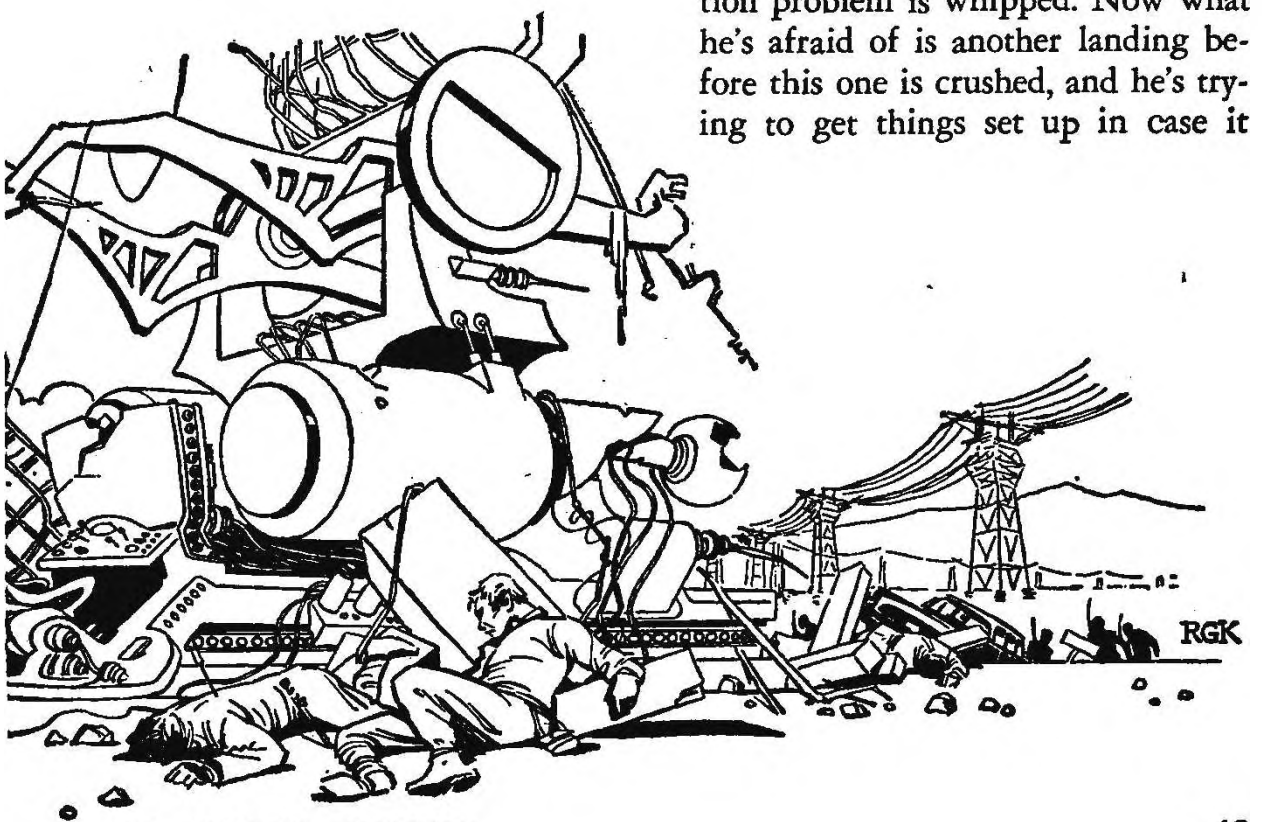
cles. It was still down on the flat land below the highway. Cardan couldn't recognize the machine, but supposed its purpose must be to straighten out the grid. As Cardan watched, the forward cylinder tried to start up the base of the embankment at the shoulder of the highway. After a short run, the cylinders ground to a stop. Both cylinders flung back dirt and rocks, then stopped, rolled backwards, and tried a longer run. This time they got about halfway up the bank, threw out an avalanche of stone and dirt, and then came to a stop, wheels spinning and apparently unable to go forward or back. Spacesuited figures milled around, then began to shove back at the forward cylinder.

Cardan studied the scene of confusion, and said, "Keep an eye on them, Mac. They must be getting desperate, and there's no telling what they'll do." He took off his headset, and turned to Miss Bowen. "What did Whitely have to say?"

Miss Bowen glanced at her notebook. "Do you want his exact words, or just the sense of it?"

"Just the sense."

"He said he'd run across a Civil War locomotive that had been repaired for some centennial, and he's rushing a trainload of troops north with it. He's found a few other steam locomotives here and there, and the tracks are being cleared while these locomotives come in to hook up with trains of specially-equipped troops. Several more locomotives are racing down from Canada, and he thinks the worst of the transportation problem is whipped. Now what he's afraid of is another landing before this one is crushed, and he's trying to get things set up in case it



happens. Other countries have offered help, but the general thinks we can finish them off ourselves tomorrow, provided you can keep them tied up tonight."

"Provided *what?*" said Cardan, sitting up straight.

"He said that he knows you're doing something to them," said Miss Bowen, "and he can finish them off tomorrow provided you can keep them tied up tonight."

Cardan growled, "Did you—"

"Sir," Miss Bowen objected, "I didn't tell him a thing. He said something about ultra-high-altitude photographs, and then he said that no one could get into the mess these aliens are in without help."

Cardan lit up a cigar. "This poses quite a problem," he said. "If he knows that much, he's going to try to find out the rest of it. And we can't tell him the rest of it."

Miss Bowen said hesitantly, "Sir, if it's for national defense—"

Cardan puffed at the cigar and said nothing.

Down the table, someone said, "Chief, I hope you aren't going to sit on this."

Cardan said, "Maybe you'd rather have the government sit on it."

There was a rustle of faint movement, followed by silence, that told him he had a suddenly intent audience.

"I can see it now," said Cardan eying the glowing tip of his cigar. "Bureaus, agencies, regulations, committees, boards, advisors, directives, appropriations, cutbacks, crash programs, reappraisals, closed hearings, progress reports, security clearance, secret files—"

Several of the men groaned, and Cardan said, "I couldn't squash this if I wanted to. The work would just go quietly on in cellars and attics, regardless what I said. With the government, it's a different matter. Consider the size and expense of the defense programs, for instance. This one device puts the whole business on the edge of being obsolete. What good, for instance, is a liquid-fueled ballistic missile when someone miles away and out of sight can get at the fuel lines before the missile takes off? What good is a naval vessel if the pressure to the turbines that drive the vessel can be leaked out by someone out of sight and reach in the distance? All calculations are thrown into doubt. The whole point and purpose of gigantic sections of industry, employing millions of men, becomes questionable. Do you think the government won't be tempted to sit on this?"

There was a low angry murmur.

Cardan said, "And while that problem has everyone in a state of indecision, what are our cat-faced friends going to be doing? Let's just imagine for a little bit that we aren't us, here. Let's imagine for a minute we're the general staff of some interstellar feline race expanding into this region of space. Earth has been scouted, found suitable for colonization, and a force landed sufficient to throw the inhabitants into chaos. After a good start, the landing force gets smashed

to bits. What is this feline general staff going to do when word of that comes in?" Cardan glanced around. "Just imagine we are that general staff. What do you say? Shall we forget the planet? Or shall we go back with twenty times the force?"

There was a tense silence.

Then from down the table, someone said with conviction, "Go back and finish the job. Otherwise there'll be trouble later on."

Cardan nodded slowly. "That's what I think, too."

There was a slow stirring in the room. Miss Bowen said, "But—If every man in our armed forces had one of these circuits—"

Maclane shook his head. "It's easy to see with this, once it's focused. But to hold your mind concentrated long enough and hard enough to *move* something—I don't know."

Cardan handed Miss Bowen his own headset. "Here, try it." He watched Miss Bowen sit down, slip on the headset, shut her eyes, frown, and ask for pointers. Maclane, wearing a headset that showed the same scene, gave her advice. Miss Bowen's attractive features gradually grew pale, and her face tense. At length, she blurted, "But what do you *do?*"

"Just keep your mind on one small object."

"I'm dizzy with watching one small object."

"Then you—watch each part of it in turn, see it all, and take *hold* of it, mentally."

She bit her lip. The minutes dragged by. Abruptly she slumped, her features twisted, and she reached up to take off the headset. Then with a plainly violent effort of will, she brought her hand down again, and sat up straight. The color seemed to drain from her face. All visible trace of emotion vanished, like ripples on a lake when the air becomes intensely calm. Gradually, the calm lengthened out. Still she sat, with a look of intense quiet.

Then she relaxed, and after a moment smiled, and reached up to take off the headset. Her eyes opened and gradually focused, and her face was that of a pretty woman waking from anesthesia.

"Well," she said smiling, "I did it. It was little, and it was light. But I moved it." She drew in a careful breath. "And I'd rather learn shorthand all over from the beginning than to do *that* again."

Cardan laughed. "It gets easier with practice."

Miss Bowen shook her head, and stood up. "I had no idea it was like that."

Maclane said, "I keep thinking, Chief, this isn't going to be everybody's dish. If we try to handle it the way we would handle . . . say . . . a new kind of rifle, there's going to be a lot of confusion, and all at the wrong time. Maybe we'd better keep it quiet, develop it ourselves, and not be too anxious to hand it over till we know what we're doing. So far as defense is concerned, we've tied this crew of aliens in knots, just on the spur of the moment. If sixteen times

as many come down on us in half a year . . . well, by then we ought to be sixteen times as tough—provided we keep working on it."

Cardan nodded, and looked down the table. "How does that sound?"

There was a unanimous murmur of agreement.

"O.K.," said Cardan. "It remains to be seen how we come out of this present mess, and then there's the problem of getting Whitely off our track. But at least we know what we're trying to do." He glanced at Miss Bowen. "When Whitely called up the last time, did he have anything else to say?"

"He wanted to know how the enemy device operates that keeps gas or Diesel engines from working, or guns from firing properly."

Cardan frowned. "Tell him he won't find that out till he captures them. How should I know?"

"He wanted a rule of thumb explanation he could give so people will know what to expect."

"Oh. Say that the enemy has a device that sets up what you might call a damping field. Any release of energy creates a reaction in the field, and this reaction tends to choke off the release of energy. The more sudden and violent the release of energy, the greater the reaction of the field. A slow smooth release of energy isn't affected too much, but a violent explosion is sharply choked back by the reaction it sets up."

Maclane said, "Chief, excuse me. This crew is slowly getting that machine up onto the road."

Cardan could hear the rapid movement of Miss Bowen's pen on her note pad as he put the headset back on, and saw that the spacesuited figures, using a winch, had the big machine almost up the bank. They had set up tall, apparently self-contained, lights on poles, and several of the aliens were studying the warped grid.

Cardan immediately tried the technique of cutting through the strands of the cable the winch was slowly turning around. At first, he had no luck at all, but then he got a tiny speck of metal loose, then another, and another. A fine stream of powder began to sift down from the cable. He said, "Mac, we're going to want to keep these birds from getting back to their ship. If Whitely is going to capture whatever operates this field, we're going to have to keep the ship from escaping with a part of the puzzle."

"I'm willing," said Maclane. "What do you want me to do?"

"Make up some more of these sets, and focus them in a line from here back to that place where we were hunting last fall. You remember that hollow maple tree on the edge of the woods?"

"Chief, that must have been three or four miles from this place."

"What's to prevent us from taking that handling machine near the lattice, grabbing one of those lights on poles, jamming a couple of the finger-controls on the handling machine, and relaying it from one place to the next?"

"It will take time," Maclane said.

"This grid," said Cardan, "attracts them like garbage attracts rats. They don't like to give it up when they seem so close to winning. I think I can string them along here for a couple of hours."

"Then we switch what's in the maple tree into their ship?"

"That's the picture."

"We'll still have to get them out of those spacesuits."

"Don't worry about that," said Cardan. "We'll get them out."

"O.K., then," said Maclane, "if you think you can handle this end alone."

In the glare of the floodlights at the road, the cable suddenly parted. The end whipped back and snapped two of the spacesuited figures into the ditch. The machine rolled halfway back down the bank, to stick in the same holes it had just been dragged out of.

Maclane said, "I guess you can handle it all right." A moment later he got up. "I'll get these other sets focused as fast as I can."

The night passed slowly. Once again, the winch drew the machine up the bank, and this time chocks were driven under the wheels every foot or so as it went ahead.

Cardan located a vital pin in the winch, and cut it away so that it sheared off. The winch unwound and the wheels jammed back onto the blocks.

Cardan could see the intent feline faces behind the faceplates as they replaced the pin.

When the machine was again almost at the top of the bank, Cardan snapped the cable for the second time.

The spacesuited figures ran out a new cable, and again dragged the machine to the top of the bank.

Cardan cut through the fitting that supported the right rear corner of the framework stretching between the two big cylindrical vehicles. The frame tipped, and the machine slid halfway off onto the bank.

The spacesuited figures stared at it for a long moment, then slowly hooked cables to it, and began to winch it up the bank on its bottom.

Cardan looked the situation over intently. He wanted to keep the aliens from actually accomplishing anything, while letting them come close enough so they wouldn't turn to something new and harder to block. But he thought all the trouble at the embankment had about brought them to the end of their patience. One more delay there and they'd try something else.

Studying the stalled cars, it occurred to Cardan that there was a lot of gasoline in the tanks of all those cars.

He glanced around and saw that the machine was coming up the bank slowly and heavily. He had a certain amount of time to work.

Methodically, he cut through several of the car bodies into the gas tanks, and liberally doused the interiors with gasoline. He stripped the soaked upholstery into long strands, rectangular sheets, and wads of vari-

ous sizes, which he built into a low mound in a shadowy place as close to the grid as he could find. Next, he stripped the insulation from a wire under the dash of another car, and touched the bare wire to the dash. A spark jumped.

Cardan looked around, and saw that the machine was now up the bank. Several of the spacesuited figures lifted off a panel to expose the controls, while others pulled out long thick cables, and began dragging them over to the grid.

Cardan brought a small square of gasoline-soaked cloth next to the bare wire as he again moved it against the dash. The cloth burst into flame. He whipped it forward to ignite the pile of soaked upholstery. From this he lifted blazing squares and strips of fire, which he wrapped around the alien's helmets and faceplates, and dropped onto the controls of the big machine, followed by sodden wads from which streamed fingers of fire as the blazing gas ran out.

In the midst of this chaos, there flashed out from some place on the far side of the traffic jam, a number of long hunting arrows.

Maclane's voice said, "I'm ready for that handling machine, Chief."

Cardan located the handling machine, knocked over all but one of the tall floodlights, seized that last one with the handling machine, and passed it to Maclane.

Off over the flat land to the east, as he did this, he saw a plume of fire and sparks racing steadily northward. That, he realized, must be the general's Civil War locomotive, bringing fresh troops to the scene.

Cardan glanced at the highway, and saw half-a-dozen motionless figures lying sprawled under the big grid, long feathered shafts jutting from their spacesuits. Others were behind the machine, firing into the jam of cars. Cardan stripped pieces of blazing upholstery from the pile, and wrapped them around the air hoses of the spacesuits. As the hoses burnt through, he stuffed wads of gas-soaked padding into the hoses. As the aliens flung these out, he jammed and unjammed the valves of their suits, giving them just enough air to struggle out of the helmets.

One of their last shots into the traffic jam had blown a car apart. Cardan spotted the car's battery amidst the wreckage, and transferred the battery acid from the battery to the invaders, draining it down the backs of their necks.

Just then, one of the big cylindrical vehicles rolled down the hill, crossed the highway, and started down the bank and across the flat farmland. It was followed by another, and then another. Cardan glanced out into the dim distance to the south and southeast, saw gouts of flame leap out. Whitely, he realized, must have dropped troops off there as a diversion, and these troops were using flamethrowers on the enemy outguards.

Overhead, a bright light on a pole passed rapidly over the highway, illuminating a seething brown pile on the handling machine that carried it.

The aliens below were struggling out of their suits. One of them jumped over to try to get at the wires that ran out from the machine. An arrow streaked out, and this time Cardan saw where it came from—a slit under a raised cover on the side of the disabled monster tank.

A few moments later, Maclane said, "The bees are in the ship, Chief. And, boy—the aliens are out of it!"

"Any trouble?"

"Not much. I just had to move the queen, and the rest came along. They weren't in a good mood, though, believe me." Maclane was silent a moment, then said, "What a shambles. And these are the people who almost had us whipped a few hours back."

"When it started out," said Cardan, "they could hit us without our striking back. Now the situation is reversed."

"I hope they don't get it reversed again."

"Their time's running out. Whitely's closing in on them. If he does it the way I think he'll do it, he'll draw them off first by hitting them from the south and southeast, then he'll come down on them like a ton of bricks from the north."

"What do we do?"

"Keep them miserable. And somehow we've got to get Donovan out of that giant tank and away from here. He's in there firing out arrows at anyone who tries to get near the grid, and that's fine, except that the gas may get him when Whitely attacks."

"I think I can get a message to him, Chief. He knows Morse, and I can bang and scrape a piece of metal on the tank for dots and dashes."

"Good. Go to it."

A file of cylinders started down the hill, and began to cross the road. Cardan went to work to sabotage them as they passed.

In the east, it was starting to get light.

Maclane had pursuaded Donovan to get out, and Donovan had just disappeared around the bend in the steam car, when from the opposite direction Cardan noticed a kind of fog begin to drift across the scene.

Maclane said, "Here it comes, Chief."

The fog began to thicken, rolling across the road and the flat land below. Far off in the distance, there was a sudden blaze of light.

Cardan shifted his cigar, and watched intently. The glare, whatever it was, reminded him of thermite. Then he remembered the two cylinders that had been on guard up the road.

Somewhere up the road, twin beams of light reached out through the fog, and rapidly approached, followed by two more sets of lights.

A cylinder rolled across the road, its gun swinging uncertainly around.

A burst of flame sprang out at the cylinder, and it rolled aside and smashed down the embankment.

Through the gray mist moved an old high-wheeled steam car, a man in a gas mask crouched at the wheel, and another in the seat behind him.

Behind this car came two more, and as they pulled to the side, men jumped off two long flat-bed wagons drawn behind the cars. In the mist, the gas-masked figures dropped over the bank and disappeared.

It wasn't much over an hour later when Miss Bowen said, "General Whitely's on the line, Mr. Cardan."

Cardan glanced around the room. All but one of the circuits had been disassembled, the parts put back in storage bins, and the boards burned up.

Whitely's voice jumped out of the phone. "Hello, Bugs. Where are you?"

"Inside the Milford plant."

"I've got aerial photos here, and the industrial section of Milford's been knocked flat."

"Then I guess we got into the sub-basement just in time. How are things where you are?"

"We're rounding them up, what's left of them. Say, Bugs, they had quite a run of bad luck, you know that?"

"So I gathered from your last message." Cardan studied his cigar and waited.

"We'll be in to dig you out as soon as we get this cleaned up. We're anxious to know what you did it with."

"Did what with?"

"You know what I mean."

"Don't rush too fast getting here," said Cardan. "This place is well-shielded and we've got a good food supply."

"Don't try to dismantle it, Bugs. We can use it, whatever it is. And we'll be there as fast as we can get there."

Cardan said irritatedly, "The viewer we had was upstairs, and upstairs has been blasted to bits. Talk sense, Tarface."

The general said in a low hard voice, "It's going to be like that, is it?"

"Like what?"

"You know what I mean."

"Maybe you'd better spell it out."

"I'll spell it out in private."

Cardan drew on his cigar. "Before you go running off half-cocked after some figment of your imagination, Tarface, you'd better get a good grip on that equipment the aliens were using. There ought to be enough stuff there to make you happy, provided you don't accidentally shut off the field and get blown up with your own nuclear device."

"I've thought of that long since," said the general coldly. "The fact that a man is in uniform doesn't mean that he's a fool."

"I'm sorry, Tarface," said Cardan.

After a brief silence, Whitely said, "It's all right, Bugs. But I don't understand your attitude." There was a pause. "And I don't think I like it."

Cardan's eyes narrowed. "We've known each other a long time, Tarface. But don't ever get the idea you're going to tell me what to do, or I'll tie you up in knots and beat your brains into your boots." Cardan sat up, warming to the subject.

A small voice came out of the phone. "I'm sorry Bugs. I got carried away."

Cardan cut off his next sentence. "That's O.K. I know how it is."

"Listen, we'll be in to dig you out as soon as we can."

"Don't take any unnecessary risks. We're all right here."

"O.K. And thanks, for whatever it was."

"You're welcome, for whatever it was."

The general laughed. "So long, Bugs. We'll be seeing you."

"So long, Tarface."

Cardan put the phone back in its cradle.

Maclane handed him the headset of the one remaining circuit. "I thought you might want to take a last look, Chief, before we disassemble it."

Cardan looked at the miserable collection of feline-faced giants, chained together, and being loaded into trucks.

Cardan studied the scene for a moment, then handed back the headset.

Maclane said, as he started to disassemble the circuit. "It's an imperfect world, where you can have a thing like this and not be able to use it freely and openly."

"Imperfect," said Cardan, "but it's still ours. And as long as that's so, some day things may be different."

"I'm not so sure," said Maclane. "I've been thinking about it, and I'm afraid it would cause terrific dislocation."

Cardan nodded. "Sure," he said. "It will cause dislocation. But there's a precedent for that. Remember, they used to clap certain people in prison, excommunicate them for heresy, jeer and make jokes about them. What they were doing caused dislocation, too. Therefore it had to be stopped, or so it seemed."

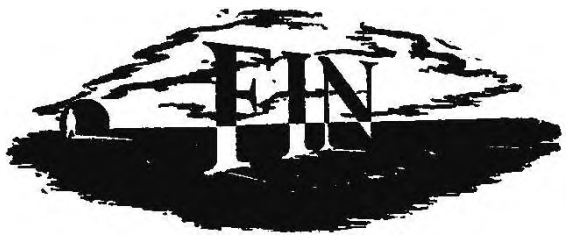
Maclane scowled. "You mean, witches practicing withcraft?"

"No," said Cardan, "I mean, scientists practicing science. Think what happened to Galileo."

Maclane said somberly, "New things throw people off balance. They don't like it."

Cardan nodded. "Taking a step forward throws the human body off balance, too. But it's a good sign when the first steps are taken, however hesitantly.

"When someone starts to walk, even with screams of fear and rage, he's growing up."



ATTRITION

By JIM WANNAMAKER

Of course if Man is to survive, he must be adaptable, as any life form must. But that's not enough; he must adapt faster than the competing forms. And on new planets, that can be tricky . . .

Illustrated by Krenkel

HE faxgram read: REPORT MA IS INSTANTER GRAVIS. The news obelisk just off the express strip outside Mega Angeles' Galactic Survey Building was flashing: ONE OF OUR STAR SHIPS IS MISSING!

Going up in the lift, I recalled what I had seen once scrawled upon the bulkhead of a GS trainer: *Space is kind to those who respect her.* And underneath, in different handwriting: Fear *is the word, my boy.*

The look given me by the only other passenger, a husky youngster in GS gray, when I punched Interstel's level, didn't help. It was on the tip of my tongue to retaliate: *Yes, and I'd turn in my own mother if she were a star chaser and I caught her doing something stupid.* But I let it ride; obviously, it was a general-principles reaction; he couldn't have known the particulars of my last assignment: the seldom kind that had given Interstel its reputation.

The lumer over the main entrance glowed: INTERSTELLAR SECURITY, INVESTIGATION, AND SPECIAL SERVICES BRANCH, GALACTIC SURVEY, NORTH AMERICAN FEDERATION.

At the end of the long corridor between offices was a door labeled: CHIEF SPECIAL AGENT.

Gravis hadn't changed a bit in the thirty-six hours since I'd last seen him: a large, rumpled man who showed every year of the twenty he'd spent in Interstel.

"It's a nasty job, Ivy."

"Always has been," I said, completing the little interchange that had been reiterated so often that it had become almost a shibboleth.

I took advantage of his momentary silence. I'd had an hour during the air-taxi hop from Xanadu, the resort two hundred miles off the coast of California, to prepare my bitter statement. Words come fluently when an earned leave has been pulled peremptorily out from beneath you; a leave that still had twenty-nine days to go. But I was brief; the news flasher had canceled much of the bite of my anger; it took me something under one hundred and twenty seconds, including repetition of certain words and phrases.

Gravis lived up to his name; he didn't bat an eye. He handed me a thin folder; three of its sheets were facsimile extrapolations of probot reports; the fourth was an evaluation-and-assignment draft; all were from Galactic Survey Headquarters, NAF, in Montreal. The top three were identical, excepting probot serial numbers and departure and arrival times. GSS 231 had been located in its command orbit above a planet that had not yet been officially named but was well within the explored limits of the space sector assigned NAFGS by the interfederational body, had been monitored by three robot probes—described as being in *optimum mechanical condition*—on three distinctly separate occasions, and all devices that could be interrogated from outside had triggered *safe and secure.* But no human con-

tact had been accomplished. The fourth sheet—which bore the calligraphy on its upper right corner: *Attention Callum*—assumed that the crew of 231, a survey team and con alternate, had met with an accident or series of accidents of undetermined origin and extent in the course of carrying out the duty described as *follow-up exploration* on the Earth-type planet, *herein and heretofore designated Epsilon-Terra,* and must therefore be considered—

"The news is—" I started to say.

"Pure delirium," Gravis interrupted. "Haven't you read Paragraph Six? We know exactly where the ship is because it's exactly where it should be. It's the crew that's missing."

Paragraph Seven concluded: *We therefore recommend that an agent of experience be dispatched soonest to the designated star system.*

"Experienced or expendable?" I muttered.

"Ivy, after ten years in Interstel, you should know that experience and expendability are synonymous."

Inside the GS section of the Lunar Complex, I had the occasion to think semantically again.

Words like *instanter* and *soonest* seldom match their literal meaning when applied to the physical transport of human beings, but in my job —I hadn't even had time to get my gee-legs.

I stepped off the glide strip in front of the ramp marked OUTGOING PERSONNEL, handed the efficient looking redhead my Q-chit and ID, and said: "Priority one."

"Quarantine, O.K.," she checked, smiling. "Feeling antiseptic?"

I had to admit, privately, that I did not. As applied to her, the term: *coveralls, regulation, gray* was strictly a euphemism. Perhaps it was the combination of low gravity and controlled conditions that made Lunatics of female persuasion blossom so anatomically. Or maybe she was a plant, a deliberate psych experiment to put outbound starmen in a particular frame of mind.

She flashed my identification on the screen, took a long look, and became coldly efficient. *Callum, Ivor Vincent. Age: 40. Height: 5'8". Weight: 142. Hair: brown. Eyes: green. Rank: Special Agent, Interstel.* "You look much older, Mr. Callum."

She consulted her assignment list. "Lock Three."

I snapped the identoflake back in its bracelet, picked up my jump bag and briefing kit, and headed up the ramp, feeling more eyes than the redhead's. The anonymity of a GS working uniform hadn't lasted very long.

By the time I was able to capture enough breath to make coherent sounds, the shuttler was already approaching parking orbit. The pilot had used maximum grav boost, and the trip must have crowded the record.

"That wasn't exactly SOP, was it?"

"Priority one, sir," the youngster replied, showing teeth wolfishly.

I was still trying to think up an adequate rebuttal when I came out of the air lock and into the ship. Then I felt better. P 1 means, among other things, first available transportation —but this giant was the newest type, crammed to the buffers with the results of science's latest efforts to make star *voyageurs* as safe as express-strip commuters inside a Terran dome. Even the vibrations of the great Gatch-Spitzer-Melnikov generators, building toward maximum output, had been dampened to a level more imaginary than tangible. Internal gravity was momentarily in operation, as an additional blessing; and, walking down the blue-lit corridor toward Astrogation, I could feel the occasional, metallic, thermal thump that meant the IP drive was hot and critical.

I got a second lift when I saw who was bending over the robopilot console: Antonio Moya, Mexico City's gift to Galactic Survey some thirty-five years earlier; a *cafe-con-leche* type with shrewd eyes, nervous hands, silver-streaked hair that showed a defiance of geriatric injections, a slight, wiry body that couldn't have gone more than one hundred and twenty pounds at 1.0 gee, and probably the best Master Spaceman extant. Only discipline kept the grin off my face. But he was on the horn, getting traffic clearance, so I didn't interrupt.

The others were unknowns, the sort characterized by old spacers as "pretty boy, recruitment ad types," but they looked competent; I figured a medic and a spread of ratings; counting Moya, a basic GS unit. I'd expected both a con crew and a standby. Either this was the total of available personnel, or the brass had decided not to risk more men than absolutely necessary. If I'd had illusions about the assignment, they would have faded at that instant.

It's this way in Interstel: you're taught to be a loner. You're expected to have absolute confidence in your own abilities and complete skepticism about the talents of others. You're supposed to be suspicious, cynical, courageous, and completely trustworthy. And you're not expected to have friends. Which, obviously, in the light of the aforementioned and part of what is yet to come, could serve as the definition of redundancy. You're required to weed out incompetents wherever you find them without prejudice, mercy, or feeling. The standing order is survival, yet you are expected to lay down your life gladly if the sacrifice will save one, pink-cheeked, short-time, assistant teamer who gives the barest suggestion that he might some day grow up to be a man and repay the thousands of credits squandered upon his training in that profound hope. Which, stated another way, has become the Eleventh Commandment of special agents: *Remember the body corporeal and keep it inviolate;* and, if the reaction of the rank-and-file of Galactic Survey to Interstel is used as criterion, is the best-kept secret in the explored, physical universe. "The agent's burden," Gravis calls it.

Moya's jaw dropped when he caught sight of me—apparently he had been told only to expect an agent—but he recovered quickly.

"Hello, Callum," he barked. "I won't say it's a pleasure. Stow your gear and strap down."

The claxon sounded stridently, and the inflectionless voice of the robopilot said: "Sixty seconds."

I got into the indicated gee couch and squirmed around seeking some measure of comfort. It had been designed for a much larger man, and I gritted my teeth in the expectation of taking a beating.

After a bruising few minutes, we went weightless, then the servos put us back on internal gravity, and the crew unstrapped.

They ignored me studiously; it wasn't entirely bad manners; there's plenty to be done in the interval prior to the first hop, and it isn't all in just checking co-ordinates and programming master con.

The usual space plan calls for several accelerations and a lot of distance between Terra-Luna proximity and Solar System departure. But Space Regs are disregarded on Priority One missions. So, for probably less than an hour, things were going to be busy in Astrogation.

I retrieved my kit and looked for an unoccupied cubicle.

GS star ships are designed to accommodate twenty-four men in reasonable comfort—a figure arrived at more historically—the sum of experience—than arbitrarily, as the minimum number necessary for the adequate exploration of a new star system.

It breaks down this way: six men to a team, four teams maximum; three for planetary grounding, one for ship's con; since any given team can do either task, they are interchangeable, who gets which depends upon rotation; three for exploration, then, because averages spread over several generations of interstellar capability bear out the fact that mother primaries generally possess no more than three planets that are in the least amicable to humans.

I was more than cursorily familiar with the drill. The basic requirement for Interstel is five years' service with a survey team. I'd spent nine. Which is another reason for general GS enmity: the turncoat syndrome. That and the fact that prospective agents are not even considered unless they rate in the top one per cent in service qualification and fitness reports: the jealousy angle. I'd known Moya from my last regular duty ship. I'd worked up from assistant under his tutelage. I'd been ready for the Team Co-ordinator/Master Spaceman exams when I'd applied for transfer. Moya had raged for hours. But he'd given me a first-rate recommendation. Call it service pride.

I was just getting a start on the vid tapes when the cubicle's panel dilated and Moya stamped in, bristling like a game cock.

"What's all this about Epsilon-Terra?"

I removed the ear bead and grinned at him.

"Hello, Tony, you old space dog! You're looking fine. What happened? Did they pull you off leave, too?"

He held the acid face until the panel closed, then he brightened a little. At least, he didn't refuse my proffered hand.

He stood fists on hips, glaring at me.

Finally, he growled: "I had hopes you'd wash out. When I heard you'd made it, I was plenty disappointed." He shook his head. "You seem healthy enough, but I still think it's a waste of a good spacer." And that, apparently, was as close as he was going to come to saying that he was glad to see me again, because, in the next breath, he reverted to Starship Master.

"Now, let's have the nexus. All I know is that I got orders to round up a short crew, was handed a space plan with co-ordinates that were originally filed for GSS 231 a few months back, with an ultimate destination of a planet I orbited five years ago."

"You've been there?"

"I just said so, didn't I? Don't they teach you vacuum cops to listen?"

I gave him the background.

He nodded soberly a couple of times, but his only comment was: "I heard rumors." Then he said: "That's all I've got time for now. We make our first jump shortly. That'll take us to where 231 went on GSM. From there on out, we follow her plan precisely."

"Until we locate and grapple, Tony, then we start making our own mistakes."

"I don't doubt that."

Moya moved to leave, paused, said over his shoulder: "What's this about old Ben Stuart being cashiered for misconduct?"

"It's true."

His back stiffened and his hands clenched. He turned to face me again. "I went through the Academy with Ben. How about doing me a favor? For old times sake. Tell me who it was that put the finger on him. Just give me a name. I might spot it sometime on a register."

I figured there was no sense prolonging the agony.

"O.K. Ivor Vincent Callum."

Moya's face blanched; he took a backward step and uttered something under his breath that sounded like the Spanish equivalent of—

He turned abruptly, opened the panel, and stalked out.

Somehow I expected him to come back and ask for details, but he didn't show.

I won't dwell on the trip. Any schoolboy who watches tridee space operas can quote chapter and verse and use phrases like "paraspace hops" and "rip-psyche phenomenon" as trippingly as "Hey, Joey, let's play swap-strip!" Citizens from Venus and Mars, vacationing on Terra, speak knowingly, too, whenever they can bring themselves to cease complaining about the gravity, crowded conditions, and regimentation, and can

squelch the bragging about how well they're doing on good old whatever. But don't let them kid you. GSM drive is restricted to *interstellar* transport. Colonists from the nearer systems are picked people, stiff-backed pioneers, who don't sob to come "home" every time their particular planet completes a circuit around its primary; and, when they do return, they're generally too busy lobbying for essentials to bother telling tall tales. So, comparatively few people are really familiar with star ships and the ins and outs of paraspace. Ask a starman, you won't have any trouble recognizing one, even in mufti; or, better yet, get a spool labeled: "THE CONQUEST OF PARASPACE: A History of the Origins and Early Application of Star Drive." It's old, but good, and it was written especially for laymen.

I'll say this: it took about a week. Sure paraspace hops are, to all intents and purposes, instantaneous, but there is a limit to the capacity of the GSM drive, and regulations re-

strict the jumps to a toleration well within that capacity. We might have made it sooner had we not been bound to follow 231's space plan—but not much. Once a plan has been filed, only an emergency can justify deviation. So, if you'll pardon the expression, let's just say that interstellar distances are astronomical.

Every time we came back into objective space—and I'd managed to recapture my soul—I applied myself to the tapes.

I got little from Moya, and not because of enmity. Even after refreshing his memory, he couldn't offer much. Although he had been master of the ship that had first remarked E-T, he hadn't set foot upon its surface.

The planet was comparatively undistinguished.

It was about the size of Melna-Terra, had an atmosphere with a good balance of nitrogen and oxygen, plus carbon dioxide, argon, et cetera, was mostly surface water, yet offered polar ice caps and a reasonable land area, as taken in the aggregate, although present in the form of scattered, insular masses. The largest of these, about half the size of Terra's Australia, was a comfortable number of degrees above the equator and had been selected as representative for detailed examination. Briefly: standard terrain—a balance between mountains, desert, and plain; flora, varied; fauna, primitive—plenty of insect life, enough to keep an entomologist occupied for years, but not much for specialists in the other branches of zoology; warm-blooded creatures comparatively rare; and, according to the original survey team, nothing bacterial that had overburdened Doc Yakamura's polyvalent vaccine; the kind of planet that pleased Galactic Survey because it looked promising for future colonization, come the day and the need.

"The type that skeptics like me view with grave suspicion," I told Moya. "Like saints, women of unblemished reputation, heroes, politicians—"

"And all Interstel agents," Tony offered dryly.

In the interim, since the divulgence of my part in the Stuart affair, Moya had thawed somewhat. After all, he and I had been friends at one time, and the present situation held no brief for head-on, personality clashes. The phrase "all in the same boat" applies with particular meaning to spacers. Tony undoubtably figured that 231 might have been his ship. He even went so far as to express an interest in seeing E-T from the ground level.

"I work alone, Tony," I said. "But thanks for the offer. Tell you what: I'll strike a compromise. If I get into serious trouble, it'll be you I shout for. All right?"

Moya scowled. "Probably a wild goose chase anyway."

But he said it without enthusiasm.

It reads like this: regs require that messenger vehicles be returned to the Solar System on their miniature equivalents of paraspace drive, periodically, with complete informa-

tion as to conditions encountered, work in progress, et cetera. None had been received from 231. There's a joke—not at all funny, I'll admit—that concerns itself with just this situation. It ends with the opening lines of the GS Memorial Service.

The last skull work I did was to familiarize myself with the personal dossiers of each of 231's crew, paying particular attention to psych reports. It's a part of my job that I've never liked. But I recognize the necessity.

The crew seemed fairly typical. The average was relatively inexperienced, the sort you'd expect on the type of assignment that was often used as advanced training. I managed to single out several possibles —men who might crack, depending upon the gravity of the situation. The captain-designate wasn't one of them; nor was the survey-team co-ordinator.

GSS 231 was on station—big and reflective and innocently ominous, held methodically by robopilot in an orbit that matched exactly the rotation of Epsilon-Terra—precisely over the largest land mass.

Moya conned us in like a dream, paralleled, rectified, grappled, and mated locks.

I showed up in Astrogation in a full-pressure suit, carrying the helmet.

The crew gawked, and somebody snickered.

"You think it's silly, do you?" Moya snapped.

"Better flush your side as soon as I get clear," I advised.

Moya nodded, lowered and secured the helmet, checked lines, and rapped O.K.

An hour later, I still didn't feel silly. I had the helmet open now. I sat in front of the communications console.

Moya responded as if he had been waiting with his finger on the stud. I didn't have to specify taping; all star ship radio traffic is automatically recorded.

"Level O.K.?" I asked.

"Yes, man; what's the story?"

"Inner lock and all compartments: air pressure, density, temperature, and purity optimum; all intrinsic gear optimum; three shuttler berths vacant; hold shows standard environmental equipment for one team gone; messenger racks full, no programming apparent; absolutely no sign of crew; repeat—"

"I got it; have you checked the log?"

"Who's doing this, you or me?"

I figured they could edit Moya's comment.

The log was strictly routine—space plan had been followed exactly; arrival had been on schedule; survey team had been dispatched with minimum delay, had reported grounding and camp establishment without incident, had relayed particulars of commencement of operation —until the last entry. It was eerie listening to the emotionless voice of 231's skipper: "Sub-entry one. Date: same. Time: 2205 Zulu. No contact with base camp. Surface front negates visual. Am holding dispatch of

M 1. Will wait until next scheduled report time before action."

There was no sub-entry two.

I broke the recorder seal, reversed and played back the comm tapes. There wasn't much. Distance obviates any talky-talky from ship to base once the Solar System has been cleared. What I learned was simply a substantiation of what I'd already surmised. I cut off when I heard a familiar voice say: "250 from 231."

Moya helped me strip off the pressure suit. No matter what the physio manuals say, there's room for improvement. Nothing beats your own skin.

He trailed me into the gear compartment.

I returned the suit to its clips and began sorting through the welter of what the well-dressed spacer wears for a bug rig somewhere near my size. The tag is not completely adequate. It's a light-weight outfit, with intrinsic filters and auds, designed to be worn under conditions that involve the suspected presence of dangerous bacteria or harmful gases. Its efficacy does not extend beyond the limits of reasonable atmosphere.

"Now don't start jumping to conclusions," I told Moya. "All I know is that whatever happened happened quickly and down below."

From the weapons' chest, I selected a little W&R 50 and the biggest clip I could find. "Fifties" aren't much for range, but they are unconditionally guaranteed to make a creature the size of a Triceratops think twice before heading in your direction again, and, once you strap one on, you never feel the weight. That's why, even though they are officially obsolete, you can generally find a brace in most star ship arsenals.

"Remind me to report the maintenance gang of this hunk for stocking unauthorized weaponry."

"You would, too," Moya said.

On the way back to the lock, I told him:

"Let's save time by not making a duplicate recording. I'll transmit additional information and intent going down. There's one shuttler left in 231, so I'll use it. If I find I need something that isn't in the shuttler, I'll fetch myself. Under no circumstances are you or any of your boys to leave this ship without my say-so."

"What happens if—?"

"You've had thirty years of deep space, Tony; am I supposed to tell you your job? Go by the book. Either launch another messenger and sit tight for instructions, or get out and risk a board inquiry, depending."

"You can rot down there for all of me."

"Thanks a pile. Make certain your crew understands. I wouldn't want any of them getting their pretty hands dirty."

But I didn't feel so cocky going down. I hadn't the least idea of what to expect. Sure, I'd gleaned something from the comm tapes: the unsuccessful attempts to contact the survey team at base camp; the happy-go-lucky report from the kid sent in shut-

tler II to investigate, saying that the camp was deserted but everything looked fine, just fine; the unsuccessful attempts to recontact him; and then a blank except for my own voice. Apparently, the skipper had followed with the rest of the con crew. I could even guess why he had failed to make additional entries in the log, or not transmitted from the camp in lieu thereof. He figured it was something he could work out himself, and he didn't want anything on record to show that he had broken regulations. He wanted to keep the errors of personnel under his command—and his own—in the family. He figured, after the situation was resolved, that he could make cover entries and nobody's slate would be soiled.

The camp was at the edge of a plain marked "Hesitation" on the chart.

I plucked a scrap of verse out of my mind:

On the Plains of Hesitation
Bleach the bones of countless millions
Who, when victory was dawning
Sat down to rest
And resting, died.

I wondered how prophetic that was going to be.

I grounded within yards of the other three shuttlers. They were parked neatly parallel. Their orderliness made my scalp prickle, and I was sweating long before I got into the bug suit, squeezed out of the tiny lock, and set foot on Epsilon-Terra.

The sky was blue, naked except for a tracing of tenuous clouds.

I could see neither of the star ships.

I wonder if you can imagine how it feels to be on a planet so far away from the Solar System that the term "trillions of miles" is totally inadequate? If you can grasp even a bit of it, then add the complication of a small but insistent voice inside your head that keeps telling you that no matter where or how far you go, you're not—

Let's just say it gives your sweat an odor and your mouth a taste and makes you want to look over your shoulder all the time.

I walked the hundred yards to the white plastidome, avoiding the few bulbous plants and tussocks of short yellow grass that dotted the dry plain.

Through the aud cells of the suit's hood, I could hear the light buzzing of insects that served only to heighten the overbearing quiet of the area.

The port was closed. Inside, everything was correct, except for the little dirt brought in on boot soles during erection and subsequent goings and comings.

There was a packet of nutratabs, lying open on an empty crate that had been pressed into service as a table. Some one had fortified himself before trekking off into the nearby bush. There was much equipment still sealed in cartons. Bunks were made up. Tucked under the blanket of one was a little book with stylus attached. All pages were blank except the first. The entry read: "TC in a sweat to get going. Rain potential. No rest for the

weary. This seems to be a nice spot though. Am kind of eager myself to take a look at some of the vegetation hereabouts. Have several ideas along the lines of Thompson's prelim research concerning extraction of—"

I replaced it under the blanket. I was ready to give odds that each of the previous finders had done the same: the kid that had arrived in shuttler II, and probably 231's skipper; and each from the same motive—*He'll be back; after all, a diary is a personal thing.*

I went back outside, shut the port, and made a complete circuit of the camp. I looked into each of the three shuttlers. I found nothing that could offer the least positive clue to the fate of the twelve men from 231.

I returned to shuttler IV, beamed Moya, and filled him in, forcing myself to be cheery.

"How's everything upstairs?"

"Right now we're having a little zero-gee drill; keeps the boys alert."

"Good idea. Now here's my plan: I've got ten hours of daylight left, so I'm heading out into the bush. Figure departure in five minutes. Weather has obscured signs, but I don't think I can go wrong by following my nose and taking the shortest route. I'm traveling light, just the bug rig, the R&W, belt kit, and a minicomm. I'm going to set up this transceiver to record and transmit on command-response. I suggest you interrogate every hour on the hour from now on. Catchum?"

I broke off, made the necessary adjustments, strapped the minicomm on my wrist, and exited the shuttler.

The antiseptic air that I drew into my lungs was beginning to seem inadequate, I felt slippery all over, and there was a cottony taste in my mouth.

I made it to the start of the bush in fifteen minutes. Don't be misled into picturing jungle. There was a variety of vegetation, including trees, but none of it was what you'd call heavy going. Beyond somewhere was a stream, significant enough to be noted on the chart as "First Water." And several miles from the camp was the start of a series of rolling hills. Blue in the distance was a chain of mountains—"The Guardians." The over-all impression was of peaceful, virgin wilderness.

The original survey team had made its camp in the relative frankness of the plain, then, after preliminary tests, had moved to higher ground, specifically, the lee side of one of the nearer hills.

They had cleared an area, using heat sweepers to destroy encroaching vegetation, and R-F beams to disenchant the local insect population.

Insects there were: a regular cacophony of buzzings, chirpings and monotonous mutterings. By the time I'd reached the bank of the stream, I'd lost track of individual varieties.

The stream was a bare trickle; the bed was spongy and dotted with tall, spare plants that resembled horse tails; I negotiated the fifty feet to the opposite bank without difficulty.

I threaded through a thicket and came out into a brief expanse of savannah.

There I found the first evidence of the fate of 231's people.

It was a small object, oval, flattened, the color of old ivory.

Although I hadn't been walking along with my head under my arm, it took me a moment to tumble to what I'd discovered.

Then my hair tried to stand on end. I rid myself of it and used the minicomm for the first time.

Speaking to a recorder was altogether too impersonal for what I had to report.

"I've just found a patella; a human knee-cap. I'm about a hundred feet beyond the far bank of the stream in almost a straight line from the camp. I'm in grass about two feet tall. I'm casting about now, looking —Hold it. Yes, it's scraps of a gray uniform. More remains. Here's a femur; here's a radiusulna. The bones are clean, scattered. Evidence of scavengers. No chance for a P-M on this one."

I got out the chart from its case on the suit's belt, x'd the location, and went on, feeling more lonely all the time.

It wasn't that I was unconversant with the physical evidence of death. I've marked corpses on planets you've probably never heard of—corpses resulting from disaster, unavoidable accident, stupid error, and even murder. What I've learned is that you never get used to coming face to face with human death, even when its manifestation is the inscrutable vacancy of bare bones.

You can put this down, too, and think what you want about incongruity: I was angry; angry with the spacer that had got himself catapulted into eternity so far from home; angry with myself for having assumed before leaving the Interstel office in Mega Angeles that this is what I would find; angry because the assumption had done nothing to prepare me for the reality. No space padre would have admired what I said inside the bug suit's hood—nor the refinements that grew more bitter with each new discovery.

Within three hours, I'd accounted for all twelve of 231's missing crew.

The search had led to and beyond the hillside where the original team had made its second and permanent camp. In one place, I found enough to separate four skeletons of men who had fallen within a few feet of each other. The rest were randomly located. There was a small plant growing up through the hole in the left half of a pelvis. Somehow it looked obscene, and I had to fight the impulse to tear it out. But it was simply one of many, struggling for survival, that I'd seen growing here and there throughout the area: a species that seemed to bear a familial kinship to those that sprinkled the plain.

There was equipment: field kits, a minilab, a couple of blasters, each showing full charge.

Cause of death: that was the enigma.

"So far I'm stumped," I said into the minicomm. "I've retrieved a few scraps of uniform bearing stains. Maybe analysis can discover something. The tapes say that E-T's birds and mammals are comparatively rare, but *comparative* doesn't mean much in the light of what I've seen. So far, though, everything I can come up with seems totally inadequate. Bacterial invasion, animal attack, insect incursion—none were problems with the first survey gang, so why should they be now? Rule out gas poisoning or allied concomitants; the suit tab shows white. Speaking of that—I'm peeling now. Keep your fingers crossed."

The air was warm and still, heavy with the ubiquitous smells and sounds of wilderness.

I was in the approximate area of the first team's camp. As per custom, they had struck the plastidome, dismantled the scanners, power panels, and other reusable equipment, and destroyed the debris of occupancy. The clearing had repaired itself. But for the slight concavities on the hilltop that marked shuttler settlings, there was little to indicate their previous presence.

I sat down and waited.

The suicide complex has never been a part of my psyche, but there are times when you have to place yourself in jeopardy; it's occupational, and I've got the gray hair, worry lines, and scars to prove it.

I waited for three long hours.

The sweat dampness of my uniform evaporated only to be replaced by the stains of new perspiration. I sucked in great gulps of E-T's air and found it consistently comfortable in my lungs. Insects came, investigated, and retreated, mostly because of urging. I was not approached by anything larger than a line of creatures the size of Vici-Terran milatants, and I was able to avoid them by evasive action. As far as I could determine, I wasn't invaded by anything microscopic or sub-microscopic either, because at the end of the three hours, I felt nothing beyond the personal infirmities that I'd brought with me.

The definite decline of E-T's sun forced me to give up.

The walk back to the plain wasn't entirely fruitless; I found something that I'd overlooked previously: the scattered remains of a small vertebrate. Many of the bones were missing.

"What happened to you?" I mused. "Did you come for a meal and get killed by a larger animal? Or were you caught in the same disaster that—?"

There was no way to tell.

What was it about Epsilon-Terra that could accept one survey team for months of occupancy—occupancy that had involved detailed examination of the region within miles of the plain and the hillside, and cursory examination of thousands of square miles of the rest of the insular mass by air, including touchdowns at key points for short stays—and that five years later could entice, enmesh, and

destroy the entire complement of a modern star ship, indiscriminately, within a matter of hours?

It was late afternoon when I reached the camp.

I was tired, dirty, thirsty, hungry, and thoroughly frustrated.

I drank from a previously unopened water bowser and wolfed several nutratabs.

Then I stumbled over to the shuttler, secured the recorder and interrogation setup, raised the star ship, and brought Moya up to date.

"I'm going to move this vehicle to the hillside and spend the night there. I figure I'd better give E-T a full twenty-six hour rotation interval to come up with something before the next step. Tomorrow, I'm going to need a man down here to witness the location and disposition of the corpses. You know the drill. It's your decision whether they should be identified singly, if possible, and secured for removal to Terra, or whether they should be interred here, commonly. My recommendation is to make a film record and plant them, but I'm too tired to argue. One thing more: whoever you send—if he gives me any lip, I'll cut him down like a small tree. There's been enough mistakes made here already."

I spent the night in the shuttler. Call it an atavistic response to the unknowns of darkness.

It was a restless interval between dusk and dawn.

Occasionally, I illuminated the hillside and surrounding area. A couple of times, I glimpsed the eye reflections of small animals. They seemed to possess the shyness of most nocturnal creatures. But I couldn't help wondering—

Morning dawned gloomily; there was a light mist hanging over the streambed, and much of the sky was turgid with clouds.

I gave the star ship the go-ahead and specified dispatch because of the threatening weather.

Moya mentioned plastibags, a filmer, and a porto-digger. His decision was obvious. I figured it wise but had the uncomfortable picture of a GS representative trying to explain the reasons to bereaved relatives.

I spent a few moments going over meteorological details. As I recalled from the tapes, this was the rainy season. Judging from the look of the area, it could use precipitation. Things were growing, but the stream was mostly dry, and the plain seemed parched. Apparently the mountains blocked much of it.

Sitting on hands has never been my delight, so I exited the shuttler and went down the hill for another look-see.

Insects buzzed noisily; the air seemed heavy and oppressive; but nothing had changed—there was no evidence of the creatures I'd seen during the night.

It took about an hour for the shuttler from 250 to show.

In the interval, several things happened.

The first was a perceptive darkening of the sky, followed by a light,

preliminary shower. I'd anticipated that, and was considering heading back for the bug suit when the second occurred.

I'm not going to offer excuses. From the advantage of retrospection, you can say what you want about slipshod detective work. The point remains that I'd covered the area more than cursorily and had not encountered anything specifically dangerous.

The timing was pure luck.

The shuttler penetrated the overcast about ten miles off target, located, and started its approach.

And something bit me on the leg.

I pulled up my pant's leg immediately, hoping to catch the culprit, but saw nothing save a thin red line about an inch long. It looked more a scratch than an insect bite. But I hadn't brushed against anything.

The shuttler grounded on the hilltop, and I headed up.

Perhaps it was exertion that speeded the reaction.

There was no pain, only a local numbness.

Before I'd traveled ten yards, my leg from the knee almost to the ankle felt prickly asleep.

I paused and looked. There was no swelling, no other discoloration.

I heard a raspy voice from the hilltop.

"Are you going to give me some help, or do I have to haul all this gear myself?"

Despite the leg, I didn't know whether to laugh or explode.

Moya was rattling around in an outsized bug suit and carrying the biggest Moril blaster contained in a star ship's arsenal that could still be called portable.

"What in condemned space are you doing here?" I shouted.

I was ready to give it to him right off the top of the regs about the relationship between ship's master and agents-on-assignment and the responsibilities of command, but the leg chose that moment to fail. Until then, I hadn't really been worried. I fell forward against the pitch of the slope, caught myself with my arms, and rolled over on my back. I hit my left thigh with my fist and felt absolutely nothing. Massage didn't help.

I heard Moya panting down the brow of the hill.

"Keep away!" I shouted. "Get back to the ship!"

Moya bent over me; he had opened the hood of the bug suit, and his face was grave.

"What's the trouble, Callum?"

"Can't you take orders?"

He shook his head. I pointed to the leg. He looked swiftly at the broken skin.

"How does it feel?"

"That's the trouble; it doesn't."

He grabbed my arm, put it over his shoulder, and got me on my feet.

We made good time, considering.

"Too bad you're such a shrimp," I said.

"I can take you on any time."

Shuttler IV was closest, parked on a shelf fifty yards below the top of the hill, but Moya was heading to miss it.

"I programmed for auto, just in case, and the generators are up to power. We waste time to save time. That way I can give you some help on the ascent."

The generator part was fine; the rest wasn't.

It started to rain again, just before we reached 250's shuttler.

I put my face up to it.

Moya got me through the lock and onto an acceleration couch. Then he headed for the panel. I was beginning to feel a desperate weakness, but my head was still clear.

"Wait a minute," I said. "What's your gee tolerance?"

"High, but—

"So strap me and raise this couch to vertical. Then override the auto and take us up fast."

He blinked.

"Listen," I said. "This feels like a neuro-toxin. Remember snake-bite aid? Well, the numbness is up to my groin now. No place for a tourniquet. And nothing here for freezing."

It was strange going up. I blacked out almost immediately, but Moya took it flat and apparently stayed alert all the way.

"Space!" I managed to gasp finally. "Any more of that sort of thing and I'd have ended up stupid."

Then there was utter confusion.

I came to full awareness under the luminescence of the infirmary's overhead. I was naked on the padding of the table. I could see a respirator off to my right, and a suction octopus near it. The medic was just stowing an auto-heart. But for a different tingling in my leg and an all-is-lost sensation south of my diaphragm, I felt reasonably sound.

The medic approached. I hadn't gotten a very good impression of the lean, blond youngster on the trip out, but now he seemed Hippocrates, Luke, Lister, Salk, O'Grady, and Yakamura all rolled into one.

He weakened it by asking the classic redundancy.

"How do you feel?"

I elbowed up for a look at the leg. There was a series of little welts the length of it, masked by forceheal.

"Where did you learn your trade?" I asked. "In a production expediter's office?"

He grinned.

"It took more than three hours, Mr. Callum. Suction, flushing, full transfusion. You've got some good blood in you now."

I lay back and let him talk.

"There'll be nerve damage, probably. Regeneration should take care of most of it, but you might need transplants. You were lucky. First, that whatever nipped you barely broke the skin. Second, that the skipper was there to help. And third, that you had the sense to block the spread of the toxin by gee forces."

"Yeah. Remind me to thank Moya —immediately after I write him up for leaving his station."

The medic looked pleased.

"Well, now, the way I got it—and I believe the recorder will bear me out—is that you requested a witness. You left it up to the skipper to make the selection."

He cleared his throat.

"And, by the way, Moya said he'd look in on you after a bit. The thing to do now is rest."

I sat up again.

"Where're my clothes?"

The kid commenced noises of disapproval.

"Damnation! I'm not going anywhere. I just want to look over that pant's leg."

Came the dawn.

"What'd you say Moya was doing?"

"Oh, I expect he's busy up forward."

The trouble was that he looked me straight in the eye. It takes practice to lie convincingly. And the Space Academy doesn't list the Art of Prevarication among its curricula.

"That misbegotten little son of an Aztec! He went back down, didn't he?"

I tried to jackknife off the table.

The medic flexed his muscles and said: "I can't take the responsibility—"

"When are you people going to get it through your stubborn heads that the responsibility for this whole shebang is mine and mine alone?"

Two more of the crew showed up. Under other circumstances, I might

have enjoyed tangling with them. I know tricks that even the inventors of karate overlooked.

"All right," I gasped. "But give me the dope. He's not alone, is he? Are you in contact?"

It developed that Moya had returned to the site of the disaster immediately upon learning that I was out of danger. He'd taken a crewman. He was also equipped with my chart of the area complete with locales of the remains. The last word had been that the two had grounded and that the weather front was dissipating. He'd been gone about two hours.

"They both had bug suits," the medic offered.

"Great," I said. "Just splendid. Suppose there's a creature down there that can go through plastic like—"

For the first time the three lost their smug expressions.

"We destroyed your clothes," the medic said sheepishly. "We figured—"

I railed at them for a couple of minutes, but it was mostly unfair. Moya's decision could be justified, too.

They rustled up a uniform and helped me to Astrogation. The remaining crewman was at the comm. The freeze was beginning to wear off, and my leg burned.

I alternated between berating myself and trying to think up an adequate explanation for the possible death or injury of two men ostensibly under my control.

After several hours of sweat-agony, Moya's voice came over the horn. He sounded tired.

"We've done it. You'll be happy to know that we gave them an official burial."

I could picture the little Mexican, standing beside the long mound, head bowed, with the Specter probably staring over his shoulder, going methodically through the complete Memorial Service, ending with: *And the whole galaxy is the sepulcher of illustrious men.*

"It's not much of a place, but the sun is shining now. Expect us shortly."

"Are you *sure* you're all right?"

I was propped on my elbows on the bunk in my cubicle, nursing the jangle in my leg. Maybe it was that—but I was as confused as a mouse in a psych maze.

"Why wouldn't I be?" Moya said.

"And you wore the suits all the time?"

"Affirmative. If you'd done the same—"

The medic showed with lab analyses.

"There wasn't much of that stuff in you," he said. "And I can't break it down. Too complex. You used the cobra venom analogy—Well, this makes that look as simple as mother's milk."

He held up the stained pieces of uniform. Moya had kept his wits about him.

"A combination of weather, soil, et cetera," the medic said. "Completely innocuous."

"About the toxin," I said. "Given time, could you work up an antivenin?"

"Probably. But I'd need plenty. Both time and toxin." He looked at me. "Oh, I see what you're getting at." He became professionally parochial.

"In other words—" I said.

He snapped his fingers.

"You know how it hit you."

The confusion persisted, so I allowed the medic to use a pressure hypo.

Hours later, I felt better—physically.

On the vid screen, the magnified surface of the insular mass seemed almost to beckon. *Sireni,* I thought.

Little remained of the weather front. Over the area of the plain and the rolling hills were meager wisps of clouds. Darkness again was creeping across the face of E-T.

"That storm didn't amount to much," Moya said.

Storm, I thought. *Rain.*

"I know what I'd do," Moya continued. "I'd radiate and have done with it."

The medic dissented on clinical-curiosity grounds.

"I can't reconcile things yet," I said. "But let's assume that it was a tragedy of errors. Let's say that what hit me, killed them. But what was it? Where did it come from? And why? No, I'll have to go down again. It's my burden to find *all* the answers."

Moya growled: "There's a time for stubbornness."

I caught the rest of the crew staring at me; their expressions were a motley.

Back at the same old stand, open for business, looking at the pitiful alteration, feeling lonely, feeling vulnerable, too, despite the bug suit, Moya's parting blast still burning in my mind.

He'd ferried me down to the hilltop in the long shadows of early morning. I'd had to order him to return to the star ship. I stood now beside the communal mound. Moya had said, pointing down the hill, anger making him illogical: "These are the people you sold out when you transferred to Interstel. They could have used your kind of brains. Post-mortems aren't going to help them, now."

It was simple, wasn't it?

Something on E-T was a killer: quick and deadly.

If it got any sort of clean shot at you—

Something visible. Something big enough to make a mark. And not static, like a thorn. A ground crawler? My pant's legs had been tucked securely into my boot tops. A flier? It would have to be strong enough to pierce a GS uniform and make an entrance into flesh. Or to leave a scratch from a glancing blow. And I hadn't seen anything.

But only a recent problem.

And restricted to the area beyond the stream.

And random.

And terribly innocent. Innocent

enough to be overlooked until it was too late.

Think.

I thought and came up with a brainful of nothing.

Think again.

Strong enough to pierce two thicknesses of cloth—It must have gone entirely through, although the overzealousness of the crew had removed any possibility of proof.

How about the bug suit?

Assume the plastic was protection enough—

Wouldn't the wearer notice a blow? Or hear something?

I'd felt but not heard.

But then the rain had been falling.

No insect had hit me forcibly before—

Moya and his helper had noticed nothing after—

A few meager drops of rain, sibilantly soaking into the eager soil of Epsilon-Terra.

Whoever first mouthed that bit about cursing being the audible manifestation of a mediocre mind completely missed the point.

There's something infinitely comforting in the crackle and sweep and roll of heartfelt invective.

I left the site of the common grave and made it back to the hillside and shuttler IV as fast as discretion and terrain and my game leg would allow.

"I *am* thinking," Moya grumbled over the comm. "If these details are so important, why—?"

"Don't blame Interstel," I said. "The tapes were put together by GS headquarters."

"Well, whoever. They should have included more information."

"Thompson," I prodded.

"Sure, sure, I remember him. Big, awkward, slow-moving—always babbling about plants."

"What kind?"

"*All* kinds."

"But anything particular? Something that he wanted to extract something from."

"Well, let's see—He brought back lots of sample specimens, but there *was* one that he played with all the way home. It was an insectivorous or carnivorous species, as I recall—"

"Yes? Yes?"

"That produced a chemical he thought might prove useful if it could be extracted and concentrated or synthesized—Now, hold on. Are you trying—?"

"Why not? And why didn't you mention this sooner?"

"For the simple reason—What got you off on this tangent?"

"*Rain.* The kid's diary said '*rain* potential.' The captain's log mentioned a *surface weather front.* And it *rained* just before I was hit."

"I fail to see the connection. But think about this: It rained on the survey team I ferried here, too—not often, but more than once or twice—and nothing happened to them."

That was the trouble with firing off at half thrust.

But there was still this nagging conviction: rain plus vegetation equals death.

I could picture Moya and the crew speculating that I'd taken complete leave of my senses.

But sometimes you have to play the game blindly—"by the seat of your pressure suit," as the pioneers stated it.

I went to the shuttler's locker, located a canteen in a survival kit, filled it and left the ship.

I started where I'd found the largest collection of remains.

Moya's memory had failed to particularize the plant, but I had enough evidence to negate indescriminate baptism.

I felt supremely foolish—for a while.

My thoughts began to focus, and I recalled the little plant that had grown up through the hole in the pelvis.

Casting about, I located adult specimens. They seemed to fit the requirements. Again it struck me that they bore a familial kinship to a variety that occurred on the plain.

I couldn't place the difference.

Finally I selected one about two feet tall.

It was bulbous, thick skinned, terminating in broad members that were clustered to form a rough funnel. Their inner surfaces were coated with a glutinous substance. The main body of the plant was studded with warty projections about the size of walnut halves. And just below the terminal funnel was a corona of tapering members like leaves beneath a bizarre blossom. They ended in sharp points, bore flimsy surface bristles, and seemed to serve as protection for the trap.

I prodded the green-and-yellow mottled skin of the thing. It was tough, resistant, almost pneumatic—

I had this sudden, strong feeling.

About ten feet away was a tree with dull-reddish, overlapping bark segments on its trunk. There was a branch close enough to the ground to be reached if my leg would support the necessary spring. I tested the leg for leap and the branch for support. They held.

I uncapped the canteen and sprinkled the remaining water over the plant, making sure that some reached both the funnel and the corona.

I ran.

Seconds later, perched monkey-see, monkey-do on the branch, I lost any lingering feeling of foolishness.

I sat there for quite a while, sickened. I thought about the crew of 231, and the other pieces of the puzzle. One of them had to be arrogance —the natural arrogance of picked people that leads to a belief in corporeal immortality: *Nothing can happen to me; you, maybe, but not me.*

Even though I knew exactly what to expect, it was impossible not to jerk back involuntarily with the others.

We were in the star ship, clustered around a bell jar. The jar contained a small specimen of the killer that I'd dug up gingerly and brought back for evidence.

I'd introduced water into the jar, and the first reaction had just taken place.

"Watch closely," I cautioned.

Again it happened—innocently at first and then too swiftly for the eye to follow. One of the little protuberances seemed to swell slightly—*Ping.* Something struck the wall of the bell jar hard enough to evoke a clear, sharp, resonant note.

"I don't know the exact range of a mature specimen," I said, grimly, "but I saw leaves shake a good twenty yards away."

"A seed," one of the crewmen breathed. "Nothing but a tiny, insignificant *seed.*"

Moya shook his head.

"A deadly missile, son, wearing or containing a virulent poison. And people used to blather about curare."

I began to draw concentric arcs on the chart.

"I kept fetching water and testing and retreating all the way back to the plain. Pretty soon there's not going to be any place safe within miles of where these mutants can take root. Near the plain's camp, they're still innocuous—the original species. The propagation response is triggered by rain, all right, but the seeds just pop out, and, of course, the poison is undoubtedly weak—a bother only to insects."

"But they weren't a problem—" Moya interjected.

"Time, I said. "Five years. Look here on the chart. I figured this to be the center: the first team's permanent camp on the hill. Now what happened there? Heaters to destroy immediate vegetation, and *Radio-Frequency* beams to kill insects and their larvae over a wider area. R-F—don't you see? Cells react to certain portions of the radio spectrum. Some are destroyed, depending upon intensity. Some behave strangely—the 'marching protozoa,' the 'dancing amoeba.' In others, chromosomal aberrations occur, resulting in mutations. Remember the experiments with yeasts, garlic, grains? The growth of some microorganisms is stimulated by R-F irradiation."

"Then these glorified flytraps got mad at what was happening to their innards and decided to fight even harder for survival?"

"You're anthropomorphizing," I told Moya, "but that's the way I see it. They just responded along already established lines."

I paused and noted the expressions on the faces of the crew. Maybe it was that, and maybe it was the fact that my leg hadn't held up very well under the beating I'd given it. And maybe it was twelve good men—Anyway, I spent the next half hour pulling no punches. When I'd finished, Interstel had regained its reputation. Nobody—neither short-timer nor veteran—likes to hear dead comrades characterized as "stupid." But I figured the crew would remember.

Moya seemed unfazed, as if he'd paid scant attention to my speech; he rubbed his chin reflectively.

"The bug suits—"

"Were they any protection? At long range, probably. But up close—"

Moya apparently could think of nothing more to say.

We radiated the danger area, left

231 for a pick-up team, and headed for home.

Moya walked with me from Quarantine to the Terra Ramp. The leg still wasn't right.

"Did you mention me kindly in your report?"

"Of course not," I told him.

He chuckled and put his hand on my shoulder.

"About Ben Stuart—"

"It's a nasty job," I said.

"Did he rate getting cashiered?"

"He did, Tony."

"Well, take care of yourself, Ivy."

The redhead again was on duty at the outbound desk. She ignored me.

Xanadu!

It was night, and there was a heavy fog. Standing alone on the open promenade outside the dome, I was grateful that I couldn't see the sky—and the ominous stars that were not so far away.

A couple of months later, I heard that Epsilon-Terra had received its official name: *Atri-Terra. Atri* from attrition. I've wondered ever since whether GS based the choice upon the secular or the theological definition.

THE END

IN TIMES TO COME

Next month, look hard for ANALOG. We're going to have a new make-up—a new cover design. As of now, I think we can assume that at least a majority of our readers know that ANALOG is ASF—so we don't need to tie ourselves to the logo that maintains the ASF design. We're moving more in the direction we want—a truly modern science-fiction magazine, that *looks* like the product it is.

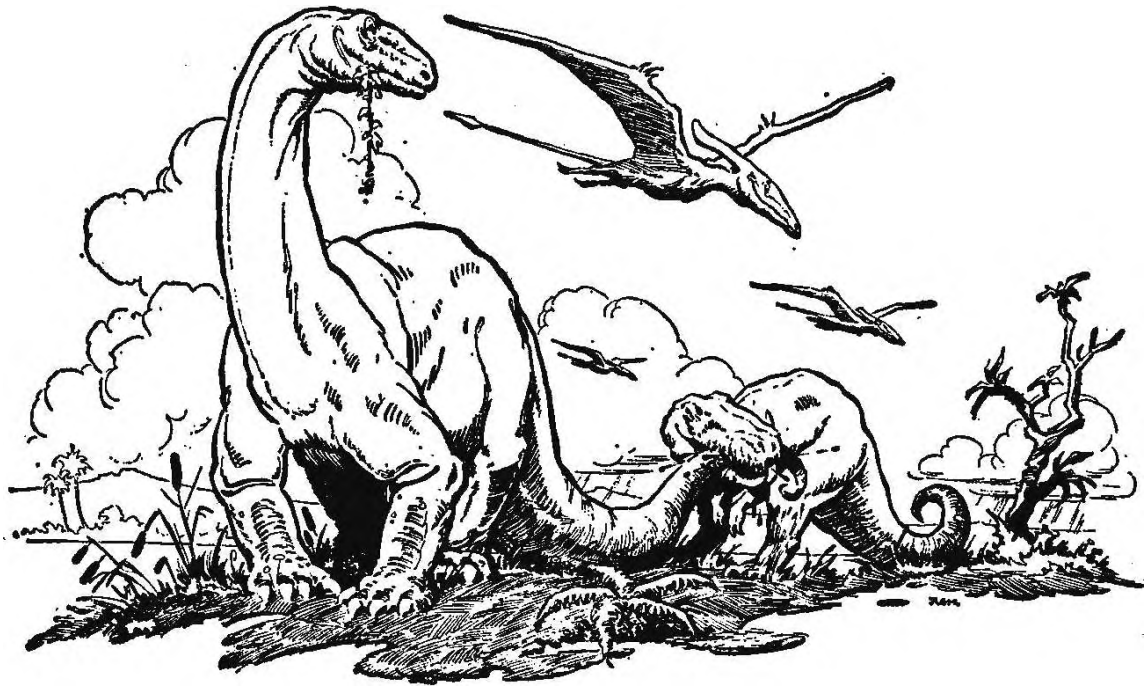
The cover painting is by Gene Thomas, "Neptune Orbit Observatory." The astrophysicist's #1 dream is, of course, a space observatory, outside of this @¢.**?! atmosphere. If they only had the Palomar mirror outside the atmosphere, several stars would be visible as disks; we could *learn* something; Given that dream—and that one's close!—the next dream is for a longer baseline for astronomical measurements. So . . .

And the lead item will be "Black Man's Burden," by Mack Reynolds. Reynolds has been living in North Africa for some years—and he's projected the turmoil of Africa just a few years into the future. One of the big troubles in Africa today is that not even 0.1% of the inhabitants of the continent know they're Africans. And there can never be an Africa until there are people who know they are Africans.

What will it take to make Africans know they are Africans? How long? And how many violent wars will *that* take . . . ?

The Editor.

A PROBLEM



IN COMMUNICATION

By GEORGE O. SMITH

Or—"Please Don't Eat the Dinosaurs!"

Illustrated by Krenkel

OST people know by now that radar ranging is done by measuring the transmission lag-time from the main burst to the echo that returns from the target. The same principle is used in underwater sound, and variations of the time-lag measuring process are used in loran, shoran, tacan, and other devices for pinpointing the position and measuring the course of ships and aircraft. Beyond this, the transmission time-lag does not seem to be important other than to become a nuisance now and then. For example, folks who live in the area between Chicago and Cincinnati can tune their radio sets to 710, which is between WLW at 700 kilocycles and WGN at 720 kilocycles; when receiving both stations during a network broadcast, the program sounds as if it were originating in an echo-chamber because of the time-lag between the two cities.

Now, that time-lag problem does not involve interplanetary communications. The Earth-to-Moon path has a time-lag of about two and one half seconds. This will not bother anybody; some years ago I made a simulated conversational two-way for the Second Symposium on Space Travel and demonstrated this time-lag. But now it can be told: To make the effect noticeable, I had to delay the apparent transmission-time by almost two to one, otherwise it sounded just like a normal conversation between slow-speaking people. For all other celestial bodies, conversation is out, and lag-time is unimportant.

The problem is one of nervous transmission. That is, the speed at which a nervous impulse travels along the nervous system from one end of the animal to the other.

Tests show that the speed of propagation is about ten feet per second. This is the so-called medical normal; it varies widely from individual to individual, centering in a distribution curve about the ten-foot-per-second velocity. That the nervous impulse is not instantaneous can be checked if you don't mind inflicting some pain upon yourself. Just rap your big toe with a hammer to create a sudden shock, then observe how long it takes for the toe to start hurting. This experiment is often loused-up because the individual is rare who can observe a hammer descending upon his foot without the main office upstairs shuffling through the card file, coming up with a memory, and pointing out that this is how it will feel if the old muscles do not take corrective action.

Luckily, the human frame is properly sized to take care of the problem. It is big enough to take care of itself naked in an unprotected environment, and small enough so that the nervous time-lag does not make Man sluggish. The eyes, sensibly enough, are very close to the brain. If we assume a nervous path of about two inches, the transmission lag is only about one sixtieth of a second. This leaves five sixtieths of a second to analyze the situation, decide what to do, originate the messages calling for muscular activity, and fi-

nally react so that the physiologist or neurologist can write in his book that human reaction time is about a tenth of a second.

But consider the dinosaur. Particularly the Brontosaurus. Here stands a beastie of vast dimensions; my encyclopedia says that he assays some eighty feet from bowsprit to backstay. This presents *some* neutral time-delay, friends.

But wait. The brontosaurus is a reptile, and all the rules of chemistry and metabolism suggest that a cold-blooded animal should have a slower velocity of neural propagation than the warm-blooded animal. I grant a dearth of information on the subject, and I admit that this theory is conjecture, but it is not an idea pulled out of a vacuum. So let's take this into consideration and suggest that the velocity of neural impulses in the cold-blooded brontosaurus is only three feet per second instead of ten feet in Man. Now, here is our brontosaurus, minding his own darned business when the tyrannosaurus, that is always found with the brontosaurus in moving pictures and museums, ambles up and takes a bite of the brontosaurus' tail—

Thirty seconds elapse.

Now the front office discovers that something unpleasant is going on back in the after region. Objective consideration reveals the desirability of determining the nature of this disagreeable sensation prior to embarking upon a program of unplanned circumvention.

The neck of this animal is some twenty-six feet long, articulated with neck bones about seven inches long. Upon the decision to take a look-see, the head-bone turns upon the first cervical vertebra, about a tenth or so of a second later the first cervical vertebra turns upon the second cervical vertebra. Another fraction of a second passes whilst the nervous information progresses along the spine to the next joint, then the second cervical vertebra turns upon the third —and so on down the neck of this animal until, like a windjammer warring ship at the end of a tack, the long neck has turned the head to a favorable position to survey the tail and whatever is creating the disturbance.*

Forty seconds have now elapsed, and the brontosaurus is in possession of the facts. It's that tyrannosaurus that Hollywood insists upon placing in the same prehistoric era. He is having lunch. Hollywood demands that the brontosaurus bite back, but the brontosaurus knows that he is a herbivore, and that the proper way to stop this foolishness is to remove the dinner from the diner.

Some twenty seconds pass whilst the removal-information travels from the head to the base of the tail, causing the first caudal vertebra to move. Some fraction of a second later the second caudal vertebra moves, and so on. Now, of course, the tail of the beast tapers from near body-size at the pelvic bone to a snakelike end,

* This process, if envisioned properly, is a faithful mental reproduction of the Hollywood model-animation motion.

and the velocity of motion will increase as the mass diminishes. Like a great bullwhip, this wave-motion courses down the tail at three feet per second until the impulse gets to the point of disaster, something like a minute and ten seconds after the dinner bell rang. Like the whip, the tail lashes itself out of the tyrannosaur's mouth.

Hollywood demands that this move should be followed by an instant counterattack, with the tyrannosaur leaping after his lunch, but the tyrannosaur knows that he's a carrion-eater who doesn't like living food.

Peace reigns once more in the Jurassic Forests.

The authorities, however, tell us that the brontosaurus had two brains, one of which was located in a small cavity near the pelvic region. The afterbrain supervised operations in the tail department, thus circumventing metabolism and the nervous transmission time-lag.

As every organization-man knows, this is an efficient way of doing business. It keeps the board of directors from the burden of making decisions that are simple routine for the maintenance department, and it allows the maintenance department to function without forwarding a statement of work and a request for action resulting in an official directive from the usual mob of vice presidents.

However, a problem remains with this two-brained operation; it is a matter of divided authority.

For example, did the brontosaurus operate with an "override" process? Let's consider the following example. The brontosaurus is walking through the forest primeval when he finds that his head is looking out over a cliff. Very little cerebration brings the forebrain to the conclusion that further pursuit of this compass heading will deprive him of all visible means of support. If the animal is equipped with an emergency override system, the forebrain merely generates the command to *halt!* and the total activity comes to a slowly grinding cessation of forward motion as the various operating muscles receive the message. The afterbrain's previous order for the rear legs to march in synchronism with the forelegs has been overriden.

Now we must veer for a moment. The velocity of nervous propagation must be faster than the forward velocity of the animal if the beast is to survive. This is true today. If you do not believe this, take your car out on the highway on some foggy day and drive fast enough so that you can not possibly stop within the distance that you can see through the fog. One foggy morning in the spring of 1960, forty-odd drivers proved this statement in a serial rack-up along the Garden State Parkway in New Jersey. Now, this principle is helped by vision, since none of us can exceed the speed of electromagnetic radiation. But if we remember the brontosaurus wending his way through a foggy, steaming, thick Jurassic forest full of heavy ferns, he

had better walk slower than the command to *stop!* propagates from the front office to the department of operating mechanisms.

From the evolutionary standpoint, the afterbrain will never develop if the forebrain makes all of the decisions. We must therefore assume that the afterbrain has some authority, and we can conclude that the afterbrain—being concerned with mechanical operations such as deciding whether the rear legs shall follow the forelegs in walk, trot, canter, pace, lope, or gallop * instead of being concerned with an awareness of food and danger—will develop a conservative, middle-of-the road distaste for change. Hence:

"Woah!"

"Why? Aren't things going just dandy?"

"No. We are approaching a cliff."

"What is a cliff?"

"Ye Gods! Don't you know what a cliff is?"

"You've got the peepers, friend. So you tell me what a cliff is."

"A cliff is where the ground comes to an end and we fall."

"Fall?"

"Fall. Extremely unpleasant sensation."

"How so?"

"If I break my neck, you'll hurt like the devil."

"Can't we just turn? Stopping is so . . . so . . . certain. I don't like this business of always changing things. It upsets me, and—"

"Skippy, stop all this arguing."

"You and your reckless leadership."

"Well, somebody's got to keep things going."

"I don't like following a brain that doesn't look where it's going."

"Listen, friend, we're in this together. As James Madison is going to say in 50,001,775 years. 'We must hang together, or we'll hang separately.' "

"It isn't going to be James Madison. It's going to be Benjamin Franklin."

"You and your damned educa—Yeeooowwww-w—w—w—w!"

On the other hand, we can assume that the forebrain will gain active experience in dealing with this sort of a situation. Since the sensory organs are located near the forebrain, we will find that the forebrain becomes the contact-man for dealing with the outside world, whilst the afterbrain develops a protected, philosophical attitude that deals in broad, general policy for the welfare of the organism, which the forebrain interprets in light of operating in the immediate environment. Thus we might find this:

"Ouch! Something bit me!"

"That was me. I had to attract your attention."

"What's up?"

"We're approaching the Le Brea Tar Pits."

"From one point of view, this might prove interesting."

"How so?"

"Why, some fifty million years

* This six-gaited brontosaurus seems pretty smart for a reptile, but we must remember that two brains are better than one.

from now we might end up in the American Museum of Natural History in New York City."

"But we're only about eight hundred years old. Right in the flower of our youth."

"Yes, you have a point. O.K. Let's synchronize our alpha patterns, and at brainwave number ten after the *mark!* we'll all stop together. Ready? Count, three, two, one, *Mark!*"

Conversely, if we assume a dull-witted brain-pair, a low order of intelligence, and an equally short memory, we could wind up with:

"Ouch! Something bit me!"

Twenty seconds pass.

"I know. That was me."

Twenty seconds pass.

"What was you?"

Twenty seconds pass.

"What are you talking about?"

This one we can skip. Obviously, the brontosaurus was smart. This information we deduce from the evidence. The brontosaurus is a reptile, and all reptiles continue to grow from birth to death. Obviously, the brontosaurus grows until the inter-brain communication lag-time creates a severe problem in getting things done, then he runs afoul of some situation that must be handled rapidly and fails. The death of the gigantic dinosuar simply must have been due entirely to the failure of communications as the animal increased in size. Nothing else caused death. Otherwise we might find a *small* brontosaurus standing around in his bones in the museum—

And so until someone unearths a pint-sized brontosaurus, gentlemen, I rest my case.

THE END

A Martyr, many times,

is an individual who has established

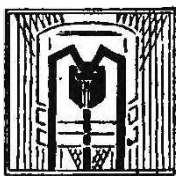
a comfortable residence

behind the eight ball.

GRAVITY INSUFFICIENT

By HAL CLEMENT

For centuries after Newton, men thought that gravity, singlehanded, ruled the Universe. Now . . . we're learning about the stupendous magnetic forces actually at work—of magnetic explosions measurable not in megatons of TNT, but megabombs of hydrogen bombs!



Y IMAGINATION is not a very estimable character. He's an artist without being a craftsman, which is almost immoral; he's lazy; and he's sneaky.

He's an artist because he paints pictures. He's not a craftsman, because unless he is closely and rigidly watched the pictures won't follow rules—rules of art or of nature or even of plain consistency. He's lazy and sneaky because he leaves out essential details from his pictures whenever I'm not watching to point out that they should be there.

In addition, he's a bit on the incompetent side. He doesn't really create; he reassembles things from my memory, and if other people can't see where they came from he feels he's done something smart. When he can't do a job at all, he sulks.

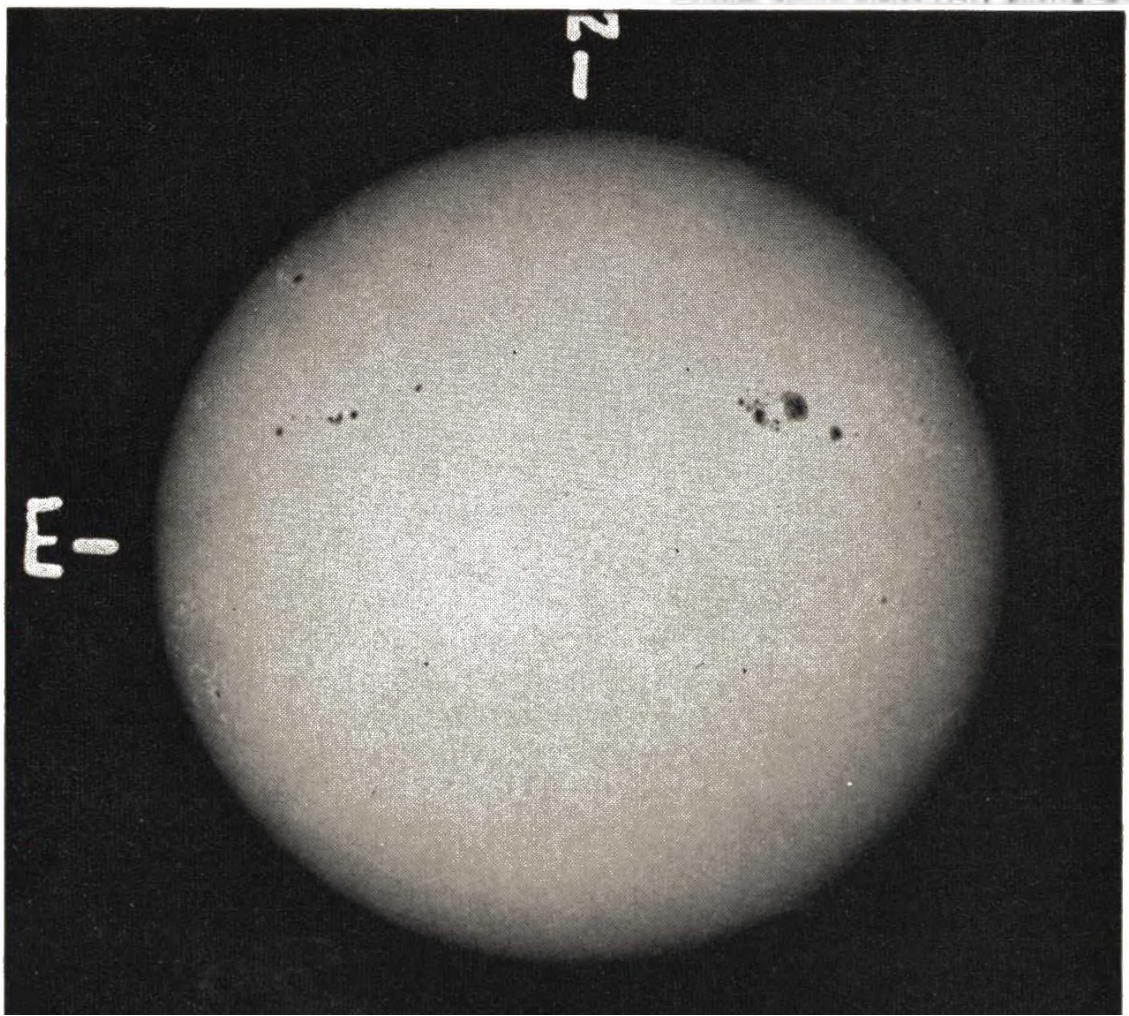
For example, he can't do a thorough job on the picture of a rocket taking off, because some of the essential data is not to be found in my memory. It's a little embarrassing for a science-fiction writer to admit that he has never seen first hand the blast off of a large rocket, but it's true in my case; all my imagination has to work on is a collection of movie and television scenes.

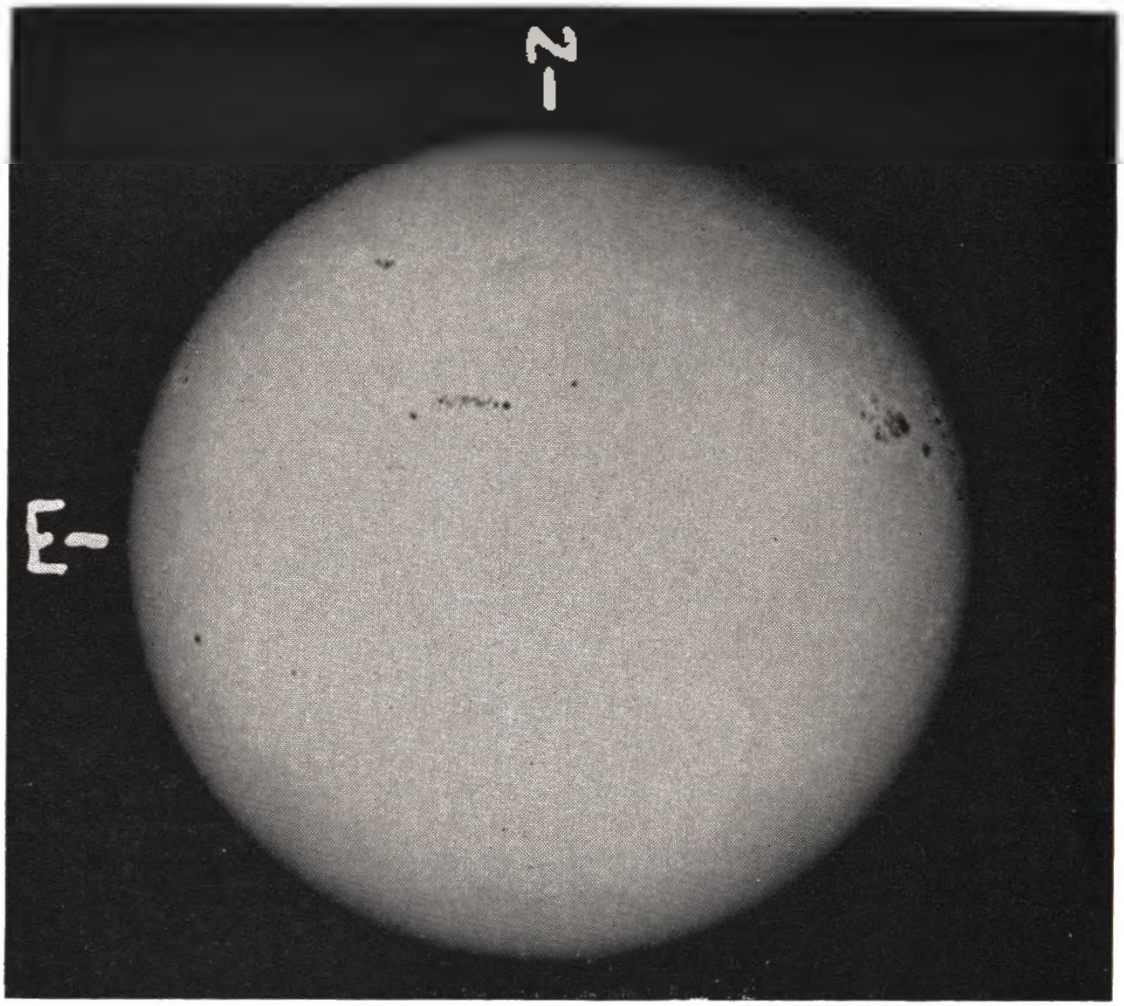
Now, there's a fair amount of detail in those memories; he can paint a good visual picture, I guess. (How can I be sure?) It shows that flakes of frost shedding away from the hull

around the liquid oxygen tank as the airframe trembles to ignition shock, the cloud of steam from the water spray in the blast pit, the column of incandescent gas marked with shock diamonds as the great metal cylinder eases its way upward from the pad. It shows the hasty, here-and-there hunting of the fire tongue as the gimbaled motor responds to commands from the guidance device to keep the machine vertical, the blue of the background sky and the white and gray of its clouds, and the vast column of white smoke being slowly twisted by the winds until it no longer marks the course of the departed rocket. I can see all these things in my imagination's picture; but I can't feel the ground tremble as the blast first cuts loose—I'm not even sure that it does. I can't hear the thunder of the gas stream; what I've heard in theaters and in my living room is a pale, shadowy imitation. The electronic system that can record and reproduce that sound hasn't been made yet. Even gunfire doesn't really come through—I know at least one person who enjoys TV westerns

The sun is the only star in the Universe that we can observe in close detail . . . and that's not easy! This shot, taken in white light, was made March 15, 1958.

Official United States Navy photograph





Official United States Navy photograph

This one, also white light, was taken two days later—March 17, 1958. The rotation of the sun, and some change in the easterly sunspot group can be clearly seen.

but won't willingly go near a shooting gallery because of the noise—and gunfire doesn't begin to approximate the sound of a rocket exhaust, I'm told.

I can *guess* what I'm missing, of course, and that's how I know the imagination is lying down on the job. My memories do have records of some fairly loud noises. They include the environment of a B-24 cockpit when bomb doors and flight deck hatch were open and flak was bursting close enough to be heard above the propellers. They include the time dirt was being dumped down my neck by the sound wave from a forty kiloton nuclear blast four thousand yards away—the authors of physics books who claim that the actual displacement of air molecules in a sound wave is negligible aren't considering sound waves with a pressure peak of several pounds per square

inch and a half-cycle time of over a second. There's quite a breeze during that second. The same blast set the desert rocking under my feet with a set of ripples remarkably like those on a pond disturbed by a stone. It's a little disconcerting to have a trench which has been dug in hard soil seesaw like a raft in the wake of a speedboat; I remember it vividly. I can guess, therefore, that I'm missing a good deal from this rocket takeoff picture; but I can't *know* what I'm missing. My imagination isn't competent for the job.

At that, it may not be entirely his fault. I'd miss a good deal even if I were actually in the blockhouse and all my senses were on the job. I could see, hear, feel, and smell, but it's no news to anyone reading this magazine that those four senses don't cover a very wide band of phenomena. The radiation of four to eight thousand Angstrom electromagnetic photons; the broadcasting of atmospheric pressure waves at about all frequencies and energies which the properties of the air itself will permit; the transmission of shock waves to and through the solid ground; the fouling of the air with partly decomposed hydrocarbons and/or hydronitrogens—is that all that's going on? Not on your tintype. That's merely all I'm personally equipped to detect.

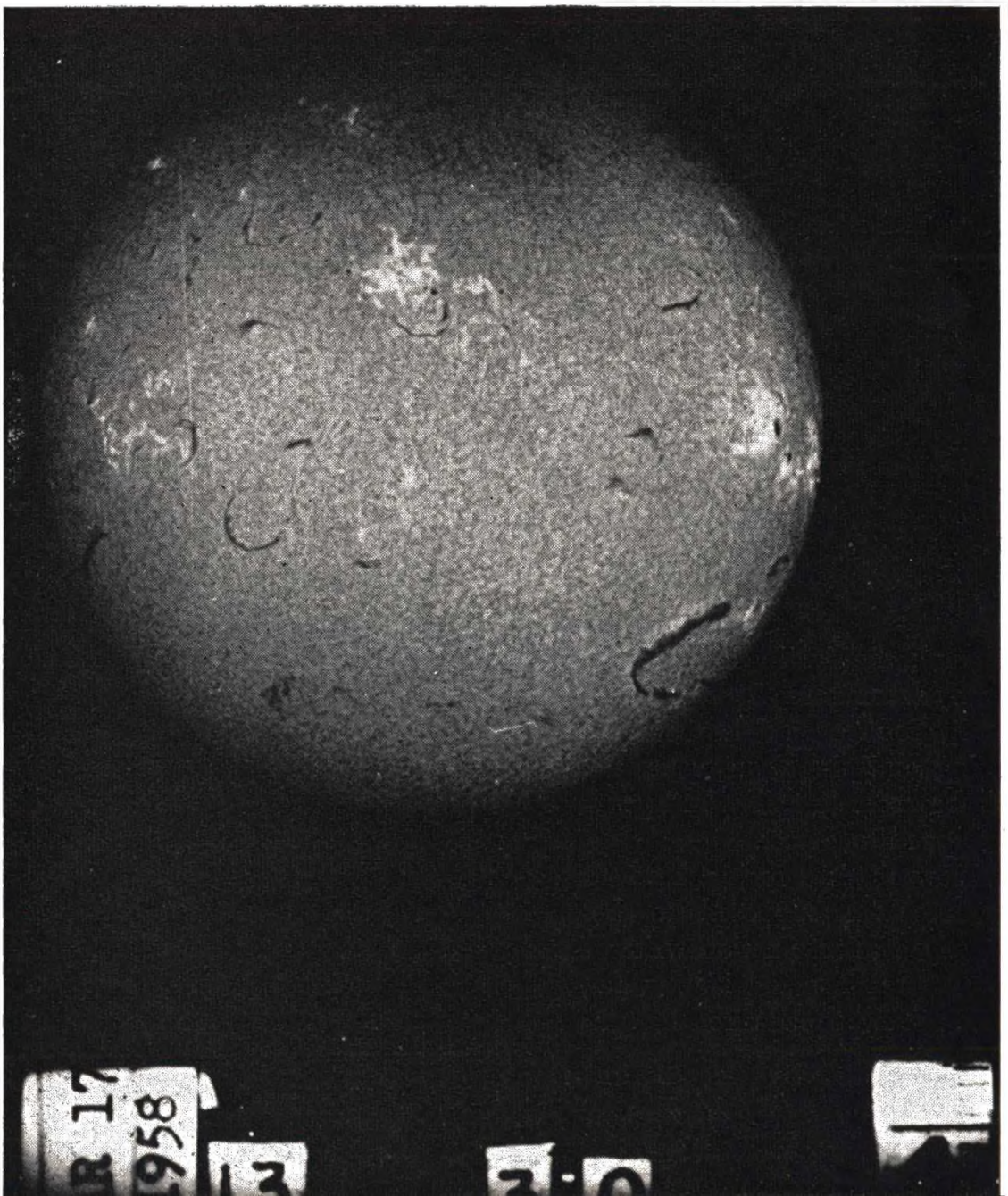
Now that's a major disadvantage, because I'm supposed to be not merely a science-fiction writer but a science teacher, and it's my business not merely to admire the pictures my imagination paints but to transmit them as completely as possible to other people. If my own pictures are incomplete, how can I or anyone who listens to me possibly understand what's really going on—and more important, why it's going on?

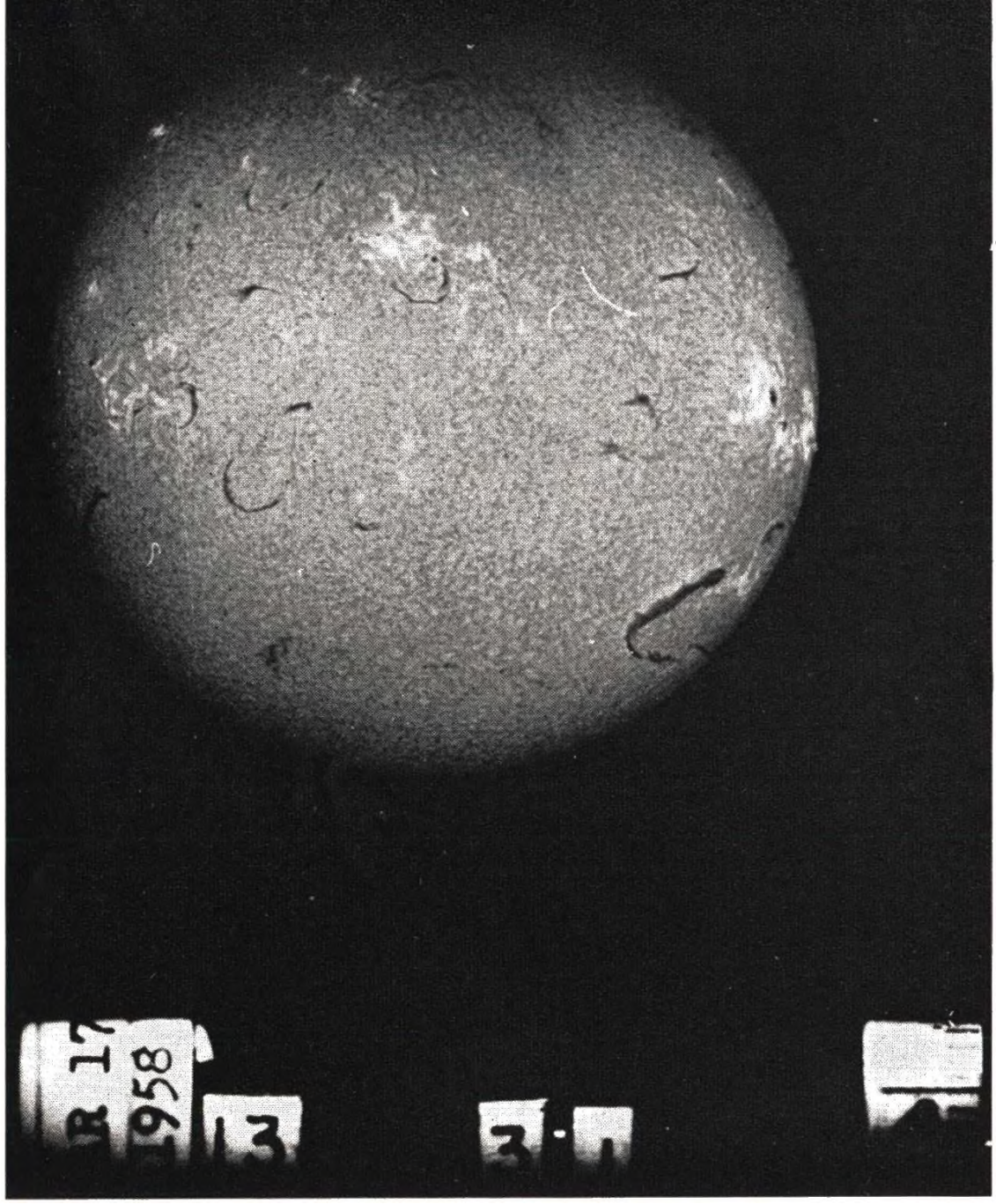
My sloppy imagination has gotten away with a lot, there, for a good many years. Maybe there's some excuse. Like every other scientist, an astronomer works from incomplete data; but in his case the incompleteness is due not merely to his personal sensory limitations but to the sheer distance from the things he's studying, coupled with the rotten conductivity of the intervening medium. About all space will transmit is electromagnetic radiation. Until recently, I never thought of a single astronomical factor in terms of anything but light. And that is bad.

For example, half a dozen times a year I aim a five and a half inch telescope at the sun, set up a white paper screen behind the eyepiece, and spend three quarters of an hour trying to account for the details on the screen to a group of ninth graders. We can see a disk of light, visibly less brilliant away from the center and trembling noticeably at the edges. Usually we can see a number of small dark patches with not-quite-so-dark rims around them. If we look closely, we can see large, very irregular patches which are somewhat brighter than the general disk—these show up best near the edges. That's it. That's what distance, the natures of the intervening media, and our

The pictures on pages 86, 87, 88 and 89 are from an automatic monitor system; each frame is dated and timed to the second. This sequence occurred on March 17, 1958—and compare them with the white-light picture of the same date! These were taken through a very narrow-pass filter, by the light of the hydrogen Alpha spectrum line. On the west (right) limb of the sun, in the course of these four minutes, a "small" flare (10,000 miles perhaps?) erupts a pimplelike excrescence, and collapses.

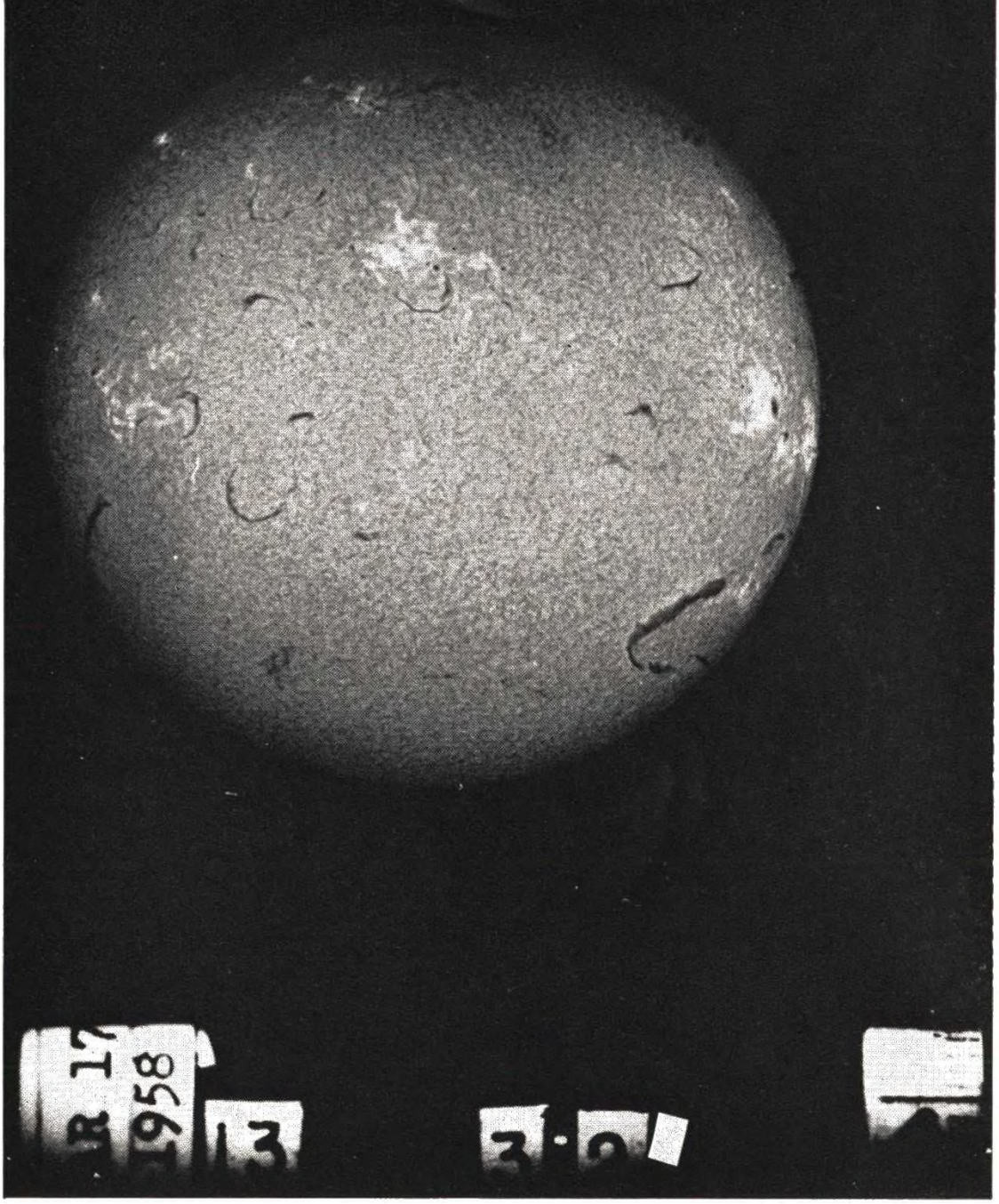
Official United States Navy photograph





sensory and instrumental limitations let us see. We hear, feel, and smell nothing, unless some youngster with more humor than sense puts a pencil or notebook cover right behind the eyepiece.

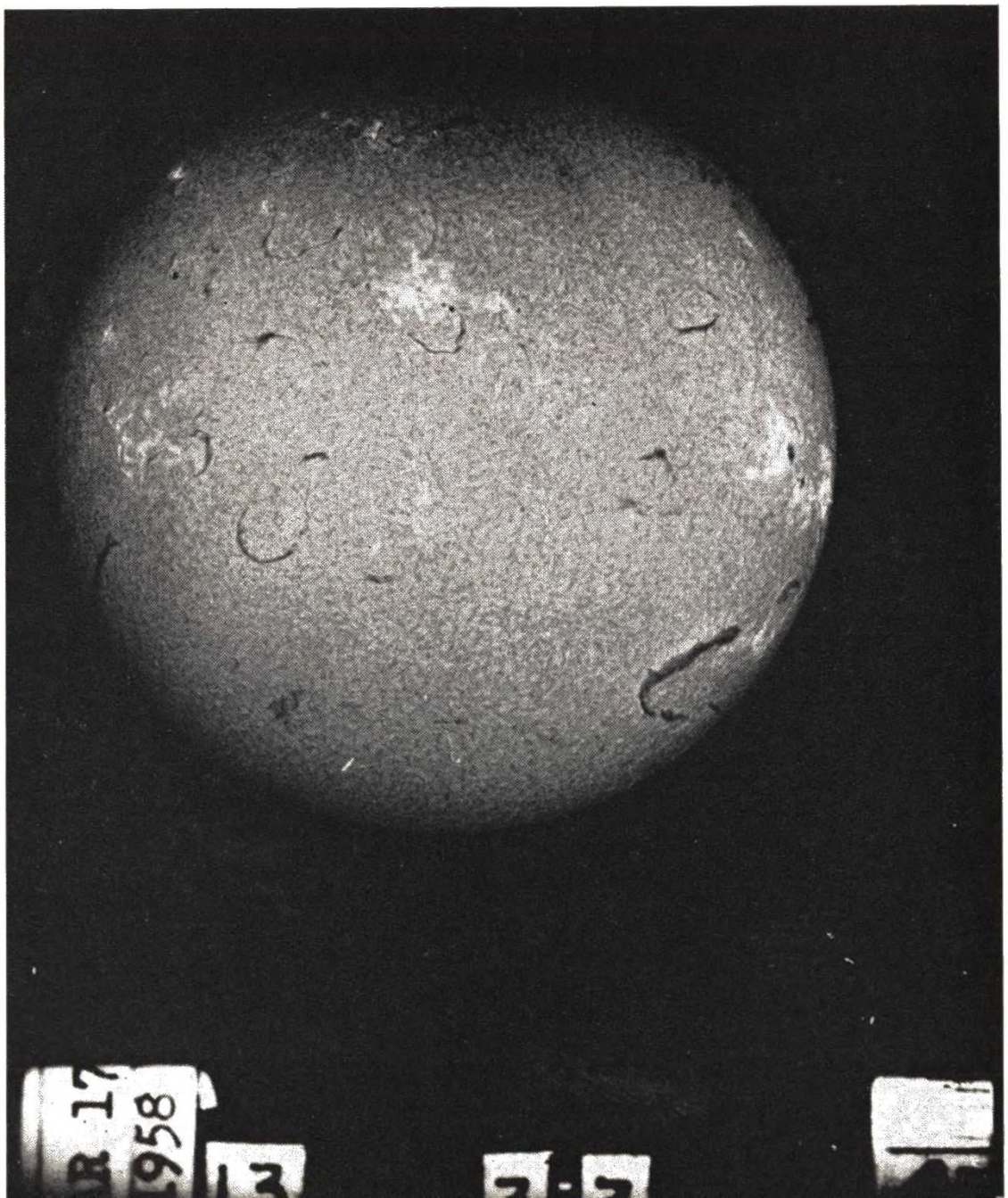
Years ago my imagination painted a picture of the original of that image—and he's gotten away with it all that time, even though it's a *silent picture!* Worse, I've been passing that picture on to my students. I can give reason for that, but not an excuse. I simply was never impressed with a noise-image even in the days when sunspots were described as solar tornadoes. The bubbling "rice grains" that show on the best photographs—my little instrument can't make them out—and the glowing faculae; the



prominences swirling, floating, fountaining upward and raining downward out of nothingness; I saw them first on silent films, and silent they've been to me. The rumbles and whistles from the radio telescopes didn't impress me as real sound, just as an arbitrary translation of impulses which didn't result from the action of a microphone at the other end. They were just as arbitrary, those noises, as the wiggles recorded on graph paper by the present equipment; and the wiggles are easier to scan and interpret than memories of changing sound, though the sounds I suppose are really just as meaningful. It was a ghostly, silent sun to me, and I'm ashamed of my imagination. (1, 2)

Others had different pictures. John

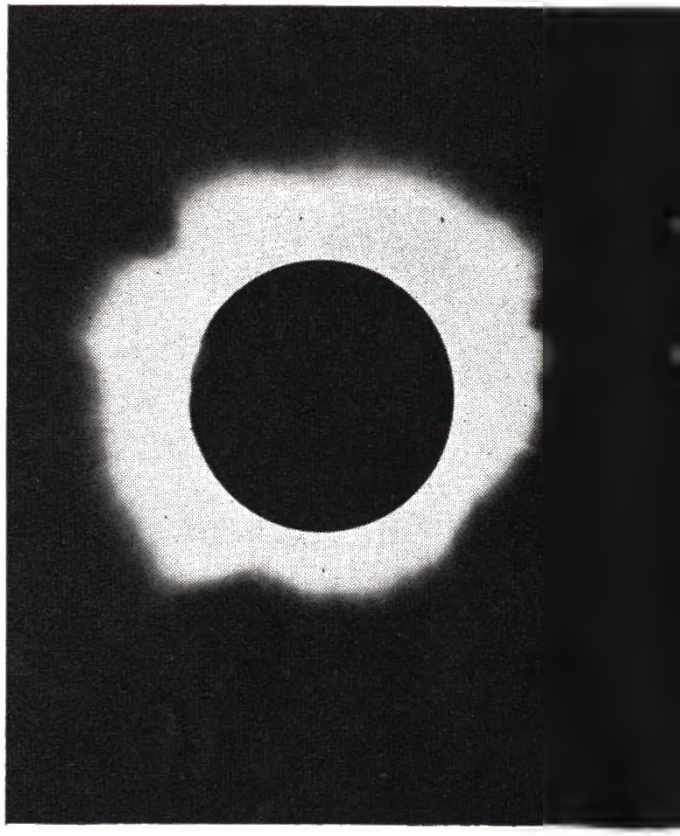
Campbell writes, and apparently thinks, of the stars as "roaring furnaces of the cosmos." It's not just a figure of speech, either. Stars are made of matter, the matter has a pressure which can vary and a temperature which can vary and what else does sound need? If I'd been properly alert, I could have held any of a score of physics texts in front of my imagination's bleary eyes and swished a cat-o'-nine-tails until he'd added a sound track to the picture. Could have done it years ago, I mean; it's done now. However, now that I realize just what the loafer has been getting away with, I'm going to keep after him. I'm dragging him out of his lotus-eater's paradise and driving him back to the sun to redo his picture from the canvas out; and if the old high school and college physics texts



will be of any use, they're standing by.

Of course, we can't let the poor fellow just paint. He has to be guided; so we'll start him out from a well equipped observatory—one with gear which can make a nice, big, detailed solar image in any of a reasonably wide choice of wave lengths, is high enough up on a mountain to have the worst of the atmosphere below it, has short-wave radio equipment both for communication with other observatories and ionosphere research of its own, and is in communication with a widespread group of stations all equipped to detect temperature changes, magnetic changes, high energy particles, and anything else some imaginations which have been more on the job than mine have dreamed up.(6) Given all this equipment, let's ride along to the sun with our chastened imagination, and really *look.* And listen.

Even if we don't bother to select wave lengths but merely look in white light, we can see a lot of detail as we swoop toward the sun and come to rest a couple of thousand miles above the photosphere—the "surface." The sunspots are obvious, with their moderately cool penumbrae sloping gently down toward the really chilly—say, forty-seven hundred Kelvin—umbrae. The granules are clearly visible as bright humps a few hundred miles across, perhaps a hundred degrees or so hotter than the surrounding photosphere. The imagination, being lazy, is fond of these "rice grains;" it's easy to picture them as



The very brilliance of the sun makes observing it difficult. The sun's corona used to be visible for study only during total eclipses. This United States Navy photograph was taken June 8, 1937, by setting up equipment on Canton Island . . . and then having good luck with the weather.

the tops of small convection currents. They are quick-change artists, losing their identity completely in ten or fifteen minutes.(2, 11, 29)

The faculae are also brighter, but on a different size scale; they are thousands of miles across—sometimes tens of thousands. They seem to hump up a trifle above the general "surface," and *maybe* they, too, represent the tops of convective masses; their much longer lives, as compared

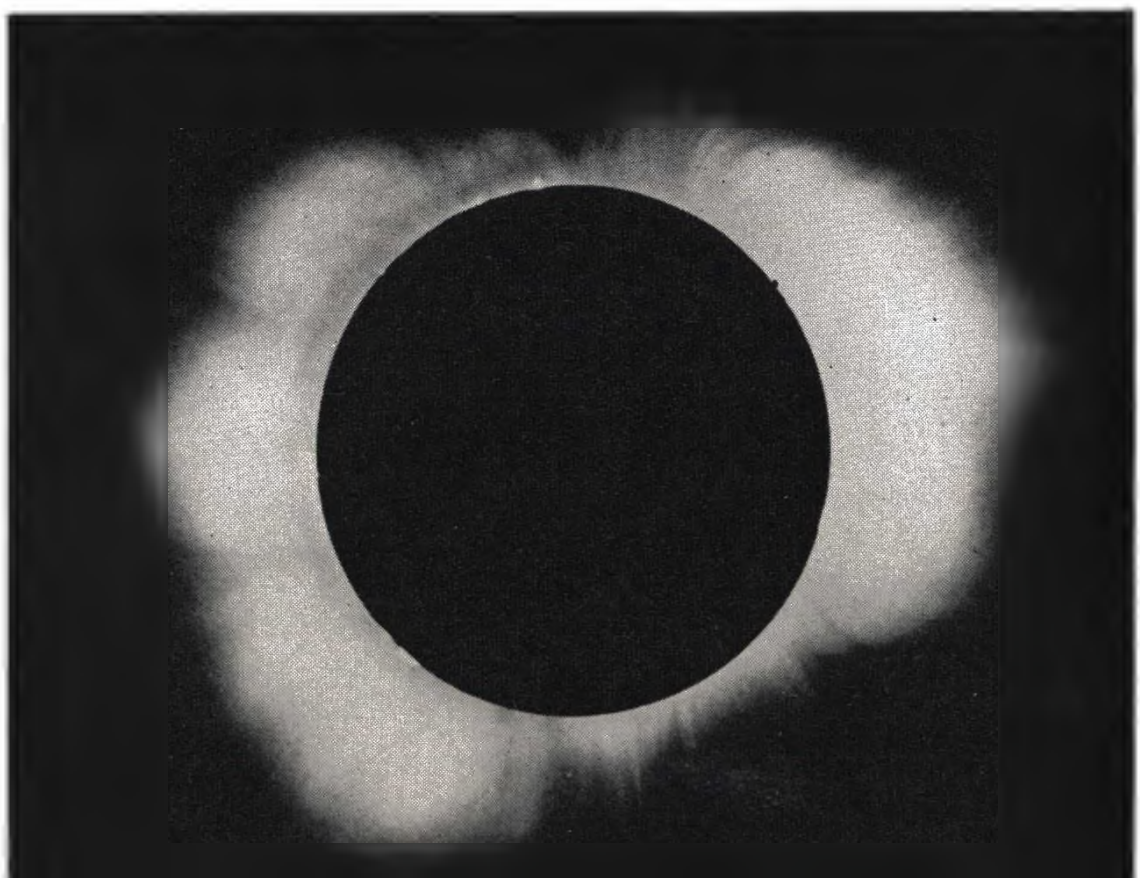
to the granules, may be just a consequence of greater size.

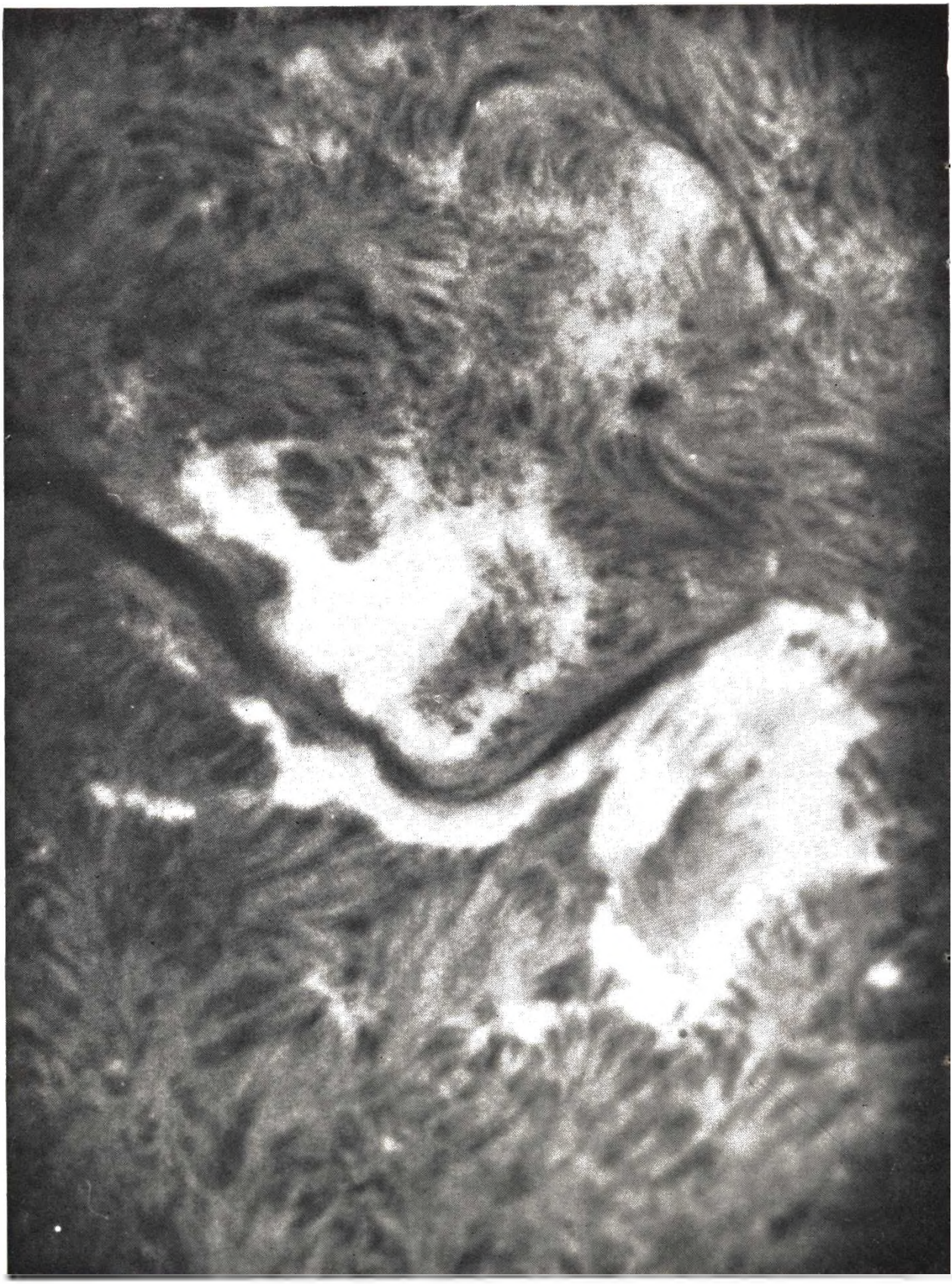
We can see the spicules, "baby" prominences flashing upward for a few thousand miles during their brief lives, which compare with those of the rice grains, but we find we can see these better if we are more selective in the wave lengths we use for observation. If we pick a nice, narrow band around one of the hydrogen wave lengths, we find we can really see prominences; and they're fascinating things to watch.

Gigantic clouds of hydrogen float motionless here; form shifting, wavering, dancing pillars and columns and fountains and curtains in other places; blasting upward in some spots, hurtling or drifting or raining downward in others—with the downward motions seeming to predominate, at least if we do our observing in hydrogen-alpha light. Presumably hydrogen is going up in some form to keep up the supply that comes down, but if so, few of its atoms during the upward trip are in condition to make electron swaps between the second and third quantum levels. We'd have to use some other wave length to see them, if they're either radiating or absorbing at all.(9, 14)

The whole medium is thin, of course—a few thousandths as dense as Earth's atmosphere at sea level—but it is hot, it is material, and the imagination with a sheepish expres-

This far more detailed picture was taken at the High Altitude Observatory, at Climax, Colorado, on November 19, 1949—using a coronagraph, which artificially eclipses sun.





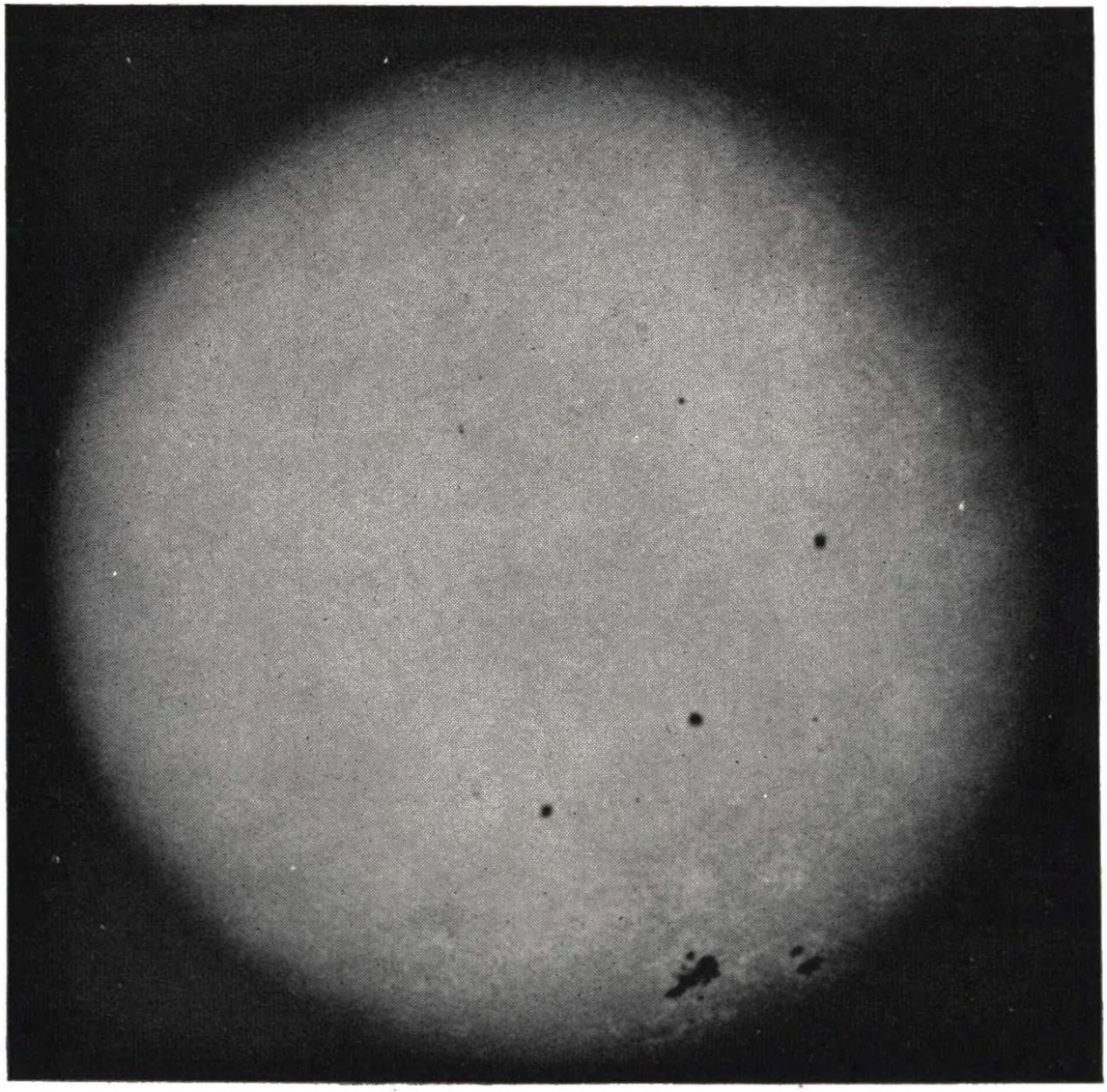
Getting details of the structure of the sun isn't easy, either. This, taken at the Sacramento Peak Observatory, through an H-alpha birefringent filter passing a band only 0.65 angstroms wide, shows an active area of the sun on a large scale. The blurring of poor resolution is obvious—and due to Earth's atmosphere, not poor camera quality.

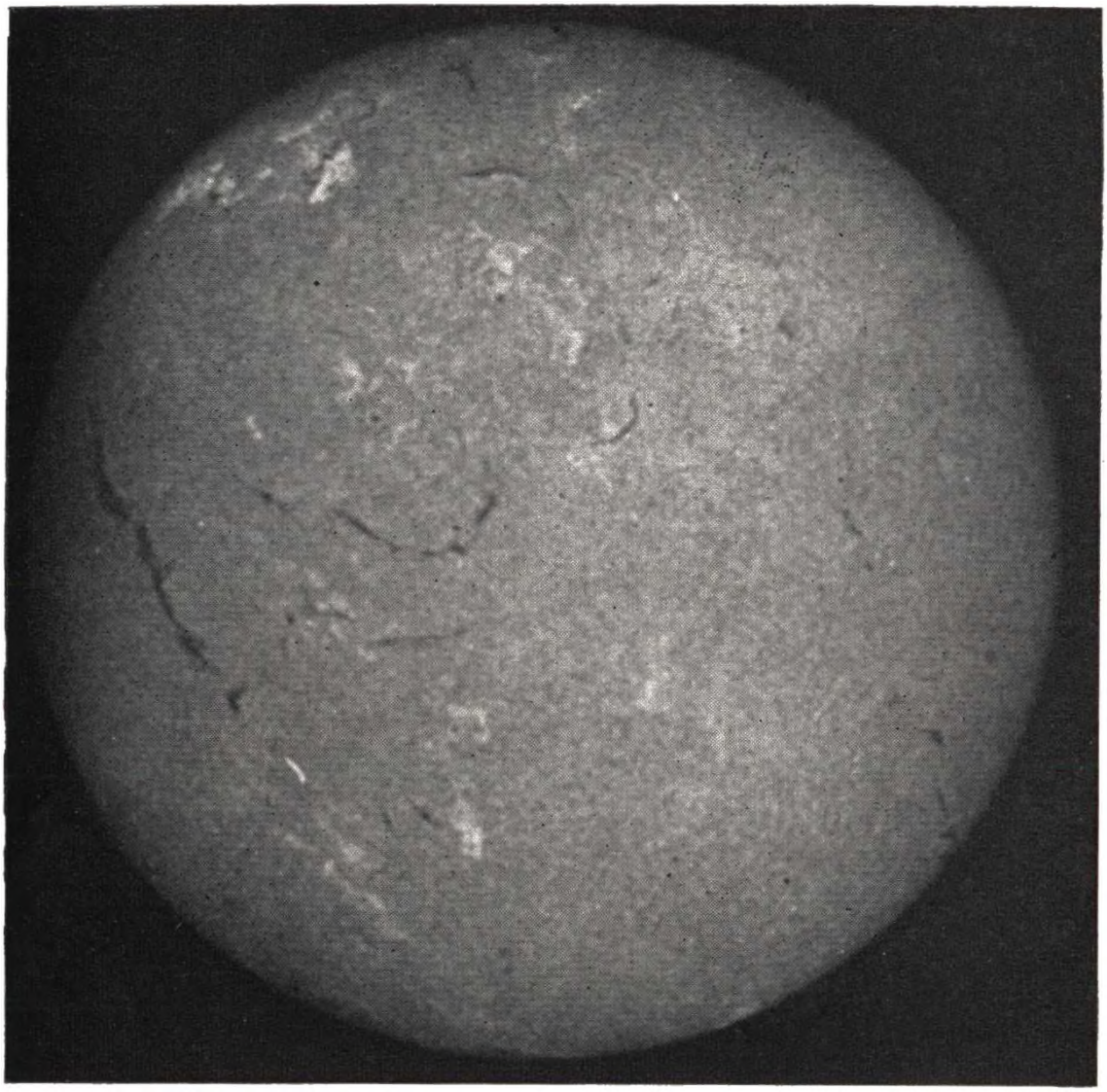
sion on its face looks over and admits that the picture isn't silent at all. It's ear splitting. Shrieks and booms, growls and rumbles, cracks and hums —any sound which words have been found for and virtually everything for which they haven't. The imagination wants to go off to watch a rocket launching as a relief—or possibly to hide his embarrassment—on the grounds that rocket noises couldn't possibly match this racket. Even the nuclear explosion in the memory record would go unnoticed in this bellowing hell. Actually, the sudden bang of an explosion is about the only thing missing here—no, we have even that; the planet-splitting crack of a gigantic mass of gas accelerating upward from somewhere below the photosphere until it reaches a speed supersonic both for itself and the surrounding gas. After all, that's just what happens in a dynamite explosion; why should the sound be different? The sun does seem to have good imitation explosions; but the imagination remarks with a slight sneer that you could hardly expect the real thing in that environment. Convection-driven—that is, gravity-driven—phenomena just aren't sudden enough to qualify. He never seems to learn, that imagination—

But he learns quickly enough. We've already gotten used to the sudden brightening of a hydrogen flocculus—one of the clouds of gas hanging almost motionless a few thousand miles above the photosphere, looking like dark blobs against the brilliant "surface" when seen from above—and this particular brightening doesn't attract our attention at first. If we notice it at all, we dismiss it with the thought that the thing will fade again shortly. Well, it does; but first, it *does* attract attention.

It gets brighter and brighter and hotter and hotter—in every sense. We need more than just our optical instruments back on Earth, now; light alone isn't going to tell the whole story. There *is* light, sure; all sorts, from soft X rays to the longest radio bands we can receive. There is also sound, and the imagination winces. Here, at last, is the really big bang. Or can it be called a bang, which implies relatively brief duration? This one doesn't stop. Each second seems as though it must represent the peak, but each second the sound grows louder. Atoms hurtle frantically against each other, showering electrons abroad and claiming others with a vicious spit of radiation. Electrons traveling too fast to be caught are accelerated as they pass near stripped nuclei and radiate unpredictably themselves. Nuclei driven at speeds

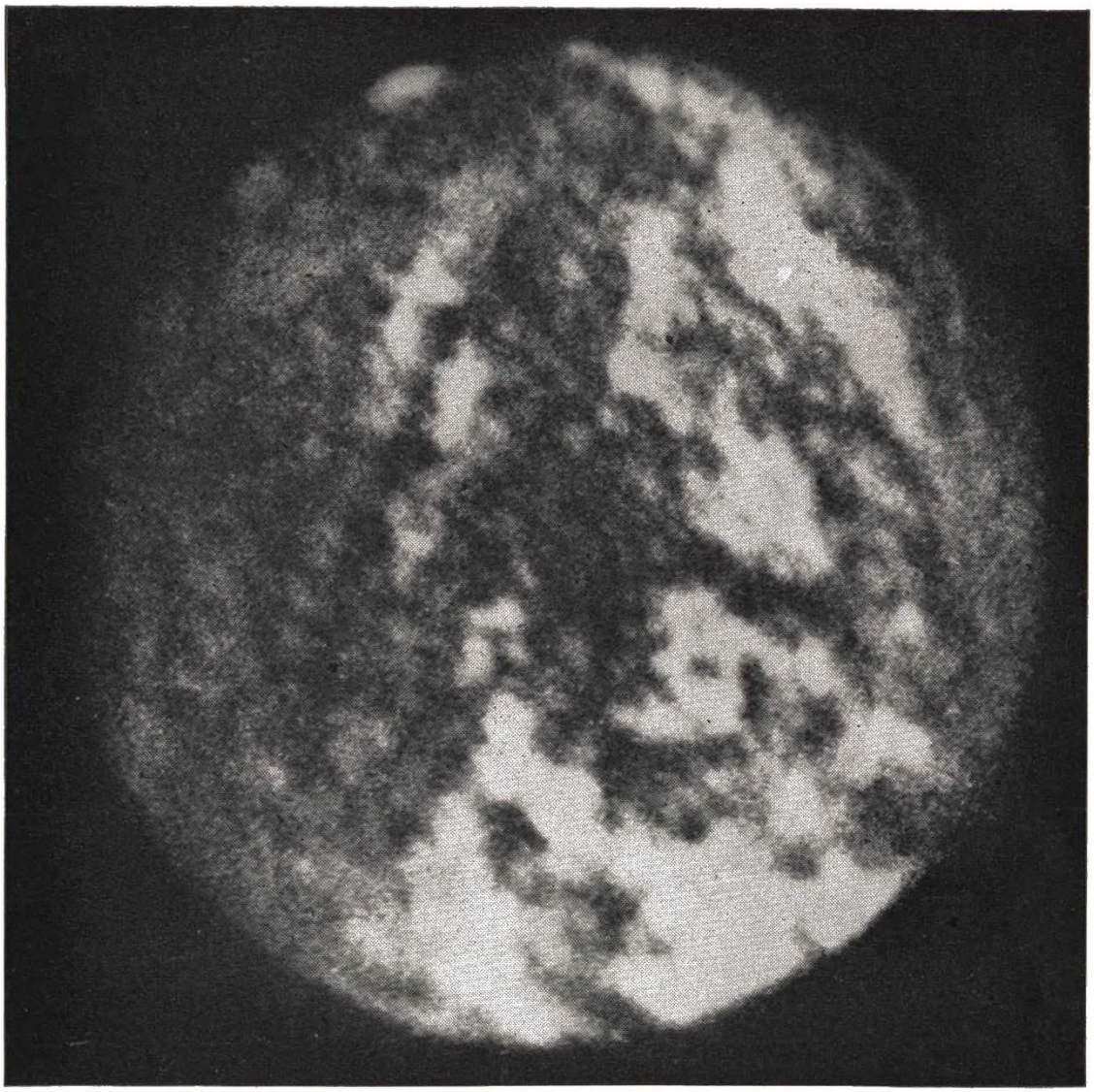
These three shots (pp. 94, 95 & 96) were taken almost simultaneously on March 13, 1959—but by three very different techniques. Photograph on Page 94 was taken in ordinary white light, at the United States Naval Observatory, in Washington, D.C. The one on Page 95 is from the United States Naval Research Laboratory, also Washington, D.C., using the birefringent filter centered on the H-alpha line. However, the picture on Page 96 was taken from an Aerobee-Hi rocket, using a special camera developed by the Navy, and also using a filter, centered on the Lyman-alpha line of Hydrogen.





half that of light hurtle out of the region still ionized.(13) The flocculus, now an expanding, rising bubble of gas blazing even by solar standards drives upward at perhaps four hundred miles a second. The work of expansion, work done against the local force fields, and the emission of radiation all strive to rob the mass of energy; but it is many minutes before the effects of the losses can be noticed. Eventually they can, and the mass cools; one to three quarters of an hour after the start of the phenomenon, there remains a not every unusual prominence, as far as the sun is concerned. In that time, the flare has disposed of enough energy to put the top half mile of North America into orbit. (17,19,25,26,30)

On Earth, things are still happening. The light, of course, reached our instruments a little over eight minutes after it was emitted. The noise,



thanks to the nature of the transmitting medium, is mostly refracted into the body of the sun; what little is actually broadcast gets to us very late and too feeble to detect. (Yes, I did say *very late,* rather than *not at all.* The earth is technically inside the sun's corona, which is not a perfect vacuum and *will* transmit shock waves).

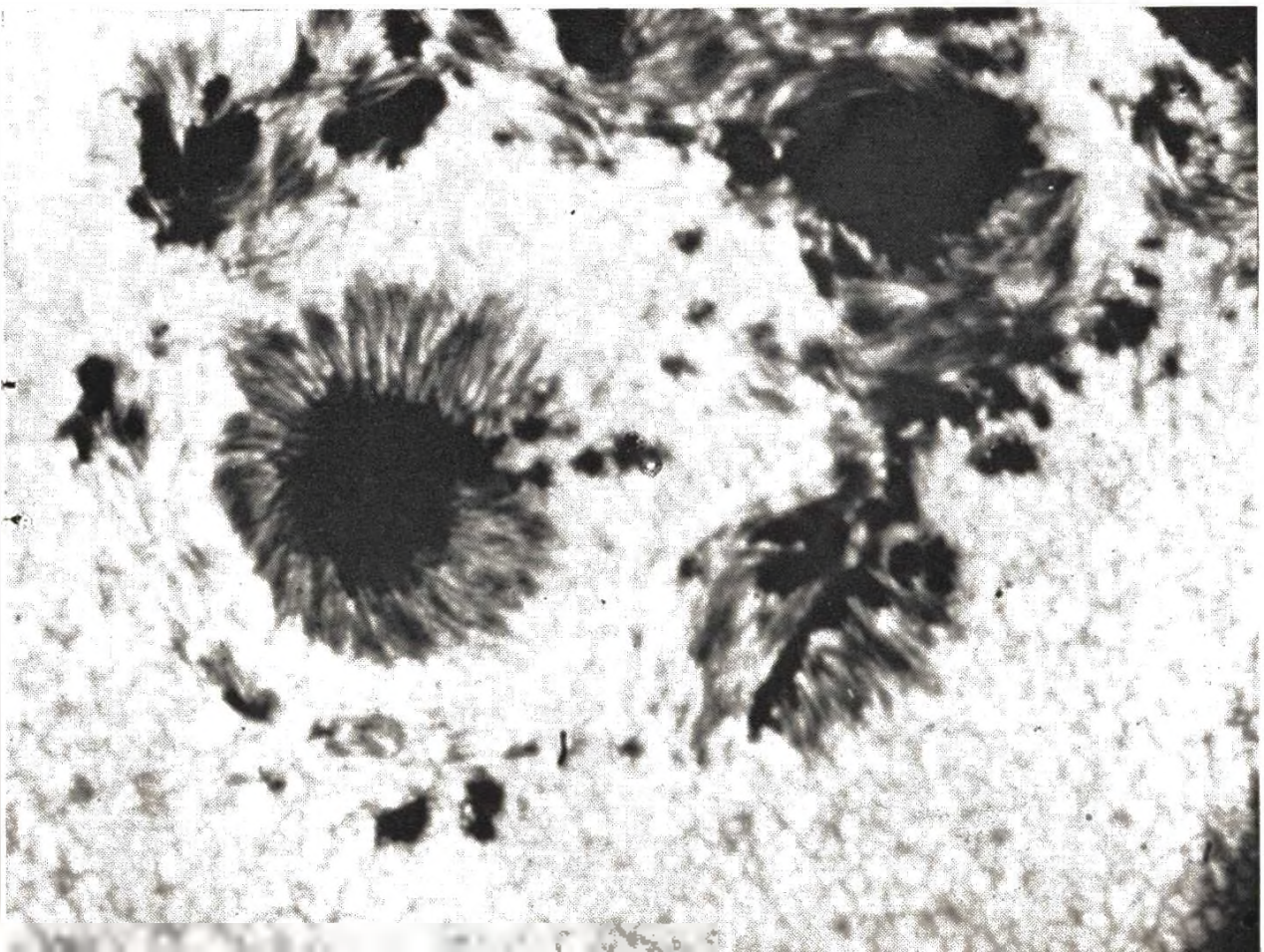
Particles also reach us. A few minutes after the first of the light makes itself noticed, particle counters on the sunward side of the earth start clucking. Strictly speaking, they have never been entirely silent, since there's a fairly steady background of cosmic "radiation" which isn't particularly affected by little things like solar explosions; but now the counters, and the men keeping track of them, really start to sit up and take notice.

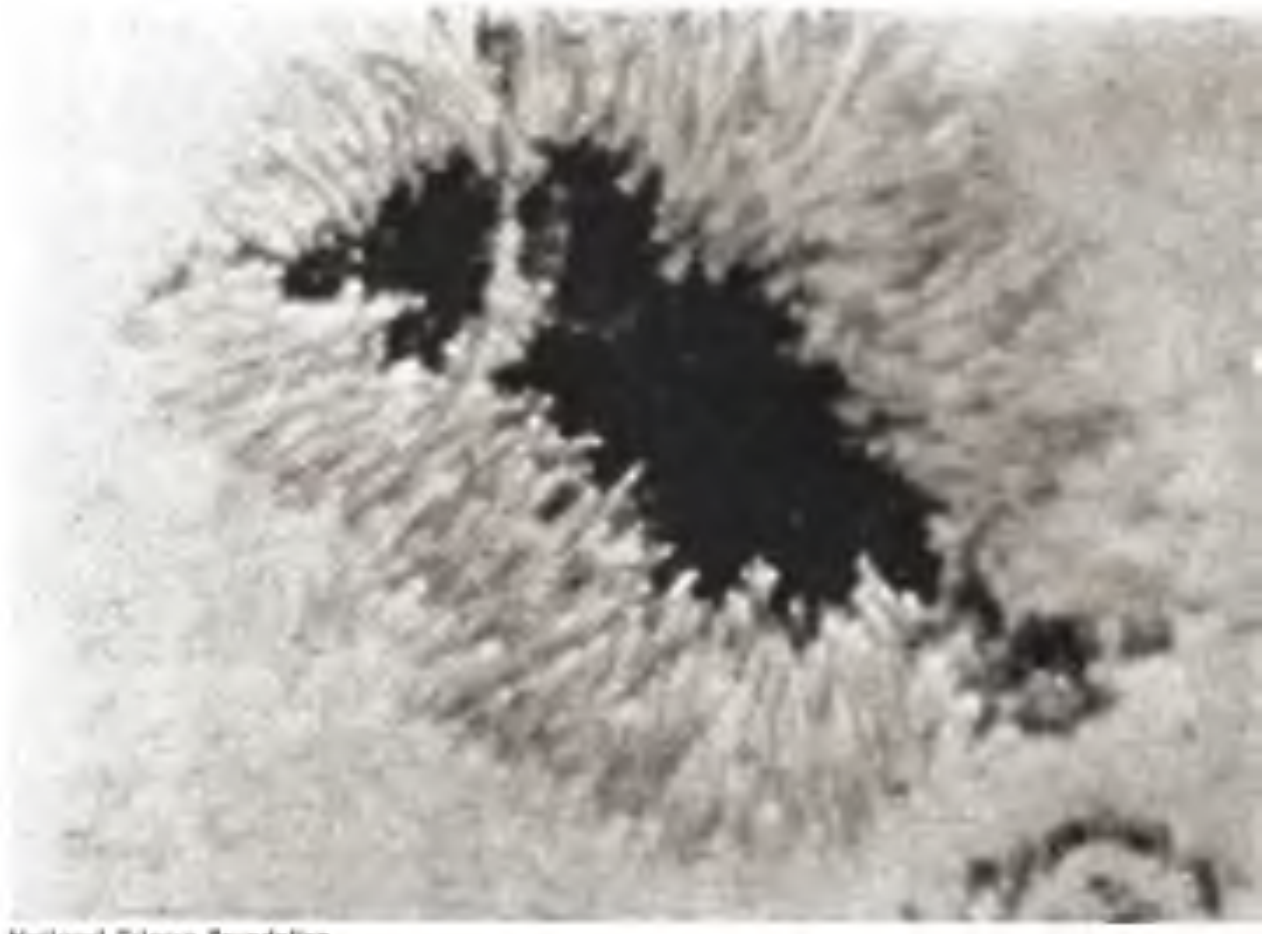
Actually, the counters aren't regis-

tering particles straight from the sun —at least, the ground-mounted ones aren't. What the equipment in orbit does I'd very much like to know. What are actually recorded are showers of nuclear fragments produced in the upper atmosphere by collisions between the nuclei of atmospheric atoms and ultra-high-speed, ultra-high-energy nuclei which may either have come from the flare directly or, more likely, have been produced in another collision a split second earlier. What finally reaches the surface may be the fifth or tenth or fiftieth generation descendants of the original particle (fiftieth doesn't seem likely; target shooting conditions are pretty bad), forming a shower which may spread over acres.(6)

Rockets can get out into space . . . but United States rockets can't, as yet, carry the massive equipment needed for precision photography. Balloons can carry the essential equipment to 80,000 feet—and did, on August 17, 1959. This active sunspot group produced a major magnetic storm on Earth the day before the flight, causing major disturbances to radio communications, and a brilliant auroral display. The photographs obtained by the balloon-borne telescope revealed never-before detected detail.

National Science Foundation





National Science Foundation

White dots in center of sunspot are shown clearly for the first time in this photograph taken 80,000 feet above the earth in STRATOSCOPE I balloon-borne telescope. Less than 200 miles in diameter, these spots are apparently convection cells of rising gases, hotter than the surrounding area, but strongly suppressed by the magnetic field of the sunspot. The long diameter of the black area is roughly the diameter of the earth.

Even so, it is possible to measure pretty closely the direction from which the original particle came, especially if quite a lot of its descendants are spotted; and there seems little doubt on the basis of direction and time that the flare was the original source. As the minutes go by, the particles keep on arriving, but with gradually decreasing energy. The imagination notes this, and nods his head happily. Obviously most of the particles started at the same time—the time of the flare—from the sun, and quite naturally the ones with the hardest kick reached us first. Situation well in hand. The things will probably keep coming for hours.

They do, but long before the flare is over the imagination is less smug.

In fact, it's tearing its hair. Within a very few minutes, in fact, the nice definite direction readings which said that the flare was the source of the particles—or at least, that the sun was; there's a limit to the precision of this cosmic-ray-direction business—are starting to scatter. North, south, east, west and all reasonable combinations of these directions—the source is *spreading*. Maybe these late, low energy arrivals are being scattered by the atmosphere? Qualitatively sound, but quantitatively inadequate—the stuff is starting to arrive on the night side of the planet. *One* particle might get around there after a series of collisions, even though each collision doesn't deflect it much; but three quarters of an hour after the flare starts, the night side of Earth is being "illuminated" by the things as thoroughly as the sunward side. Trying to blame that on the atmosphere is like dropping a double handful of turkey dressing into a Mixmaster and getting out half a loaf of bread and a thimbleful of spice—conceivable, but no one would put much money on it.

We can't assume that particles of non-solar origin are responsible, either; this flood started within a few minutes of the solar flare, and it's the best part of a day afterward before the number of arriving particles drops back to normal; and this is the usual story—if it were an isolated instance we could invoke coincidence, but that's out in this case.

Well, how about gravity? That accounts for celestial motions in general. It's a force that can certainly bend the path of a moving object; maybe that's what is swinging these nuclei around to Earth's night side. Unfortunately, that notion never gets off the ground, though; the slowest of the particles is traveling at many times the escape velocity of the sun, so that Earth's gravity would hardly put a kink in its path and even the sun's much greater pull can't possibly drag it back to collide with the spaceward side of our planet. Poor old lazy, conservative imagination! What's happening, anyway? Critics finding fault with your pictures, just because of a few blank spaces on the canvas?

It's been a rather conceited imagination, of course, anyway; one which felt that a couple of dozen pieces of a thousand-piece jigsaw puzzle were plenty for judging the nature of the picture. He could live in this happy dream world as long as his dozen pieces were all bits of leaves and branches, and he could feel sure the picture was a forest; now, however, someone has found some blue that might be either sky or water, and some yellow that may be desert sand or possibly part of a campfire, and at last the imagination has come in with his ears drooping. He wants a lot more pieces of the puzzle before he does any more picture painting; people are getting too critical of his fragmentary efforts. What's this bit of brown, boss—part of a hat, or is there a bear stealing something from beside the campfire—if it is a campfire—or is it maybe part of a tree trunk

as I thought in the first place?

Less figuratively, if the particles received in the last eighteen hours all came from that flare, why didn't they all come from the direction of the sun, as Newton's laws seem to say they should? If the downward-moving material in the prominences is falling, why isn't it accelerating at twenty-seven gees? That's what gravity should do to it. Why, for that matter, does some of it not fall but just hang there? The gravity isn't *that* much weaker a few thousand miles above the photosphere. Why are the sunspots cooler and quieter than the rest of the "surface"? Why does a flare start emitting soft X rays, and gradually shift to longer and longer waves—sometimes quickly and sometimes much more slowly? (26) It's not just temperature change, since the flare isn't hottest at the beginning. Why do prominences which are raining down at a steady rate quite suddenly change to a different rate? (14) And why, above all, does a flocculus or quiescent prominence which has been hanging inoffensively above the photosphere making its presence known only by the hydrogenalpha light it was absorbing, so that it looked like a dark splotch against the sun, suddenly run from a temperature of perhaps thirty thousand degrees Kelvin to—what? A hundred thousand degrees? Eight hundred thousand? Two million? Just what do we mean by these temperatures, anyway? (8)

People have been known to snicker at Sir William Herschel's belief that sunspots were holes in a luminous cloud envelope through which we were viewing a darker, colder, perhaps habitable world; thermodynamics—which didn't exist as a scientific discipline in Herschel's time—tells us firmly that the inner part of the sun can't be generally cooler than the outer since energy is patently flowing from the inside out. That's all very well, but now astrophysicists speak calmly of photospheric temperatures of six thousand degrees, prominence temperatures around thirty thousand, and coronal temperatures running from eight hundred thousand in quiet regions up to four million or more in really disturbed ones. (8,9,11). Have the laws of thermodynamics been repealed?

No, not yet. It's perfectly possible, by doing the appropriate kind of work in the appropriate place, to pile heat energy up in one spot against the "normal" temperature gradient, or to pump it out of one spot and leave an energy vacuum. You probably own a refrigerator and are familiar with the latter trick, and you've certainly familiarized yourself with the former one by lighting a match.

In addition, it's perfectly possible to have some of the particles in a given mass of matter at a higher temperature than the rest—in fact it's inevitable, since we have come to regard temperature as a measure of the kinetic energy of the particles and you never have a mass of material with all its particles moving at exactly or even nearly the same speed.

We seem to have two alternatives,

then. Either the high temperatures we seem to find in prominence and corona simply represent the tiny fraction of their atoms which would be moving that fast anyway, strictly according to probability, or some unexplained work is being done.

My lazy imagination makes a dash for the first alternative and has to be beaten off with a horsewhip. It just isn't so. There could not possibly be enough atoms at a million degrees, according to the observed behavior of gas clouds, to affect our instruments this far from the sun in the way they are affected. Hot as the general mass of gas may be and is, only a tiny, tiny percentage of its atoms could be that much hotter; and that tiny percentage would not make itself known in the "noise" of their more conservative fellows. No, somehow, somewhere, work is being done.

For three centuries now whenever there was evidence of work being done in the cosmos, the astronomer has thought of gravity. Work involves force and distance; and what other force is there? What else is holding the planetary system and the star clusters and the galaxies together? What keeps us and the air we breathe and the water we sail over clinging to this mud speck we call the earth? And what, for that matter, makes it such a grim task for our rockets to get away from it? Celestial mechanics has been built on gravity; surely there's some way we can imagine for gravity to do the work which is being done here in the sun's atmosphere.

To a certain extent, there is. Parts of a few of the questions we have just asked can be explained by our old friend. A bubble of gas a little hotter than its surroundings, for example, will start rising because of gravity and if it rises into regions of lower and lower density it can reach supersonic speeds. That will set up shock waves whose compression effect can give us temperatures in the prominence category. (9)

If the convection bubble has, say, a millionth of the mass of the earth, and reaches a speed of eight or nine kilometers a second, it will have a kinetic energy comparable to that released in a solar flare; all we have to do is find a large, brick wall for the bubble to run into, and we can expect the energy to come out as heat. And right there, gravity has to move over. We can imagine a gravity field which would "brickwall" such a mass of gas near the surface of a white dwarf star, but most emphatically not anywhere near our own sun. I was tempted at this point to tell my imagination that his canvas was mostly blank instead of having just a few little gaps, but before I could get my mouth open he got his own blows in. Smeone must have told him that the best defense was an attack.

"All right!" he cut in. "I'll paint the rest of the canvas. Just get me the information. Let me know what forces are acting, and give me equations describing their behavior, and how much there is of everything, and I'll put da Vinci and Michelangelo in the shade. Just give me complete infor-

mation and I'll have the universe on canvas, not just this dinky little star."

Sneaky character. After all, it's *his* business to tell *me* what forces *might* be acting, so I can look for them after he's helped me design apparatus for the search. When I put this to him, though, he came back with, "What have I been doing all your life? You've been doing experiments yourself, and reading about other people's. You're familiar with a lot of forces; I've told you about 'em already. Now get to work with those observations and let me relax for a little while!"

And he's right, darn him. Back to the—no, not the lab and observatory, but the old textbooks. As he says, I've heard about a lot of forces already; let's see if they can be made to do this work before we try to find any brand new ones.

There seem to be four principal candidates: nuclear force (which may be a whole family of forces); electricity; magnetism; and the gravity we've already discussed.

Nuclear forces are certainly sufficient, as far as sheer intensity goes. In fact, it's no news in these pages that they probably account for the prime driving force of any star. Unfortunately the conditions which seem necessary to make them available for outside labor seem to be met in the cores of stars, not in their atmospheres. (Exception: If you're wearing a luminous-dial watch, there are a number of fifty billion degree particles on your wrist—some intense local heating supplied by work done by nuclear forces). It is, of course, conceivable that nuclear reactions stimulated by unknown means actually occur on the spot to turn a dark flocculus into a flare, but there seems no evidence just now for such an assumption and a good deal to be said against it. What we seem to need is less a prime source in the atmosphere than methods of transporting energy from core to surface, methods for storing it in some form at or near the surface, and methods for converting that stored energy quickly into other forms when conditions are right. Nuclear forces don't seem to fill the bill.

Gravity, at the other end of the line, has been pretty well disposed of already, but deserves another word or two. It's the feeblest of the forces, if one can really make comparisons on a common basis. Electricity, magnetism, and gravity all seem to be described adequately by the inverse square law—that is, the force each exerts can be expressed algebraically by $F=kXY/r^2$. While the X and Y terms are not really comparable, being mass in one case, charge in another, and pole strength in the third, the "k" term for gravity as the equations are usually used is far and away smaller than the "k" for either of the others. In more concrete terms, two nickels a thousand miles apart will exert a gravitational pull on each other of about 7×10^{-23} dynes; but if the positive and negative electric charges in a single nickel were separated by the same distance they would

attract each other with a force of about two thousand tons. (Those figures are rough, believe me; but a factor of something like 10^{32} is quite a difference even with a few slide rule errors.) Gravity, it should be plain, needs a lot of mass around before it can accomplish much; electricity doesn't.

The sun, of course, does have a tremendous amount of mass, but its gravity field is a nice, symmetrical, radially decreasing one except for very tiny percentage variations due to local differences in density in and around convection currents. If the equations we use to describe gravity are even roughly correct, its only contributions to solar phenomena are the core pressures which make nuclear reactions possible in the first place and the convection currents we've already mentioned.

Electric field, all things being equal, seem far more powerful at least potentially than gravitational ones. Like the latter, they are inverse square forces; unlike gravity, they come in two sorts. Ben Franklin noticed this, and decided that like sorts repelled each other and unlike sorts attracted, which was clever of him; but I wish he hadn't called the two sorts positive and negative. Have you ever tried to discuss electric fields with a batch of ninth graders who haven't really digested their first year of algebra? If only Ben had called them Red and Blue, or Pat and Mike . . .

But he didn't and we're stuck with plus and minus. That's really the principal fact about electric field interactions—Ben's rule mentioned above. Of course, we can find or set up a physical situation which will demand quite highbrow math for a numerical solution, but fundamentally kXY/r^2 tells the story. We've made some headway, though; we now have potentially a pushing force as well as a strictly pulling one.

The interaction of electric fields with magnetic ones, and of magnetic fields with each other, turns out to be a far more complex story, though. Perhaps this is why Hale, back in 1908, developed the healthy suspicion that to understand the sun and solar phenomena we would have to learn a lot about solar magnetic fields. He may also, of course, have been influenced by the decided resemblance —sometimes—of the solar corona to the typical high school diagram of the lines of force around a bar magnet. Whatever inspired him, he started a line of solar magnetic investigation which has continued both in astronomical observatories and physics laboratories down to the present.

A picture has been building up here, from the combined efforts of a lot of investigators and their imaginations. It is a different picture in many ways from the relatively simple, glowing, tornado-riddled ball of gas which my own imagination has just scraped off the canvas. It still has many blank areas, and will have for a long time yet; but what shows already is certainly interesting. To see it all clearly, though, I had to do just

what we said a little while ago; go back to my undergraduate days, dig out the old books, and bring my imagination with me. The lazy critter kicked about it, but he came, and neither of us regrets it.

Here's what we got—in words. Some day I may be able really to think and express myself in the far more terse and convenient language of higher math, but the day hasn't come yet.

Some of you have probably amused yourselves with a little gadget looking rather like a hockey puck which appears to have the laws of friction suspended at its lower surface. It skates merrily around a table top at the slightest push with no sign of wanting to slow down, until the little CO_2 bottle inside it runs out and the flow of gas from the central hole out over the lower surface stops. Perhaps you have tried to force the toy down into overall contact with the table by main strength; if so, you know what the word "slippery" really means. The slightest sideways push and off it goes. It's like trying to catch a drop of mercury.

A similar form of amusement in a high schol physics class is to get a couple of football players, arm each with a husky Alnico horseshoe magnet, match like poles on the magnets, and have the boys try to push them together. Once again, there is large resistance to compression but none to any sideward component. The boys keep skidding the poles out of line, and if they lose their tempers run some risk of bumping heads.

Seemingly, there is some analogy between a magnetic field and a mass of gas. Perhaps it is not a very close one; analogies can certainly be pushed too far—witness the effect of the Bohr solar-system atom on a generation of science fiction. One of my chemistry teachers enjoys pointing out that no analogy is perfect; if it were, it would be an identity instead. We'll keep our eyes open for weaknesses, then. One is obvious enough; if we turn one of the magnets over so that unlike poles match, they stick together. Comparing that attraction to a pair of Magdeburg hemispheres or even Bernouilli force would be straining things pretty badly.

Still, the analogy will have its uses. There is a force from a confined mass of gas, and from a magnetic field; both forces act over an area, so they furnish pressure; both forces can operate through a distance, so they can do work—one thing we need desperately to solve our solar problems. Both, therefore, involve *energy*.

Fundamental differences seem to lie in the fact that the gas pressure is nondirectional—it makes no difference where we bore a hole in a tank of compressed air; out it comes anyway—and will act on any matter whatever. Magnetism is highly directional and is very choosy about the sort of thing it pushes or pulls. In general, it is interested only in another magnetic field. Its action on an electric charge is explainable on the basis of the magnetic field the charge itself possesses, and its action on matter is a function of the latter's elec-

tronic structure and therefore its charge and magnetism. (4,5)

If we want to make sensible comparisons or even paint halfway realistic pictures of either gas cloud or magnetic field, we must be quantitative. How much energy is in field or cloud? Find or invent a formula—stop sniggering, Imagination—on the basis of reason or experiment or both. Which way does the force act? Find out by experiment, and express it with vectors. Words actually aren't enough, as we've already admitted, but they help; words like "volume" and "molecule" and "line of force." We can't help using these words in discussing this subject. The first two we probably understand fairly well—at least, hearing them probably flashes similar pictures in your mind and in mine; but just what is a line of force?

To most of us it's probably a pattern of iron filings formed on a piece of paper lying over a magnet—the thing our high school science teacher showed us some years back. To the mathematical physicist it's a symbolic convenience with little or no concrete picture behind it. Maxwell likened some of the properties of magnetism to a flow, but he made no attempt to explain what was flowing and certainly knew that it wasn't a very good analogy. When he talked about magnetic "flux" as being expressed by so many lines of force per unit area he certainly didn't mean to imply that there was magnetism-free space between the lines, though I've read science fiction stories whose authors seemed to think so. It must be those iron filings.

Whatever Maxwell and Faraday thought, they certainly regarded the lines simply as useful fiction. One could describe the behavior of magnetic fields by saying that the lines of force tend to shorten like stretched rubber bands, that they tend to repel each other, and that each line is a closed loop. The last fact is simply another way of saying that the line of force is so drawn that its tangent at any point gives the direction of the magnetic force vector at that point, and that magnetic fields as far as is known contain no discontinuities. There are lines going through *every* point in the field, even though the number of lines, by convention, is finite. Of course around the magnets our football players were using the field volume was so small that we could consider the lines packed in contact anyway (or at least, a certain sloppy imagination of my acquaintance could); but in the space between planets, and still more in the vaster spaces between the stars and galaxies, the temptation to spread the lines out and think of real gaps between them might get a little too strong.

I didn't say *empty* space, of course. We all know better than that. There's too much matter in space to call it empty, and too much of that matter is electrically charged for a magnetic field to treat it as empty. That is really why magnetic fields have become so interesting to astronomers.

While uncharged matter may be affected somewhat by magnetism, the real, prime problem is the interaction between magnetic fields and the charged gas clouds of varying densities which make up the stars, the cosmic rays, the aurora, the interstellar nebulae, and the solar wind that Isaac Asimov described here a few months ago. Just what do magnetic fields and plasmas—charged gas clouds—do to each other?

We have some laboratory evidence, and even some everyday experience, on that. Our plasma may be a group of hydrogen ions in a cyclotron or a group of relatively free electrons in the metal windings of an electric motor. In either case when the charged particles are forced to travel across lines of magnetic force they experience a sidewise kick—a thrust at right angles both to the lines of force and to the direction of motion of the particles. In the first case, the ions take up a spiraling motion in the field, since the push changes direction just as rapidly as the particles do; in the second, the electrons are confined to the limits of the wire and the force on them is transferred to the wire and thence to the armature, which obediently spins (remember that!).

These experiments, though, involve too many solids. What happens if the whole system is gas? Things might be a bit different. For one thing, how do we get electric currents in the spaces between stars? And with no electric currents how can we produce magnetic fields?

We've given away the answer to that one, of course. Space isn't empty. Ten atoms, even a thousand atoms, to the cubic centimeter may be a better vacuum than man has made yet; but if any significant fraction of those atoms are ionized then charge can travel. If a charge travels, there is an electric current and a magnetic field. There's no law requiring the charge to be wrapped in metal. There's no problem in ionizing atoms in space, either, particularly near stars. There are plenty of high energy quanta ready to blast electrons out of their snug potential wells even between galaxies, and once the electrons are loose they don't get back in a hurry at those densities. Inside a star the densities are higher but the supply of quanta is larger too, so we still have ions and electric currents. Conductivity is far better here because of the high ion concentration. The plasma is moving—we've already seen that, in the sun. There *have* to be magnetic fields.

Which may not leave us much better off, if we don't check the statement more directly. Once upon a time there had to be an edge to the world, and not too long ago whatever went up had to come down again. Merely saying what we said about leaves us with two crying needs—to observe directly those fields which "have to be" there, and to find a quantitative, checkable means of describing and predicting them and their behavior.

The latter can be accomplished in the laboratory, if you don't mind do-

ing your experiments on a small scale and extrapolating. Getting direct observational evidence is another story; so far our ability to explore space directly with magnetometers is sharply limited. Astronomers are used to this situation, of course. About all we've ever had to work with is light. We're a bunch of photon pinchers, putting every bit of radiation we can intercept through boot, thumbscrews and rack—pardon me, spectrograph, polarimeter, bolometer, interferometer, and whatever else our imaginations could dream up—in the effort to wring information from it. Then we plaster the poor thing up in a photographic emulsion and file it away until we can think of some new torture. But will all this technique, which was developed for photons, help us much in chasing down invisible magnetic fields?

The discipline will, anyway. Photons may not be of too much use here, but as we'll see they're far from being completely useless; and there *are* other things which reach us from outside. They arrive after being shaken, twisted, speeded up, slowed down, deflected, and generally mishandled by the very fields we want to study, because they are charged particles; it would be strange if a good collection of Imaginations couldn't get some understanding of the forces from their effects—soft soap, you'll notice.

These things which may, and as it turns out do, help so much are the *cosmic rays,* those viciously energetic arrivals from beyond which were so badly misunderstood for so long. There is still a chart on the wall in one of my classrooms which describes them as part of the electromagnetic spectrum with "wave length much shorter than gamma rays." That description isn't entirely wrong, at that; they do have a wave length. We know now that they are atomic nuclei, some of them at least coming from solar flares—particles down in that strange, foggy land of physics where the distinction between wave and particle grows hazy. They have a wave length, and it is certainly short by gamma ray standards, for wave length is inversely proportional to energy and some cosmic rays arrive with energies of ten billion billion—ten to the nineteenth power—electron volts. That, packed into a single atom, is energy of motion which my six- and seven-year-old sons would have some trouble pushing into a thrown baseball. If our bodies could really stop such a particle, we'd feel it —would even be hurt by it.

Fortunately, we couldn't stop it; it would either sail through us unaffected or would strike a single atomic nucleus in our tissues, shattering it into fragments which would go on without our noticing them, carrying most of the original energy with them. That's what happens in the upper atmosphere. The new fragments collide with nuclei in their turn, and those with others, and what we finally detect on Earth is a shower of remote descendants of the original particle, as we've already seen. If we have instruments scattered thickly enough

over a large enough area of countryside to give us a fair sampling, we detect the suicide of the original cosmic ray by the practically simultaneous response of most or all of them. The number and energy of the responses and the area they cover gives us a reasonable estimate of the energy of the original particle.

Of course, particles of the ten billion bev variety aren't too frequent. If they were, we'd have a warm environment. Since temperature is average energy per particle it is perfectly reasonable to measure temperature in electron volts. In the room where I'm typing this article the temperature is about a fortieth of an electron volt per air molecule; there can't be a very large percentage of the whoppers described above. There are plenty of less violent ones coming in all the time, though, and the cosmic-ray flux is one of our sources of information about the magnetic fields in the space around our planet.

It's a little embarrassing to have to admit that it's almost the only source, too, as far as interplanetary space is concerned. Some of our satellites have carried magnetometric gear, but they haven't swept out a very large volume of space so far. Most of the rest of our magnetic information concerns the sun itself; and here our habits of photon pinching become useful once more. The spectroscope and some of its descendants have given us most of this information. (1, 9, 10, 15, 18, 21, 23)

Some of the information came from the ragged edge of the sensitivity limits of the early instruments, and the old, simple picture of the solar magnetic field is another one that Imagination has had to scrape almost to the canvas. This consisted of a fairly uniform field rather similar to the earth's and about twice as strong —say, a little over a gauss—detectable as might be expected principally in high latitudes. There were local irregularities; a suspicion of higher strength around the rice grains and definite, powerful concentrations around sunspots and sometimes areas not marked by spots. These sometimes ran up to several thousand gauss. The main field was directed oppositely to that of the earth; that is, the pole near the sun's north pole of rotation was a north magnetic pole. The spots were usually bipolar, with the leading spot "north" in one hemisphere and "south" in the other. This latter situation reversed with each roughly eleven-year half cycle of sunspot activity.

In the last few years instrument sensitivity has improved enormously. We can now make magnetic maps of the sun in a few minutes practically automatically, rather than by laboriously plotting the results of scores or hundreds of individual measures on different parts of the solar disk. The result is a much more nearly continuous, and incomparably more accurate and complete, coverage of solar magnetic phenomena. The changes in our picture are mostly, as might be expected, in the weak parts of the solar field; the sunspot story remains about the same. (10)

It seems that the general field of the sun is weaker than was supposed. It is also less uniform. Concentrations running up to twenty gauss or so seem to be associated with faculae; much stronger ones, as noted, with sunspots. Both of these are bipolar fields—every north pole has a fairly close south one. Each such region seems to undergo a regular cycle of development, starting small and weak, expanding and intensifying for a time, then expanding further but growing weaker and finally dying out.

In addition, there are rare but definite unipolar regions, areas where a north or south pole can be detected without its normal opposite number in the neighborhood. The presumption is that the emerging lines of force return to close their loops somewhere, but the area of return is so large that the field strength—"lines per square centimeter"—is too low to detect. So says my conservative imagination, anyway; maybe there really *are* magnetic discontinuities, though.

A similar phenomenon has occurred during the last few years with the general field. In 1957 the field in the southern hemisphere of the sun reversed polarity, while that in the northern hemisphere did not. The general field appeared for a while to have two north poles—admittedly very weak ones. The northern field didn't get around to reversing until late in 1958. The imagination when asked to picture the detailed solar field between those two times simply sneered. "It was a time of sunspot maximum," he pointed out, "and with all those strong fields in the equatorial regions why worry about a few lines of force from the poles. Maybe each south sunspot pole was a trifle stronger than its partner, or maybe one or two of them took on the whole job." He wouldn't say any more, and I still can't see clearly a picture of any individual solar magnetic force line for January, 1958. However, until instruments get sensitive enough to prove me wrong, I'll still believe that every line of force which leaves the sun gets back to it somewhere and closes its loop inside.

So much for direct observation. We do have in the sun some well observed fields not only complex at any given time but tending to undergo complex and sometimes quite rapid changes. Can we duplicate this situation in the laboratory closely enough to justify the feeling that we really know what's going on?

Well, it's easy enough to change the direction of a line of force. That happens with each iron filing we drop into the field of our high school display magnet, though that's not very obvious. If we have a few larger bits of iron among the filings, though—or a single iron nail—it becomes obvious enough. If we put another magnet near the first one, it becomes even more so. Lines of force don't seem very rigid.

But they're not completely flexible, either. A small magnet in the field of a large one moves, if it's free to move; is turned until its own lines

of force create the least possible disturbance of those belonging to its big brother—until, in fact, the two fields merge indistinguishably and a good many of the lines of force thread their way through both magnets. An entire field can be moved, too; the sun's and earth's fields travel with them, and our football players could play catch with their magnets if we asked them to. The fields would certainly go along with the magnets.

But will moving *gases* carry magnetic fields with them? The answer to that question is not exactly self-evident, but it's one we can check in the laboratory. When charged gases and magnetic fields occupy the same space, but have different motion, which wins? Or is there some complex interaction with nobody winning?

The answers to these questions lie in a relatively new discipline, or hybridization of disciplines, which has been named magnetohydrodynamics. Like geophysics and biochemistry it is an application of the techniques of one field of study to the problems of another; in this case perhaps the synthesis is more complete than in the others. Biochemistry is certainly chemistry applied to biological problems more than it is biology applied to chemical problems, but magnetohydrodynamics cannot so easily be described as electromagnetic equations applied to the gas laws or van der Waals equations applied to magnetic fields, or even as both with any degree of completeness. Like most disciplines which include the term "dynamics" in their title this one is highly quantitative and its laws are best expressed mathematically, often in nasty things like differential equations. It's possible to express some of its facts and conclusions in words, of course; it's also possible to tell an orchestra how to play "Tannhaüser" without using written music, but the task would not be worth the effort as long as there were people around who could read music. In scientific matters it has become very worth while to make the comparable attempt of explaining an inherently mathematical subject without the mathematics. That's what I'm doing here, and anyone who thinks I'm trying to cover my ignorance of the math in question is wrong. I'm admitting it.

Roughly, the experimental and theoretical results seem to agree on the following answer to the questions we asked a moment ago. The field and the charged cloud *do* interact. There is no simple situation in which one stays put and the other gets pushed around, though we can sometimes approximate one. Each offers some resistance to being moved; each exerts a displacing force on the other—which in turn reacts on itself.

For the gas—or for that matter a liquid or a solid—the resistance is of course its inertia. (Doesn't it feel nice to have a familiar name for something, even if we don't know what it is?). The gas' ability to impart energy to something else depends on its own energy density—

that is, the "concentration" both of thermal energy, which is the random kinetic energy of the particles composing it and whose concentration can be called temperature, and of the overall energy of motion. That is, if a meteor or gas cloud is traveling at five hundred kilometers per second with respect to a magnetic field and has a temperature of a thousand degrees Kelvin, both the temperature and the speed are relevant.

For the magnetic field, the equivalents of inertia and energy density are harder to picture in familiar terms, which may not mean that we know any less about them. They depend on field intensity, which seems reasonable, but not in a simple way; the energy density of a magnetic field—the measure of the work which can theoretically be accomplished by destroying the field—is proportional to the *square* of the concentration of the lines of force per unit area. That may not be too startling; kinetic energy, after all, is proportional to the square of the velocity for matter.

The field and the plasma can do work on each other—can transfer energy, in other words—when the relative motion is at right angles to the lines of force. This we already know from our high school toy motors. The energy transfer involves a displacement of charge in the plasma; in other words, an electric current is set up at the expense of the kinetic energy of the cloud, of the magnetic field, or of both. If the matter involved can't conduct an electric current, it will accept no energy from the magnetic field. That's old hat to science-fiction lovers; the magnetic shields of spaceships have always been admitted to be useless against stone meteors. Theoretically, a substance of perfect conductivity would absorb all the energy from a field which tried to cross it, and would therefore be a perfect shield against magnetic force (Also the perfect shield against any electromagnetic radiation).

Even conductors which are merely "good" can take a good deal of energy in interacting with a field. Our electric generators make use of this fact, and it has shown up in other surroundings. In attempts to set up very intense magnetic fields during research projects, one technique has involved single-turn coils. These are essentially sections of thick-walled conducting pipe with a slot down one side. Electric potential applied at one edge of the slot runs a current around the wall of the pipe to the other edge. If a good, healthy jolt is applied, as by unloading a roomful or two of condensers, a very intense, though very brief, magnetic field is established. In the ten microseconds or so that a million-gauss field lasts in such a system, funny things can happen to the "coil." The field is trying to expand through the conducting metal, and naturally tends to induce a current in the process; by Lenz' Law, the current in turn sets up a field which tends to oppose the

one generating the current. The two fields exert pressure on each other which in effect is a pressure on the inside of the pipe. (I told you to remember that motor.) The pressure depends on the magnetic field energy, which depends on the square of the field intensity, as we said. At a million gauss, the pressure far exceeds the mechanical strength of the pipe, and the latter survives at all only because of its inertia. Ten microseconds just isn't long enough to destroy a chunk of metal that big even with as much energy as the field has. However, the inside dimensions of the pipe may increase noticeably, and there may be some melting of the inner surface as some of the energy shows up as random particle motion—heat. A way out of this might be to use a poor conductor for the pipe; but then the capacitor bank couldn't send such a big current through it and the field wouldn't reach the desired intensity. It's the good old vicious circle which researchers spend so much time and imagination breaking out of. (7)

Ionized gases, of course, will offer far less inertial resistance to magnetic pressure than will solids, since as a rule they are far less dense. In general, in this battle between gas and field to control the motion of both, the energy densities of the two are the deciding factor. If they differ greatly, it may be possible to treat the stronger one as the "immovable object" for approximate solutions to problems. If they are equal or nearly so, the full complexity of the magnetohydrodynamic equations of state comes into play and the problem may not be solvable by current mathematical techniques.

There are some steady-state solutions, as it happens; situations where the various forces are in equilibrium and a physical picture is fairly easy to see. Some of the solar picture, happily, fits into one or another of these; much of it, inevitably, does not. Some of the picture outside the sun, and possibly some well inside it, fits the "approximate" situation where one factor overwhelms the other. Let's get back to the picture, and start Imagination swinging his brush again. He's been letting Memory do the work long enough.

It turns out that in and for some thousands of miles above the photosphere the concentration of ions, and hence the conductivity, are high. So, to put it mildly, is the thermal energy of the gas; and so, at least in "active" regions, is the magnetic field intensity. No approximations here. The energies involved are high enough so that gas and field are pretty thoroughly glued together. Where one goes, at least in directions at right angles to the line of force, there goes the other—of course the gas can travel *along* the lines of force easily enough. Just which is the prime mover in a given case is apt to be a hen-and-egg problem. Like the hen-and-egg problem the answer may well lie in some form of evolution, of energy forms rather than life.

In the outer corona, at the dis-

tance of the earth, the situation has changed. With the most favorable assumptions, the magnetic field strength can hardly exceed a ten millionth of what it was near the sunspot, with its energy density down by the square of that factor. The gas has lost some density, but not so much as the field; it's down to, say, a hundred atoms per cubic centimeter against something like thirty million in the inner corona. Unless the temperature has dropped by a factor comparable to that of the field strength, then, the gas is going to hold the whip; and the temperature *hasn't* dropped.

Sure, the black body temperature —the radiation equilibrium temperature of the hypothetical perfect radiator—at the earth's distance from the sun is only about a twentieth of what it is at the photosphere; but who said this gas was in radiational equilibrium? It isn't. Gases at a density of a hundred atoms per cubic centimeter don't radiate as black bodies; they're not enthusiastic about radiating at all. Furthermore, this gas is the solar wind, with an outward velocity of around five hundred kilometers a second; how about that kinetic energy? No, we still have to credit this stuff with a temperature of several thousand degrees, if we're trying to estimate its energy density relative to that of the magnetic field. In that case, the gas is the dominant partner by a factor of something like a million. The sun's field isn't going to deflect the wind to any extent. On the contrary, the solar wind is blowing the lines of force radially outward until an honest diagram of them might be mistaken for a picture of the sun's *gravitational* force lines.

That doesn't go on forever, of course. We're still pretty sure that somehow, somewhere beyond the earth's orbit, perhaps after going through all sorts of hard-to-imagine twists and loops as the solar wind finally breaks up into eddies, the lines maintain their reputation for endlessness, sneak back across the sun's equatorial plane, straighten out as they head into the wind again, and finally dive back into the energy source where they were born. Can we check on this? Yes, rather shakily. (6)

A while ago we mentioned that cosmic rays, which are charged particles which have run the gantlet of whatever magnetic fields there might be out there, might carry some information about their vicissitudes down to us. We can observe for a particular cosmic ray its direction, its energy, and its mass—that is, we can identify the type of nucleus on the atomic weight scale. (Correction: we can't get all this information about the *same particle* as a rule, but if there are enough particles we're all right.) Generally, the things turn out to be protons; most of the ones that aren't are alpha rays —helium nuclei. About one per cent of the total are heavier species, running about up to iron. This fits reasonably well with the universe's population of atoms, we think.

But devoting our attention to the first two factors, speed and direction, what can we learn? Let's remember our solar flare—the one we watched with our imaginations a while ago. The one that released the energy of about ten trillion Hiroshima type fission bombs.

This is about equal to the total energy output of the sun's surface in two fifths of a second. Admittedly, it took the flare over two thousand seconds to unload all this energy; something like ten thousand times as long in something like a ten thousandth of the radiating area. The flare was practically a second sun. More interesting, that load of energy was more than exists as heat at any one time in the entire region outside the photosphere—chromosphere and corona combined; and in any case, there's not the slightest evidence that either chromosphere or corona were being drained of heat to feed the flare. However:

Ten to the thirty-third power ergs is *not* more energy than can exist in (a) a volume of magnetic field of the size and intensity normally found in sunspot regions, or (b) as was mentioned earlier, the kinetic energy of a quantity of gas a millionth the mass of the earth traveling at less than ten kilometers per second. If we could dream up a mechanism which would cause the sudden collapse of such a magnetic field, we might have our flare problem solved; but perhaps we don't even need to do that. Remember our need for a brick wall in front of that rising convection bubble? Imagination is positively rubbing his hands with glee; because that bubble must be largely ionized. It's no trouble at all for him to dream up an arch of magnetic force lines connecting the two poles of a sunspot or other active area, and part of that arch just has to be horizontal. The field has energy comparable to the bubble; and there is the brick wall. The gas slams into the arch—possibly even guided into it by the more vertical parts of the field—and is abruptly decelerated and compressed. The field is stretched upward like a spider web under the impact of a bumblebee; and the imagination winces again. One forty-kiloton bomb was loud enough; a trillion hydrogen bombs are in a different league.

Of course, there's a catch or two. A flare, according to this picture, ought to be slowing down as we watch it; but things don't always work that way. In at least one case, a knot of material some twenty thousand miles in diameter speeded up in its outward flight from about sixty to about seven hundred miles a second within two minutes. (17) Even though this represents some sort of record performance, abrupt accelerations do occur quite often. If we are to make this general idea work, we'll have to assume a few complications. Maybe the original bubble or cell is complex in structure—not at all unlikely—or maybe some of the energy cycles back and forth between magnetic and kinetic. Maybe we'd better go partly or en-

tirely to the other idea—that the field itself collapses partly or entirely and contributes its own energy to the phenomenon. All these possibilities are harder to check, since they do *not* represent steady-state solutions of the magnetohydrodynamic equations of state.

One such solution does help a little, though. It gives a picture of the arches we have just hypothesized, with a slight sag at the top; and resting in the sag like a sailor in a hammock is a great mass of ionized gas —a "quiescent" prominence or flocculus. We can at least "set up" mathematically for the impact we'd like. The inertia of this flocculus would contribute to the brick wall effect.

Things are encouraging so far. There seems at least reasonable chance of tying observed phenomena in with theory. Maybe if we check observations in other directions our luck will continue. Let's try the cosmic rays, since the optical observations were propitious.

About ten minutes after the flare started—or rather, was observed to start—high energy particles began to be detected on the earth. During the next ten minutes or so, when the visible aspect of the flare had reached its peak and was already subsiding, particles of gradually smaller energies continued to arrive from the general direction of the sun.

As time went on, though, the arrival directions began to scatter more and more widely; and by three quarters of an hour after the onset of the flare, when it was about over as far as optical observation was concerned, protons were arriving just about equally from all parts of the sky. It took fifteen or twenty hours for the cosmic ray count to drop back to normal, and during nearly all of this time there was not the slightest evidence that the particles were coming from the sun—or any other specific source.

It *seems* as though the first particles ripped their way to us without being bothered by any fields on the way. With energies—velocities, remember—able to get them here in less than twenty minutes that's not too startling. The next, slightly less energetic arrivals could have been scattered by the strong magnetic fields close to the sun, giving a "foggier image" of their source. Then, finally, material of widely varying energies came from all directions, like light to the eyes of a mosquito inside a frosted glass lampshade. It does indeed look as though the flying protons had tangled with randomly oriented, twisted magnetic fields somewhere beyond the earth, had been deflected in all possible directions including the ones toward our instruments, and had gradually filtered on into extra-solar space over a period of a dozen or two hours.

Other pictures are always possible, of course; of fields concentrated near sun and again near earth with little or no magnetism in between; or fairly concentrated radial tongues of

field instead of the general, low-density radial distribution; or even extra-large, low density arches similar to those we've pictured over sunspot extending far out into the solar system. At the moment, the one we've pictured seems most nearly right, but one flare isn't much to generalize from.

Of course, there have been a good many flares observed; they are far from rare, though the really impressive "class 3" exhibits aren't too frequent. The general picture secured from these agrees with the one we've just painted, but details vary from flare to flare.

The highest energies among the flare particles seem to be in the ten to one hundred billion electron volt range; the really hot end of the cosmic ray spectrum apparently originates elsewhere. At the moment, it seems unlikely that it originates inside the solar system at all; but of course, there are magnetic fields outside the solar system, too.

So far, Imagination's picture has extended from just below the photosphere of the sun to some unknown but probably not very great distance beyond the earth's orbit, with a casual admission that things went on farther outside, and lip service to the fact that the whole business really originates farther *in*side. The time seems to have come to make our tame artist dig a bit deeper.

For that he needs mathematical tools, since there is no direct observational help. That's all right; he's been down there before with the gas laws to help. That time he came back with the now familiar picture of a gas sphere steadily increasing in temperature, pressure, and density toward the center, finally reaching conditions where hydrogen fusion could go on at a rate sufficient to maintain the observed energy output. He didn't pay any attention to such details as magnetism on that trip, but that's all right. He can take the same canvas with him and just add details. Maybe.

For this trip the mathematical equipment will have to be the magnetohydrodynamic equations of state, and we can hope some of the steady state conditions apply—after all, the sun isn't *too* variable a star. There's a chance.

And, it turns out, quite a good one. We don't have the whole story yet, because he's still down there digging; but an interim sketch he's sent back is very hopeful.

It shows a pair of torus-shaped magnetic fields circling the sun below the photosphere, rather like a pair of bicycle tires, one in each hemisphere, parallel—more or less—to the equator. One is directed eastward and one westward around the star. Convection currents tend, of course, to cut across these fields; and as we've seen, this can not only slow down the currents but move the fields. At times, loops of the field are actually carried up through the photosphere, forming the arches whose existence we've already suspected; the arches, as we've seen, may be

squashed a bit by charged material settling on top, and thus form pockets to hold up some types of prominence.

The supersonic convection bubbles which heat the prominences seem to fit this picture; and such a bubble rising in a region where the toroidal field has already been lifted above the photosphere could get more than the usual supply of kinetic energy before finally encountering the field. This point, of course, is *not* a steady state and the mathematical situation is more than a little shaky; but it looks reasonable. The imagination, which has finally learned some caution, is now calling this a "constructive daydream."

This seems a rather unsatisfactory and incomplete state to leave the picture in, but it's all that can be done for now. It's almost like current history, really. Someone who has been the indisputed top for a long time—undisputed among a certain group, anyway—suddenly finds that he's not alone. American technology in the mind of the average American suffered that blow when the first Sputnik went into orbit; now it's being suffered by the old master of celestial mechanics, gravity. Move over, brother. We know you, and you've been a pretty good boss, but the books aren't balancing any more and the work isn't getting done.

Even beyond the little bubble of space and time which is the Solar system of right now, the need for something besides gravity is being felt. All attempts to account for the spiral shape of some galaxies, including our own, by gravitational forces alone have proven unsatisfactory. Admittedly, no really good explanation in terms of magnetic fields has been forthcoming yet either; but there *are* magnetic fields of galactic scope. Quite a lot of the light scattered by interstellar dust is polarized in consistent fashion, indicating that the dust particles are oriented over distances of scores of light years; magnetic fields can do that and, offhand, nothing else we know of can.

Timewise, the old question of the origin of a planetary system remains in an unsatisfactory state. The dynamic encounter theories which had the planets torn from the sun in a near-collision of stars were pretty thoroughly disposed of in 1940 when Spitzer showed that if enough matter were torn out this way to form the planets it would have to involve such deep layers of the sun and therefore such high temperatures that it would explode rather than coalesce. This at least spared us the need to assume such an unlikely event as a star collision in the first place, but left us with the various accretion theories; the descendants of the old Kant-LaPlace nebular hypothesis. These have always suffered from an inability to account for the fact that about ninety-nine per cent of the Solar system's angular momentum resides in the planet Jupiter, while a corresponding fraction of the mass is in the sun. They also have been attacked on the grounds that rings of matter circling the sun

should not coalesce into planets, either—not just on the grounds that Saturn's rings don't, but on perfectly good mathematical arguments involving gravity and energy.

Gravity was disappointing there; but fairly recently Dr. Harold Urey reconsidered the accretion problem from another viewpoint. He is a chemist, and included chemical—essentially, electrical—forces. It was all very well to show clearly that two particles colliding in space will either bounce apart or shatter rather than stick together; but it becomes hard to believe if either or both particles happen to be *wet*.

And as far as angular momentum goes, why can't a rotating star, whose magnetic field is presumably rotating with it, start pushing ions in its vicinity sideways? It makes no difference whether the ions or the field is moving; ions have trouble cutting magnetic lines of force in either case. Couldn't a star with a good deal of gas in its neighborhood start swinging that matter around it, slowing its own spin down in consequence? It would be nice to believe it, especially for science-fiction writers, who need extra solar systems in their business and would like to see them as something normal.

In that connection, it seems at the moment that most of the stars hotter than about F5 in the spectral sequence have high rates of spin, while the cooler ones in general do not. There seems no obvious reason why a mass of gas too small to form a big, hot star would automatically have less spin than its fellows; if anything, the reverse should be true—at least, my science-fiction oriented imagination immediately points out that the *less* rapidly spinning gas clouds ought to be the ones which can collect *large* amounts of mass without having centrifugal problems. There is a widespread suspicion among astronomers that most stars start out with comparable amounts of spin, but that the later-than-F5 types have transferred theirs to nearby objects—just maybe, planets. The only obvious hitch in the whole matter is that one would expect the *hotter* stars, which presumably have more ionized matter around them from that very fact, would have more stuff to transfer their spin to.

I don't claim that's an insuperable obstacle to accounting for planetary systems magnetically, but it certainly is evident that a few more details will have to be clarified before anyone can justifiably say he knows how planets are formed.

For that matter, we don't know that all stars have magnetic fields. Some certainly do—some much stronger ones than the sun; one has recently checked in with what appears to be a general field of some forty-five thousand gauss (28). We'll have to learn a bit more, though, before we start applying magnetics-based theories to stars in general.

We've made one big forward step, though, if only in our habits of thought. It may be scientific to try

to reduce problems to only one variable at a time—in fact, it's about the only way to tell what is done by each variable. When we go back to actual problems, though, having learned about the separate factors, it behooves us to remember that there may be several factors acting at once. I won't insult the astronomical profession by saying that it had forgotten there were any forces but gravity; I know it hadn't. It is high time, though, that we made more use of what mathematical techniques there are for dealing with several variables at once. Electromagnetism and the gas laws have blended very nicely—now let's hybridize a few more fields of effort.

And let's, for goodness' sake, find some means of preventing students from being afraid of higher math. I'd like to be able to do some of those magnetohydrodynamic problems myself; and I very much doubt that I'll ever be able to. If you can find that method for overcoming algebrophobia, please use it on *me, now!*

References

References here come under three headings. In the first group are a number of relatively elementary texts which my imagination and I found we needed to bone up on fundamentals. Many others would have done; the ones we actually used were:

(1) "Astronomy," Robert H. Baker, 6th Ed., 1955, van Nostrand

(2) "Our Sun," Donald H. Menzel, Blakiston, 1950

(3) "Magnetism" article in *Encyclopedia Britannica,* vol. 14, p. 673B ff. 1956 ed.

(4) "Electricity and Magnetism," Gilbert, MacMillan, 1941

(5) "Electricity and Magnetism," E. R. Peck, McGraw-Hill, 1953

The second group consists of articles of fairly recent vintage, dealing with solar phenomena in general and magnetic and magnetohydrodynamic items in particular. These were:

(6) "Science in Space," Chapter VII (Published separately), Physics of Fields and Energetic Particles in Space. National Academy of Sciences—National Research Council, 1960

(7) "High Magnetic Field Research," Harold P. Furth, *Science,* Vol. 132, 12 Aug. 1960, p. 387ff.

(8) "Hot Spots in the Atmosphere of the Sun," Harold Zirin, *Scientific American,* August 1958, p. 34ff.

(9) "Some Advances in Solar Research," Donald H. Menzel, *Sky and Telescope,* August 1957, p. 415ff.

(10) "The Magnetism of the Sun," Horace W. Babcock, *Scientific American,* February 1960, p. 52ff.

(11) "Fraunhofer Lines and Heights in the Sun's Atmosphere," Orren C. Moehler, *Sky and Telescope,* April 1960, p. 124ff.

(12) "Indirect Detection of Solar Flares," P. J. Del Vecchio, *Sky and Telescope,* August 1959, p. 546ff.

(13) "Fast-Moving Disturbances on the Sun," G. E. Moreton, *Sky and Telescope,* March 1961 p. 145ff.

(14) "The Fine Structure of Solar Prominences," Donald H. Menzel, *Sky and Telescope,* November 1960 p. 252 and December, 1960, p. 330ff.

The remaining items are brief news reports, sometimes well illustrated, from *Sky and Telescope,* which seemed to fit the picture.

(15) "Solar Magnetic Fields" October 1954 p. 423

(16) "Origin of Solar Flares" June 1955 p. 321

(17) "Great Solar Explosion" July 1956 p. 398

(18) "Changes in Sun's Magnetic Field" Sept. 1958 p. 555

(19) "Solar Flare of May 10, 1959" August 1959 p. 544

(20) "Solar Radio Bursts" August 1959 p. 556

(21) "Observing the Solar Magnetic Field" August 1959 p. 557

(22) "Project Stratoscope" December 1959 p. 79

(23) "General Magnetic Field of Sun" January 1960 p. 147

(24) "Radio Storm in Sun's Corona" January 1960 p. 147

(25) "Flare Patrol Photographs" January 1960 p. 147

(26) "Flares of July 16, 1959" April 1960 p. 339

(27) "X-ray Photo of Sun" September 1960 p. 143

(28) "Intense Magnetic Field" March 1961 p. 131

(29) "Local Doppler Effects in Photosphere" April 1961 p. 210

(30) "X-rays from Solar Flare" April 1961 p. 212

Some, but by no means all, of these news items were abstracts of longer papers which were not available to me.

THE END

THE ANALYTICAL LABORATORY

September 1961

PLACE	STORY	AUTHOR	POINTS
1.	Sense of Obligation (Pt. 1)	Harry Harrison	1.64
2.	The Blaze of Noon	Randall Garrett & Avram Davidson	2.76
3.	Fifty Per Cent Prophet	Darrel T. Langart	3.04
4.	Modus Vivendi	Walter Bupp	3.23
5.	They Also Serve	Donald E. Westlake	4.33

The Editor.

Illustrated by van Dongen

SENSE OF OBLIGATION

By HARRY HARRISON

Third of Three Parts. Dis was an unlovely planet, inhabited by unlovely people, who had richly earned annihilation. Yet . . . for cause, it was necessary to save them against their will!

SYNOPSIS

BRION BRANDD is the new Winner of Anvhar. To gain this title he has placed first in all of the events of the Twenties. The Twenties are a complex series of physical and mental contests that dominate the life of this unusual planet, far from Earth. Each year there is only a single Winner of Anvhar. The man who gains this honor is esteemed above all others, and is ensured of his place in history.

Yet Brion is not happy. He has been contacted by IHJEL, himself a former Winner, who seems to care nothing for the title Brion has just battled so hard to gain. Ihjel uses projective empathy to convince Brion that both of them will be needed to do a particular job—that of saving the entire planet of DIS from destruction. In explaining this, Ihjel reveals that he is a member of a little-known organization—the CULTURAL RELATIONSHIPS FOUNDATION. The C.R.F. works with the new science of Societics to guide the now isolated and disrupted planets that were originally settled by Earth. Many of them have been cut off and forgotten during the wars that followed the breakdown of the Earth empire.

The C.R.F. is vitally interested in the planet NYJORD, where the colonists have developed an unusual culture that has vitality without violence. Nyjord is threatened by the warlike and repellent people of Dis, who promise atomic destruction unless Nyjord surrenders to them. Dis, though weak and poorly armed, seems to be suicidally bent on destruction. Nyjord must either destroy or be destroyed—and either alternative means the death of her unique culture.

Ihjel and Brion are going to Dis, in an attempt to stop the war. They are joined by LEA MOREES, an Earth girl with degrees in exobiology and anthropology. Her assistance is sure to be needed in solving the problem of the Disans, who have made a massive adaptation to their inhospitable planet. Dis is so barren and savage that the native life forms have joined together in complicated types of symbiosis. In order to survive, the human settlers have been forced to take part in these symbiotic relationships. There are strong indications that Lea's knowledge will be needed to uncover the reasons for the Disan's apparently suicidal drives.

They land on the planet and meet disaster. Instead of a welcoming party there is an ambush. Ihjel is killed and their transportation destroyed. Brion and Lea are alone in the desert, without food and water, in a barren waste where the temperature exceeds one hundred thirty degrees every day. Brion's resilient Anvharian physique adapts to the severe climate, but Lea succumbs to heat and shock.

There is no way to obtain water from the poisonous life forms. On the second day of carrying the girl, Brion is at the point of collapse. It is then that he meets a native Disan.

Using his latent empathetic ability that Ihjel had trained, Brion recognizes that the Disan wishes to be friendly in spite of his hatred of offworlders. The Disan, Ulv, reluctantly gives them water, still suspicious. Yet he appears to desire peace as much as Brion does. He leaves them alone, but promises to send aid.

Ulv does contact the C.R.F. and they are picked up. Lea is admitted to the Foundation hospital, and Brion unexpectedly finds himself in charge of the entire organization. Ihjel left orders that Brion was to be his successor in case of death. Morale is low and the workers are preparing to leave. Nyjord has delivered their ultimatum. Dis will be destroyed in three days unless the hidden launcher and cobalt bombs are surrendered. The Disans ignore the ultimatum. All of the other offworlders on Dis are leaving. Brion makes himself extremely unpopular with the C.R.F. people by insisting that they stay until the last possible moment—in spite of the danger.

Brion discovers that the Disans have two distinct classes. One class, to which Ulv belongs, forms the overwhelming bulk of the population. But they are ruled by a minority, the MAGTER. These are the people who insist on war. They appear to be led by LIG-MAGTE, a local overlord. The magter are different in every way from the other Disans. It is obvious now that the problem of stopping the war lies in making the magter drop their suicidal plans.

PROFESSOR - COMMANDER KRAFFT is in charge of the Nyjord space fleet blockading Dis. He tells Brion that a day must be dropped from the deadline time, since the Disans are almost ready to launch their bombs. There are just two days remaining before Dis will be destroyed. Brion takes this message to the magter, but they ignore it. In fact Lig-magte attacks him, and Brion is forced to kill in self-defense, barely escaping death himself.

Returning to the C.R.F. building he finds Lea working in the lab on samples of Disan life. He carefully outlines to her his theory that the magter are without emotions and inhumanly cold. This, combined with their different appearance and way of life, has convinced Brion that they are not human at all. He thinks they are aliens, hiding their differences in order to rule. Lea is less than enthusiastic about the idea, but agrees to examine one of the magter to prove the theory true or false.

There are only thirty-six hours left. Brion contacts the illegal commando raiders from Nyjord who are operating on Dis. Their leader, HYS, agrees to let Brion come along on their last raid on a magter castle. They are still looking for the Disan bombs—while Brion needs a corpse for Lea to examine. The raid is a success, although the magter counterattack in anger when they discover that a body has been taken away.

Returning to the city with TELT, one of the Nyjord commandos, takes a long time. They must use a round-

about route to avoid being followed. They arrive after dawn on the last day. To his horror, Brion discovers that the magter have made a savage attack during the night.

The building of the Cultural Relations Foundation has been completely destroyed. There appear to be no survivors. Lea and all of the C.R.F. people are dead.

Part 3

XIV

Life was ended. Brion's mind contained nothing but despair and the pain of irretrievable loss. If his brain had been complete master of his body he would have died there, for at that moment there was no will to live. Unaware of this his heart continued to beat and the regular motion of his lungs drew in the dreadful sweetness of the smoke-tainted air. With automatic directness his body lived on.

"What you gonna do?" Telt asked, even his natural exuberation stilled by this. Brion only shook his head as the words penetrated. What could he do? What could possibly be done?

"Follow me," a voice said in guttural Disan through the opening of a rear window. The speaker was lost in the crowd before they could turn. Aware now, Brion saw a native move away from the edge of the crowd and turn in their direction. It was Ulv.

."Turn the car—that way!" He punched Telt's arm and pointed. "Do it slowly and don't draw any attention to us." There was sudden hope, which he kept himself from considering. The building was gone and the people in it all dead. That fact had to be faced.

"What's going on?" Telt asked. "Who was that talked in the window?"

"A native—that one up ahead. He saved my life in the desert, and I think he is on our side. Even though he's a native Disan, he can understand facts that the magter can't. He knows what will happen to this planet." Brion was talking, filling his brain with words so he wouldn't begin to have hope.

Ulv moved slowly and naturally through the streets, never looking back. They followed, as far behind as they dared, yet still keeping him in sight. There were fewer people about here among the deserted offworld storehouses. Ulv vanished into one, LIGHT METALS TRUST LTD. the sign read above the door. Telt slowed the car.

"Don't stop here," Brion said. "Drive on around the corner, and pull up."

Brion climbed out of the car with an ease he did not feel. There was no one in sight now, in either direction. Walking slowly back to the corner he checked the street they had just left—hot, silent and empty.

A sudden blackness appeared where the door of the warehouse had been, and the sudden flickering motion of a hand. Brion signaled Telt to start, and jumped into the already moving sandcar.

"Into that open door—quickly before anyone sees us!" The car rumbled down a ramp into the dark interior and the door slid shut behind them.

"Ulv. What is it? Where are you?" Brion called, blinking in the murky interior. A gray form appeared next to him.

"I am here."

"Did you—" There was no way to finish the sentence.

"I heard of the raid. The magter called together all of us they could to help them carry explosives. I went along. I could not stop them and there was no time to warn anyone in the building."

"Then they are all dead—?"

"Yes," Ulv nodded, "all except one. I knew I could possibly save one, and I was not sure who. So I took the woman you were with in the desert, she is here now. She was hurt, but not badly, when I brought her out."

Guilty relief flooded through Brion. He shouldn't exult, not with the death of everyone in the Foundation still fresh in his mind. But at that instant he was happy.

"May I see her?" he asked Ulv. He was seized by the sudden fear that there might be a mistake. Perhaps Ulv had saved a different girl.

Ulv led the way across the empty loading bay. Brion followed closely, fighting down the temptation to tell him to hurry. When he saw that Ulv was heading towards an office in the far wall, he could control himself no longer and ran on ahead.

It was Lea, lying unconscious on a couch. Sweat beaded her face and she moaned and stirred without opening her eyes.

"I gave her *sover*, then wrapped her in cloth so no one would know," Ulv said.

Telt was close behind them looking in through the open door.

"*Sover* is a drug they take from one of their plants," he said. "We got a lot of experience with it. A little makes a good knock-out drug, but it's deadly poison in large doses. I got the antidote in the car, wait and I'll get it." He went out.

Brion sat next to Lea and wiped her face clean of dirt and perspiration. The dark shadows under her eyes were almost black now and her elfin face even thinner. Yet she was alive, that was the important thing. Some of the tension drained away and he could think again. There was still the job to do. After this last experience she should be in a hospital bed. Yet this was impossible. He had to drag her to her feet and put her back to work. The answer might still be found. Each second ticked away another fraction of the planet's life.

"Good as new in a minute," Telt said, banging down the heavy medbox. He watched intently as Ulv left the room."Hys should know about this renegade. Might be useful as a spy or for information. Of course it's too late now to do anything, so the hell with it." He pulled a pistol-shaped hypodermic gun from the box and dialed a number on the side. "Now, if you'll roll her sleeve up I'll bring

her back to life." He pressed the bell-shaped sterilizing muzzle against her skin and pulled the trigger. The hypo gun hummed briefly, ending its cycle with a large click.

"Does it work fast?" Brion asked.

"Couple of minutes. Just let her be and she'll come to by herself."

"Killer!" Ulv hissed from the doorway. His blowgun was in his hand, half raised to his mouth.

"He's been in the car—he's seen it!" Telt shouted and grabbed for his gun.

Brion sprang between them, raising his hands. "Stop it! No more killing!" he shouted this in Disan. Then he shook his fist at Telt. Fire that gun and I'll stuff it down your throat. I'll handle this." He turned to face Ulv who hadn't raised the blowgun any closer to his lips. This was a good sign. The Disan was still uncertain.

"You have seen the body in the car, Ulv. So you must have seen that it is that of a magter. I killed him myself, because I would rather kill one, ten or even a hundred men rather than have everyone on this planet destroyed. I killed him in a fair fight and now I am going to examine his body. There is something very strange and different about the magter, you know that yourself. If I can find out what it is, perhaps we can make them stop this war, and not bomb Nyjord."

Ulv was still angry, yet he lowered the blowgun a little. "I wish there were no offworlders, that none of you had ever come. Nothing was wrong until you started coming. The magter were the strongest, and they killed, but they also helped. Now they want to fight a war with your weapons and for this you are going to kill my world. And you want me to help you?"

"Not me—yourself!" Brion said wearily. "There's no going back, that's the one thing we can't do. Maybe Dis would have been better off without offplanet contact. Maybe not. In any case you have to forget about that. You have contact now with the rest of the galaxy, for better or for worse. You've got a problem to solve, and I'm here to help you solve it."

Seconds ticked by as Ulv, unmoving, fought with questions that were novel to his life. Could killing stop death? Could he help his people by helping strangers to fight and kill them? His world had changed and he didn't like it. He must make a giant effort to change with it.

Abruptly, he pushed the blowgun into a thong at his waist, turned and strode out.

"Too much for my nerves," Telt said, settling his gun back in the holster. "You don't know how happy I'm gonna be when this thing is over. Even if the planet goes bang, I don't care. I'm finished." He walked out to the sandcar, keeping a careful eye on the Disan crouched against the wall.

Brion turned back to Lea whose eyes were open, staring at the ceiling. He went to her.

"Running," she said, and her voice had a toneless emptiness that screamed louder than any emotion. "They ran by the open door of my room and I could see them when they

killed Dr. Stine. Just butchered him like an animal, chopping him down. Then one came into the room and that's all I remember." She turned her head slowly and looked at Brion. "What happened? Why am I here?"

"They're . . . dead," he told her. "All of them. After the raid the Disans blew up the building. You're the only one that survived. That was Ulv who came into your room, the Disan we met in the desert. He brought you away and hid you here in the city."

"When do we leave?" she said, in the same empty tones, turning her face to the wall. "When do we get off this planet?"

"Today is the last day. The deadline is midnight. Krafft will have a ship pick us up when we are ready. But we still have our job to do. I've got that body. You're going to have to examine it. We must find out about the magter—"

"Nothing can be done now except leave," her voice was a dull monotone. "There is only so much that a person can do and I've done it. Please have the ship come, I want to leave now."

Brion chewed his lip in helpless frustration. Nothing seemed to be able to penetrate the apathy she had sunk into. Too much shock, too much terror, in too short a time. He took her chin in his hand and turned her head to face him. She didn't resist, but her eyes were shining with tears, tears trickled down her cheeks.

"Take me home, Brion, please take me home."

He could only brush her sodden hair back from her face then and force himself to smile at her. The particles of time were running out, faster and faster, and he no longer knew what to do. The examination had to be made. Yet he couldn't force her. He looked for the medbox and saw that Telt had taken it back to the sandcar. There might be something in it that could help. A tranquilizer perhaps.

Telt had some of his instruments open on the chart table and was examining a tape with a pocket magnifier. He jumped nervously and put the tape behind his back when Brion entered, then relaxed when he saw who it was.

"Thought you were the creepie out there, coming for a look," he whispered. "Maybe you trust him—but I can't afford to. Can't even use the radio. I'm getting out of here now, I have to tell Hys!"

"Tell him what?" Brion asked sharply. "What is all the mystery about?"

Telt handed him the magnifier and tape. "Look at that. Recording tape from my scintillation counter. Red verticals are five-minute intervals, the wiggly black horizontal line is the radioactivity level. All this where the line goes up and down, that's when we were driving out to the attack. Varying hot level of the rock and ground."

"What's the big peak in the middle?"

"That coincides exactly with our visit to the house of horrors! When

we went through the hole in the bottom of the tower!" He couldn't keep the enthusiasm out of his voice.

"Does it mean that—"

"I don't know. I'm not sure. I have to compare it with the other tapes back at base. It could be the stone of the tower, some of these heavy rocks got a high natural count. There maybe could be a box of instruments there with fluorescent dials. Or it might be one of those tactical atom bombs they threw at us already, some arms runner sold them a few."

"Or it could be the cobalt bombs?"

"It could be," Telt said, packing his instruments swiftly. "A badly shielded bomb, or an old one with a crack in the skin, could give a trace like that. Just a little radon leaking out would do it."

"Why don't you call Hys on the radio, let him know."

"Don't want Grandaddy Krafft's listening posts to hear about it. This is our job—if I'm right. And I have to check my old tapes to make sure. But it's gonna be worth a raid, I can feel that in my bones. Let's unload your corpse." He helped Brion, then slipped into the driver's seat.

"Hold it," Brion said. "Do you have anything in the medbox I can use for Lea. She seems to have cracked. Not hysterical, but withdrawn. Won't listen to reason, won't do anything but lie there and ask to go home."

"Got the potion here," Telt said, cracking the medbox. "Slaughter-syndrome is what our medic calls it. Hit a lot of our boys. Grow up all your life hating the idea of violence, it goes rough when you have to start killing people. Guys breakup, breakdown, go to pieces lots of different ways. The medic mixed up this stuff. Don't know how it works, probably tranquilizers and some of the cortex drugs. But it peels off recent memories. Maybe for the last ten, twelve hours. You can't get upset about what you don't remember." He pulled out a sealed package. "Directions on the box. Good luck."

"Luck," Brion said, and shook the technician's calloused hand. "Let me know if the traces are strong enough to be bombs." He checked the street to make sure it was clear, then pressed the door button. The sandcar churned out into the brilliant sunshine and was gone, the throb of it's motor dying in the distance. Brion closed the door and went back to Lea. Ulv was still crouched against the wall.

There was a one-shot disposable hypodermic in the box. Lea made no protest when he broke the seal and pressed the needle against her arm. She sighed and her eyes closed again. When he saw she was resting easily, he dragged in the tarpaulin-wrapped body of the magter. A workbench ran along one wall and he struggled the corpse up onto it. He unwrapped the tarpaulin and the sightless eyes stared accusingly up into his.

Using his knife, Brion cut away the loose, bloodsoaked clothing. Strapped under the clothes, around the man's waist, was the familiar collection of Disan artifacts. This could have significance either way. Human or humanoid, it would still have to live on Dis. Brion threw it aside, along with the rest of the clothing. Nude, pierced, bloody, the corpse lay before him.

In every external physical detail the man was human.

Brion's theory was becoming more preposterous with each discovery. If the mager weren't alien, how could he explain their complete lack of emotions? A mutation of some kind? He didn't see how it was possible. There *had* to be something alien about the dead man before him. The future of a world rested on this flimsy hope. If Telt's lead to the bombs proved to be false, there would be no hope left at all.

Lea was still unconscious when he looked at her. There was no way of telling how long the coma would last. He would probably have to waken her out of it, but didn't want to do it too early. It took an effort to control his impatience, even though he knew the drug needed time to work in. He finally decided on at least a minimum of an hour before he should try to disturb her. That would be noon—twelve hours before destruction.

One thing he should do was get in touch with Professor-Commander Krafft. Maybe it was being defeatist, yet he had to make sure that they had a way off this planet if the mission failed. Krafft had installed a relay

radio that would forward calls from his personal set. If this relay had been in the Foundation building, contact was broken. This had to be found out before it was too late. He thumbed on his radio and sent the call. The reply came back instantly.

"This is fleet communications. Will you please keep this circuit open? Commander Krafft is waiting for this call and it is being put directly through to him now." Krafft's voice broke in while the operator was still talking.

"Who is making this call—is it anyone from the Foundation?" The old man's voice was shaky with emotion.

"Brandd here. I have Lea Morees with me—"

"No more? Are there no other survivors from the disaster that destroyed your building?"

"That's it, other than us it's a . . . complete loss. With the building and all the instruments gone I have no way to contact our ship in orbit. Can you arrange to get us out of here if necessary?"

"Give me your location, a ship is coming now—"

"I don't need a ship now," Brion interrupted. "Don't send it until I call. If there is a way to stop your destruction, I'll find it. So I'm staying—to the last minute if necessary."

Krafft was silent. There was just the crackle of an open mike and the sound of breathing. "That is your decision," he said finally. "I'll have a ship standing by. But won't you let us take Miss Morees out now?"

"No. I need her here. We are still working, looking for—"

"What answer can you find that could possibly avert destruction now?" His tone was between hope and despair. Brion couldn't help him.

"If I succeed—you'll know. Otherwise, that will be the end of it. End of transmission." He switched the radio off.

Lea was sleeping easily when he looked at her, and there was still a good part of the hour left before he could wake her. How could he put it to use? She would need tools, instruments to examine the corpse, there were certainly none here. Perhaps there were some he could find in the ruins of the Foundation building. With this thought he had the sudden desire to see the wreckage up close, and talk to the men he had seen working there. There might be other survivors. He had to find out.

Ulv was still crouched against the wall in the outer room. He looked up angrily when Brion came over, but said nothing.

"Will you help me again?" Brion asked. "Stay and watch the girl while I go out. I'll be back at noon." Ulv didn't answer. "I am still looking for the way to save Dis," Brion said.

"Go, I'll watch the girl!" Ulv spat the words in impotent fury. "I do not know what to do. You may be right. Go. She will be safe with me."

Brion slipped out into the deserted street and half running, half walking, made his way towards the rubble that had been the Cutural Relationships Foundation. He used a different

course than the one they had come by, striking first towards the outer edge of the city. Once there he could swing and approach from the other side, so there would be no indication where he had come from. The magter might be watching and he didn't want to lead them to Lea and the stolen body.

Turning a corner he saw a sandcar stopped in the street ahead. There was something familiar about the lines of it. It could be the one he and Telt had used, but he wasn't sure. He looked around, but the dusty, packed-dirt street was white and empty, shimmering in silence under the sun. Staying close to the wall and watching carefully, Brion slipped towards the car. When he came close to the rear tracks he was positive it was the one he had been in the night before. What was it doing here?

Silence and heat filled the street. Windows and doors were empty and there was no motion in their shadows. Putting his foot on a bogey wheel he reached up and grabbed the searing metal rim of the open window. He pulled himself up and stared at Telt's smiling face.

Smiling in death. The lips pulled back to reveal the grinning teeth, the eyes bursting from the head, the features swollen and contorted from the deadly poison. A tiny, tufted dart of wood stuck innocently in the brown flesh on the side of his neck.

XV

Brion hurled himself backward and sprawled flat in the dust and filth of the road. No poison dart sought him out, the empty silence still reigned. Telt's murderers had come and gone. Moving quickly, using the bulk of the car as a shield, he opened the door and slipped inside.

They had done a thorough job of destruction. All of the controls had been battered into uselessness, the floor was a junk heap of crushed equipment, intertwined with loops of recording tape bulding like mechanical intestines. A gutted machine, destroyed like its driver.

It was easy enough to reconstruct what had happened. The car had been seen when they entered the city—probably by some of the magter who had destroyed the Foundation building. They had not seen where it had gone, or Brion would surely be dead by now. But they must have spotted it when Telt tried to leave the city. And stopped it in the most effective way possible, a dart through the open window into the unsuspecting driver's neck.

Telt dead. The brutal impact of the man's death had driven all thought of its consequences from Brion's mind. Now he began to realize. Telt had never sent word of his discovery of the radioactive trace to the Nyjord army. He had been afraid to use the radio, and had wanted to tell Hys in person, and to show him the tape. Only now the tape was torn and mixed with all the others, the brain that could have analyzed it dead.

Brion looked at the dangling entrails of the radio and spun for the

door. Running swiftly and erratically he fled from the sandcar. His own survival and the possible survival of Dis depended on his not being seen near it. He must contact Hys and pass on the information. Until he did that he was the only offworlder on Dis who knew which magter tower might contain the world-destroying bombs.

Once out of sight of the sandcar he went slower, wiping the sweat from his streaming face. He hadn't been seen leaving the car, and he wasn't being followed. The streets here weren't familiar, but he checked his direction by the sun and walked at a steady fast pace towards the destroyed building. More of the native Disans were in the streets now. They all noticed him, some even stopped and scowled fiercely. With his emphatic awareness he felt their anger and hatred. A knot of men radiated death and he put his hand on his gun as he passed them. Two of them had their blowguns ready, but didn't use them. By the time he had turned the next corner he was soaked with nervous perspiration.

Ahead was the rubble of the destroyed building. Grounded next to it was the tapered form of a spacer's pinnace. Two men had come from the open lock and were standing at the edge of the burnt area.

Brion's boots grated loudly on the broken wreckage. The men turned quickly towards him, guns raised. Both of them carried ion-rifles. They relaxed when they saw his offworld clothes.

"Savages," one of them growled. He was a heavyplanet man, a squashed down column of muscle and gristle, whose head barely reached Brion's chest. A pushed-back cap had the crossed-sliderule symbol of ship's computer man.

"Can't blame them, I guess," the second man said. He wore purser's insignia. His features were different, but with the same compacted body they were as physically alike as twins. Probably from the same home planet. "They gonna get their whole world blown from under them at midnight. Looks like the poor slob in the streets finally realized what is happening. Hope we're in jumpspace by then. I saw Estrada's World get it and I don't want to see that again, not twice in one lifetime!"

The computer man was looking closely at Brion, head tilted sideways to see his face. "You need transportation offworld?" he asked. "We're the last ship at the port, and we're going to boil out of here as soon as the rest of our cargo is aboard. Give you a lift if you need it."

Only by a tremendous effort at control did Brion conceal the destroying sorrow that overwhelmed him when he looked at that shattered wasteland, the graveyard of so many. "No," he said. "That won't be necessary. I'm in touch with the blockading fleet and they'll pick me up before midnight."

"You from Nyjord?" the purser growled.

"No," Brion said, still only half aware of the men. "But there is trou-

ble with my own ship." He realized that they were looking intently at him, that he owed them some kind of explanation. "I thought I could find a way to stop the war. Now . . . I'm not so sure." He hadn't intended to be so frank with the spacemen, but the words had been topmost in his thoughts and had simply slipped out.

The computer man started to say something, but his shipmate speared him in the side with his elbow. "We blast soon—and I don't like the way these Disans are looking at us. Captain said to find out what caused the fire, then get back. So let's go."

"Don't miss your ship," the computer man said to Brion and started for the pinnace. Then he hesitated and turned. "Sure there's nothing we can do for you."

Sorrow would accomplish nothing. Brion fought to sweep the dregs of emotion from his mind and to think clearly. "You can help me," he said. "I could use a scalpel or any other surgical instruments you might have." Lea would need those. Then he remembered Telt's undelivered message. "Do you have a portable radio transceiver—I can pay you for it."

The computer man vanished inside the rocket and reappeared a minute later with a small package. "There's a scalpel and a magnetized tweezers in here, all I could find in the medkit. Hope they'll do." He reached inside and swung out the metal case of a self-contained transceiver. "Take this, it's got plenty of range, even on the longer frequencies." He raised his hand at Brion's offer to pay. "My donation," he said. "If you can save this planet, I'll give you the whole pinnace as well. We'll tell the captain we lost the radio in some trouble with the natives. Isn't that right, Moneybags?" He prodded the purser in the chest with a finger that would have punched a hole in a weaker man."

"I read you loud and clear," the purser said. "I'll make out an invoice so stating, back in the ship." They were both in the pinnace then, and Brion had to move fast to get clear of the take-off blast.

Sense of obligation, the spacemen had felt it too. The realization of this raised Brion's spirits a bit as he searched through the rubble for anything useful. He recognized part of a wall still standing as a corner of the laboratory. Poking through the ruins he unearthed broken instruments and a single, battered case that had barely missed destruction. Inside was the binocular microscope, the right tube bent, its lenses cracked and obscured. The left eyepiece still seemed to be functioning. Brion carefully put it back in the case. He looked at his watch.

It was almost noon. These few pieces of equipment would have to do for the dissection. Watched suspiciously by the onlooking Disans, he started back to the warehouse. It was a long, circuitous walk, since he didn't dare give any clues to his destination. Only when he was positive he had not been observed or followed did he slip through the building's entrance, locking it behind him.

Lea's frightened eyes met his when he went into the office. "A friendly smile here among the cannibals," she called. Her strained expression gave the lie to the cheeriness of her words. "What has happened? Since I woke up, the great stone face over there," she pointed to Ulv, "has been telling me exactly nothing."

"What's the last thing you can remember?" Brion asked carefully. He didn't want to tell her too much, less this bring on the shock again. Ulv had shown great presence of mind in not talking to her.

"If you must know," Lea said, "I remember quite a lot, Brion Brandd. I shan't go into details, since this sort of thing is best kept from the natives. For the record then, I can recall going to sleep after you left. And nothing since then. It's weird. I went to sleep in that lumpy hospital bed and woke up on this couch. Feeling simply terrible. With *him* just simply sitting there and scowling at me. Won't you please tell me what is going on?"

A partial truth was best, saving all of the details that he could for later. "The magter attacked the Foundation building," he said. "They are getting angry at all offworlders now. You were still knocked out by a sleeping drug, so Ulv helped bring you here. It's afternoon now—"

"Of the last day?" She sounded horrified. "While I'm playing sleeping beauty the world is coming to an end. Was anyone hurt in the attack? Or killed?"

"There were a number of casualties—and plenty of trouble," Brion said. He had to get her off the subject. Walking over to the corpse he threw back the cover from its face. "But this is more important right now. It's one of the magter. I have a scalpel and some other things here—will you perform an autopsy?"

Lea huddled back on the couch, her arms around herself, looking chilled in spite of the heat of the day. "What happened to the people at the building?" she asked in a thin voice. The injection had removed her memories of the tragedy, but echoes of the strain and shock still reverberated in her mind and body. "I feel so . . . exhausted. Please tell me what happened. I have the feeling you're hiding something."

Brion sat next to her and took her hands in his, not surprised to find them cold. Looking into her eyes he tried to give her some of his strength. "It wasn't very nice," he said. "You were shaken up by it, I imagine that's why you feel the way you do now. But—Lea, you'll have to take my word for this. Don't ask any more questions. There's nothing we can do now about it. But we can still find out about the magter. Will you examine the corpse?"

She tried to ask something, then changed her mind. When she dropped her eyes Brion felt the thin shiver that went through her body. "There's something terribly wrong," she said. "I know that. I guess I'll have to take your word that it's best not to ask questions. Help me up, will you, darling? My legs are absolutely liquid."

Leaning on him, with his arm

around her supporting most of her weight, she went slowly across to the corpse. She looked down and shuddered. "Not what you would call a natural death," she said. Ulv watched intently as she took the scalpel out of its holder. "You don't have to look at this," she told him in halting Disan. "Not if you don't want to."

"I want to," he told her, not taking his eyes from the body. "I have never seen a magter dead before, or without covering, like ordinary people." He continued to stare fixedly.

"Find me some drinking water, will you Brion," Lea said. "And spread the tarp under the body. These things are quite messy."

After drinking the water she seemed stronger, and could stand without holding onto the table with both hands. Placing the tip of the scalpel just below the magter's breast bone, she made the long continuous post-mortem incision down to the pubic symphysis. The great, body-length wound gaped open like a red mouth. Across the table Ulv shuddered but didn't avert his eyes.

One by one she dissected the internal organs and removed them. Once she looked up at Brion, then quickly returned to work. The silence stretched on and on until Brion had to break it.

"Tell me, can't you. Have you found out anything?"

His words snapped the thin strand of her strength, and she staggered back to the couch and collapsed on to it. Her blood-stained hands hung over the side, making a strangely terrible contrast to the whiteness of her skin.

"I'm sorry, Brion," she said. "But there's nothing, nothing at all. There are minor differences, organic changes I've never seen before—his liver is tremendous for one thing. But changes like this are certainly consistent within the pattern of Homo sapiens as adopted to a different planet. He's a man. Changed, adopted, modified—but still just as human as you or I."

"How can you be sure?" Brion broke in. "You haven't examined him completely, have you?" She shook her head now. "Then go on. The other organs. His brain. A microscopic examination. Here!" he said, pushing the microscope case towards her with both hands.

She dropped her head onto her forearms and sobbed. "Leave me alone, can't you! I'm tired and sick and fed up with this awful planet. Let them die. I don't care! Your theory is false, useless. Admit that! And let me wash the filth from my hands—" Sobbing drowned out her words.

Brion stood over her and drew in a shuddering breath. Was he wrong? He didn't dare think about that. He had to go on. Looking down at the thinness of her bent back, with the tiny projections of her spine pushing through the thin cloth, he felt an immense pity—a pity he couldn't surrender to. This thin, helpless, frightened woman was his only resource. She had to work. He had to *make* her work.

Ihjel had done it. Used projective empathy to impress his emotions upon Brion. Now Brion must do it with Lea. There had been some sessions in the art, but not nearly enough to make him proficient. Nevertheless he had to try.

Strength was what Lea needed. Aloud he said simply "You can do it. You have the will and the strength to finish." And silently his mind cried out the order to obey, to share his power now that hers was drained and finished.

Only when she lifted her face and he saw the dried tears did he realize that he had succeeded. "You will go on?" he asked simply.

Lea merely nodded and rose to her feet. She shuffled like a sleep-walker, jerked along by invisable strings. Her strength wasn't her own and it reminded him unhappily of that last event of the Twenties when he had experienced the same kind of draining activity. Wiping her hands roughly on her clothes she opened the microscope case.

"The slides are all broken," she said.

"This will do," Brion told her, crashing his heel through the glass partition. Shards tinkled and crashed to the floor. He took some of the bigger pieces and broke them to rough squares that would fit under the clips on the stage. Lea accepted them without a word. Putting a drop of the magter's blood on the slide she bent over the eyepiece.

Her hands shook when she tried to adjust the focusing. Using low power she examined the specimen, squinting through the angled tube. Once she turned the substage mirror a bit to catch direct the light streaming in the window. Brion stood behind her, fists clenched, forcefully controlling his anxiety. "What do you see?" he finally blurted out.

"Phagocytes, platelets . . . leucocytes . . . everything seems normal." Her voice was dull, exhausted, her eyes blinking with fatigue as she stared into the tube.

Anger at defeat burned through Brion. Even faced with failure he refused to accept it. He reached over her shoulder and savagely twisted the turret of microscope until the longest lens was in position. "If you can't see anything—try the high power! It's there—I know it's there! I'll get you a tissue specimen." He turned back to the disembowled cadaver.

His back was turned and he did not see the sudden stiffening of her shoulders, or the sudden eagerness that seized her fingers as they adjusted the focus. But he did feel the wave of emotion that welled from her, impinging directly on his emphatic sense. "What is it?" he called to her, as if she had spoken aloud.

"Something . . . something here," she said, "in this leucocyte. It's not a normal structure, but it's familiar. I've seen something like it before, but I just can't remember." She turned away from the scope and unthinkingly pressed her gory knuckles to her forehead. "I know I've seen it before."

Brion squinted into the deserted

microscope and made out a dim shape in the center of the field. It stood out sharply when he focused—the white, jellyfish shape of a single-celled leucocyte. To his untrained eye there was nothing unusual about it. He couldn't know what was strange—when he had no idea of what was normal.

"Do you see those spherical green shapes grouped together?" Lea asked. Before Brion could answer she gasped "I remember now!" Her fatigue was forgotten in her excitement. "*Icerya purchasi* that was the name, something like that. It's a coccid, a little scale insect. It had those same shapes collected together within its individual cells."

"What do they mean? What is the connection with Dis?"

"I don't know," she said, "it's just that they look so similar. And I never saw anything like this in a human cell before. In the coccids, the green particles grow into a kind of yeast that lives within the insect. Not a parasite, but a real symbiote—"

Her eyes opened wide as she caught the significance of her own words. A symbiote—and Dis was the world where symbiosis and parasitism had become more advanced and complex than on any other planet. Lea's

thoughts spun around this fact and chewed at the fringes of the logic. Brion could sense her concentration and absorption. He did nothing to break the mood. Her hands were clenched into fists, her eyes staring unseeingly at the wall as her mind raced.

Brion and Ulv sat quietly, watching her, waiting for her conclusions. The pieces were falling into shape at last.

Lea opened her clenched fists and smoothed them on her sodden skirt. She blinked and turned until she saw Brion. "Is there a tool box here?" she asked.

Her words were so unexpected that it took Brion a moment to answer. Before he could say anything she spoke again.

"No hand tools, it would take too long. Could you find anything like a power saw—that would be ideal?" She turned back to the microscope, so he didn't have any opportunity to question her. Ulv was still looking at the body of the magter and had understood nothing of what they had said. Brion went out into the loading bay.

There was nothing he could use on the ground floor, so he took the stairs to the floor above. A corridor here passed by a number of rooms. All of the doors were locked, including one with the hopeful sign TOOL ROOM on it. He battered at the metal door with his shoulder without budging it. As he stopped to look for a way in he glanced at his watch.

Two o'clock! In ten hours the bombs would fall on Dis.

The need for haste tore at him. Yet there could be no noise—someone in the street might hear it. He quickly stripped off his shirt and wrapped it in a loose roll around the barrel of his gun, extending it in a loose tube in front of the barrel. Holding the rolled cloth in his left hand, he jammed the gun up tight against the door, the muzzle against the lock. The single shot was only a dull thud, inaudible outside of the building. Pieces of broken mechanism jarred and rattled inside the lock and the door swung open.

Lea was standing by the body when he came back, holding up the small power saw with a rotary blade. "Will this do?" he asked. "Runs off its own battery, almost fully charged, too."

"Perfect," she answered. "You're both going to have to help me." She switched into the Disan language. "Ulv, would you find some place where you can watch the street without being seen. Signal me when it is empty. I'm afraid this saw is going to make a lot of noise."

Ulv nodded and went out into the bay, climbing a heap of empty crates so he could peer through the small windows set high in the wall. He looked carefully in both directions, then waved to her to go ahead.

"Stand to one side and hold the cadaver's chin, Brion," she said. "Hold it firmly so the head doesn't shake around when I cut. This is going to be a little gruesome. I'm sorry. But

it'll be the fastest way to cut the bone." The saw bit into the skull.

Once Ulv waved them into silence, and shrank back himself into the shadows next to the window. They waited impatiently until he gave them a sign to continue again. Brion held steady while the saw cut a circle completely around the skull.

"Finished," Lea said and the saw dropped from her limp fingers to the floor. She massaged life back into her hands before she finished the job. Carefully and delicately she removed the cap of bone from the magter's head, exposing his brain to the shaft of light from the window.

"You were right all the time, Brion," she said. "There is your alien."

XVI

Ulv joined them as they looked down at the exposed brain of the magter. The thing was so clearly evident that even Ulv noticed it.

"I have seen dead animals and my people dead with their heads open, but I have never seen anything like that before," he said.

"What is it?" Brion asked.

"The invader, the alien you were looking for," Lea told him.

The magter's brain was only two-thirds of its normal size. Instead of filling the skull completely, it shared the space with a green, amorphous shape. This was ridged somewhat like a brain, but the green shape had still darker nodules and extensions. Lea took her scalpel and gently prodded the dark moist mass.

"It reminds me very much of something that I've seen before on Earth," she said. "The green-fly—*Drepanosiphum platanoides*—and an unusual organ it has, called the pseudova. Now that I have seen this growth in the magter's skull I can think of a positive parallel. The fly *Drepanosiphum* also has a large green organ, only it fills half of the body cavity instead of the head. Its identity puzzled biologists for years, and they had a number of complex theories to explain it away. Finally someone managed to dissect and examine it. The pseudova turned out to be a living plant, a yeastlike growth that helps with the green-fly's digestion. It produces enzymes that enable the fly to digest the great amounts of sugar it gets from plant juice."

"That's not unusual," Brion said, puzzled. "Termites and human beings are a couple of other creatures whose digestion is helped by internal flora. What's the difference in the green-fly?"

"Reproduction, mainly. All the other gut-living plants have to enter the host and establish themselves as outsiders, permitted to remain as long as they are useful. The green-fly and its yeast plant have a permanent symbiotic relationship that is essential to the existence of both. The plant spores appear in many places throughout the fly's body—but they are *always* in the germ cells. Every egg cell has some, and every egg that grows to maturity is infected with the plant spores. The continuation of the symbiosis is unbroken and guaranteed.

"Do you think those green spheres in the magter's blood cells could be the same kind of thing?" Brion asked.

"I'm sure of it," Lea said. "It must be the same process. There are probably green spheres throughout the magters' bodies, spores or offspring of those things in their brains. Enough will find their way to the germ cells to make sure that every young magter is infected at birth. While the child is growing—so is the symbiote. Probably a lot faster since it seems to be a simpler organism. I imagine it is well established in the brain pan within the first six months of the infant's life."

"But why?" Brion asked. "What does it do?"

"I'm only guessing now, but there is plenty of evidence that gives us an idea of its function. I'm willing to bet that the symbiote itself is not a simple organism, it's probably an amalgam of plant and animal like most of the other creatures on Dis. The thing is just too complex to have developed since mankind has been on this planet. The magter must have caught the symbiotic infection by eating some Disan animal. The symbiote lived and flourished in its new environment. Well protected by a bony skull in a long-lived host. In exchange for food, oxygen and comfort, the brain-symbiote must generate hormones and enzymes that enable the magter to survive. Some of these might aid digestion, enabling the magter to eat any plant or animal life they can lay their hands on. The symbiote might produce sugars, scavenge the blood of toxins—there are so many things it could do. Things it must have done, since the magter are obviously the dominant life form on this planet. They paid a high price for their symbiote, but it didn't really matter to race-survival until now. Did you notice that the magter's brain is no smaller than normal?"

"It must be—or how else could that brain-symbiote fit in inside the skull with it?" Brion said.

"If the magter's total brain were smaller in volume than normal, it could fit into the remaining space in the cranial hollow. But the brain is full-sized—it is just that part of it is missing, absorbed by the symbiote."

"The frontal lobes," Brion said with sudden realization. "This hellish growth has performed a prefrontal lobotomy!"

"It's done even more than that," Lea said, separating the convolutions of the gray matter with her scalpel to uncover a green filament beneath. "These tendrils penetrate farther back into the brain, but always remain in the cerebrum. The cerebellum appears to be untouched. Apparently just the higher functions of mankind have been interfered with, selectively. Destruction of the frontal lobes made the magter creatures without emotions or ability for really abstract thought. Apparently they survived better without these. There must have been some horrible failures before the right balance was struck. The final product is a man-plant-animal symbiote that is admirably adapted for

survival on this disaster world. No emotions to cause complications or desires that might interfere with pure survival. Complete ruthlessness—mankind has always been strong on this anyway, so it didn't take much of a push."

"The other Disans, like Ulv here, managed to survive without turning into such a creature. So why was it necessary for the magter to go so far?"

"Nothing is necessary in evolution, you know that," Lea said."Many variations are possible and all the better ones continue. You might say that Ulv's people survive, but the magter survive better. If offworld contact hadn't been re-established, I imagine that the magter would slowly have become the dominant race. Only they won't have the chance now. It looks as though they have succeeded in destroying both races with their suicidal urge."

"That's the part that doesn't make sense," Brion said. "The magter have survived and climbed right to the top of the evolutionary heap here. Yet they are suicidal. How come they haven't been wiped out before this?"

"Individually they have been aggressive to the point of suicide. They will attack anything and everything with the same savage lack of emotion. Luckily there are no bigger animals on this planet. So where they have died as individuals, their utter ruthlessness has guaranteed their survival as a group. Now they are faced with a problem that is too big for their half-destroyed minds to handle. Their personal policy has become their planetary policy—and that's never a very smart thing. They are like men with knives who have killed all the men who were only armed with stones. Now they are facing men with guns and they are going to keep charging and fighting until they are all dead.

"It's a perfect case of the utter impartiality of the forces of evolution. Men infected by this Disan life form were the dominant creatures on this planet. The creature in the magters' brains was a true symbiote then, giving something and receiving something. Making a union of symbiotes where all were stronger together than any could be separately. Now this is changed. The magter brain cannot understand the concept of racial death, in a situation where it must understand to be able to survive. Therefore, the brain-creature is no longer a symbiote but a parasite."

"And as a parasite it must be destroyed!" Brion broke in. "We're not fighting shadows any more," he exulted. "We've found the enemy—and it's not the magter at all. Just a sort of glorified tapeworm that is too stupid to know when it is killing itself off. Does it have a brain—can it think?"

"I doubt it very much," Lea said.. "A brain would be of absolutely no use to it. So even if it originally possessed reasoning powers they would be gone by now. Symbiotes or parasites that live internally like this always degenerate to an absolute minimum of functions . . ."

"Tell me about it? What is this

thing?" Ulv broke in, producing the soft form of the brain-symbiote. He had heard all their excited talk but had not understood a word.

"Explain it to him, will you Lea, as best you can," Brion said, looking at her and realized how exhausted she was. "And sit down while you do it, you're long overdue for a rest. I'm going to try—" He broke off when he looked at his watch.

It was after four in the afternoon—less than eight hours to go. What was he to do? Enthusiasm faded as he realized that only half of the problem was solved. The bombs would drop on schedule unless the Nyjorders could understand the significance of this discovery. Even if they understood—would it make any difference to them? The threat of the hidden cobalt bombs would not be changed.

With this thought came the guilty realization that he had forgotten completely about Telt's death. Even before he contacted the Nyjord fleet he must tell Hys and his rebel army what had happened to Telt and his sandcar. Also about the radioactive traces. They couldn't be checked against the records now to see how important they might be, but Hys might make another raid on the strength of the suspicion. This call wouldn't take long, then he would be free to tackle Professor-Commander Krafft.

Carefully setting the transmitter on the frequency of the rebel army, he sent out a call to Hys. There was no answer.

There was always a chance the set was broken. He quickly twisted the transmitter to the frequency of his personal radio, then whistled in the microphone. The received signal was so loud that it hurt his ears. He tried to call Hys again, and was relieved to get a response this time.

"Brion Brandd here, can you read me? I want to talk to Hys at once."

Shockingly, it was Professsor-Commander Krafft who answered.

"I'm sorry Brion, but it's impossible to talk to Hys. We are monitoring his frequency and your call was relayed to me. Hys and his rebels lifted ship about a half an hour ago, and are already on the way back to Nyjord. Are you ready to leave now? It will soon become dangerous to make any landings. Even now I will have to ask for volunteers to get you out of there."

Hys and the rebel army gone. Brion assimilated the thought at the same moment he realized he was talking to Krafft. He was thrown off balance, not prepared for the encounter.

"If they're gone—well, then there's nothing I can do about it," Brion said. "I was going to call you, so I can talk to you now. Listen and try to understand. You must cancel the bombing. I've found out about the magter, found what causes their mental aberration. If we can correct that, we can stop them from attacking Nyjord—"

"Can they be corrected by midnight tonight?" Krafft broke in. He was abrupt and sounded annoyed. Even saints get tired.

"No, of course not." Brion frowned at the microphone, realizing the talk was going all wrong, but not knowing how to fix it. "But it won't take too long. I have evidence here that will convince you that what I say is the truth."

"I believe you without seeing it, Brion." The trace of anger was gone from Krafft's voice now and it was heavy with fatigue and defeat. "I'll admit you are probably right. A little while ago I admitted to Hys, too, that he was probably right in his original estimation of the correct way to tackle the problem of Dis. We have made a lot of mistakes, and in making them we have run out of time. I'm afraid that is the only fact that is relevant now. The bombs fall at twelve and even then they may drop too late. A ship is already on its way from Nyjord with my replacement. I exceeded my authority by running a day past the maximum the technicians gave me. I realize now I was gambling the life of my own world in the vain hope I could save Dis. They can't be saved. They're dead. I won't hear any more about it."

"You must listen—"

"I must destroy the planet below me, that is what I must do. That fact will not be changed by anything you say. All the offworlders—other than your party—are gone. I'm sending a ship down now to pick you up. As soon as that ship lifts I am going to drop the first bombs. Now—tell me where you are so they can come for you."

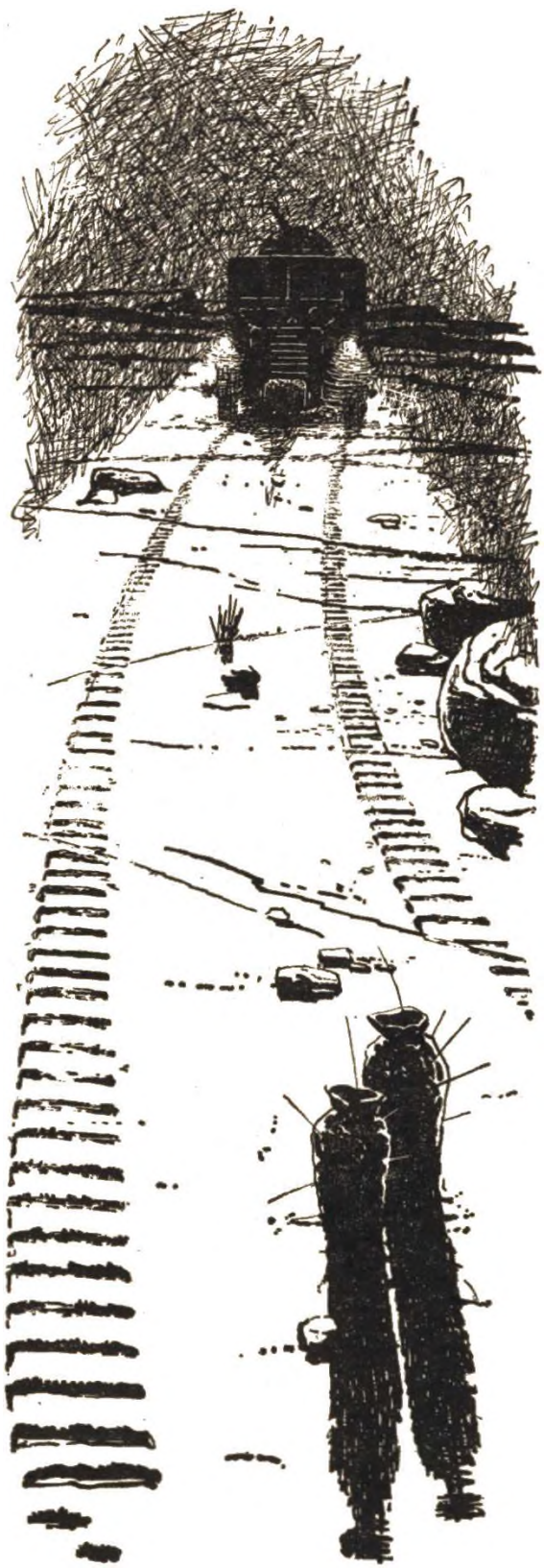
"Don't threaten me, Krafft!" Brion shook his fist at the radio in an excess of anger. "You're a killer and a world destroyer, don't try and make yourself out as anything else. I have the knowledge to avert this slaughter and you won't listen to me. And I know where the cobalt bombs are—in the magter tower that Hys raided last night. Get those bombs and there is no need to drop any of your own!"

"I'm sorry, Brion. I appreciate what you're trying to do, yet at the same time I know the futility of it. I'm not going to accuse you of lying, but do you realize how thin your evidence sounds from this end? First a dramatic discovery of the cause of the magters' intransigency. Then, when that had no results, you suddenly remember that you know where the bombs are. The best kept magter secret . . ."

"I don't know for sure, but there is a very good chance," Brion said, trying to repair his defenses. "Telt made readings, he had other records of radioactivity in this same magter keep. Proof that something is there. But Telt is dead now, the records destroyed. Don't you see—" He broke off, realizing how vague and unprovable his case was. This was defeat.

The radio was silent, with just the hum of the carrier wave as Krafft waited for him to continue. When Brion did speak his voice was empty of all hope.

"Send your ship down," he said tiredly. "We're in a building that belonged to the Light Metals Trust Ltd., a big warehouse of some kind. I don't know the address here, but I'm



sure you have someone there who can find it. We'll be waiting for you.

"You win Krafft."

He turned off the radio.

XVII

"Do you mean what you said, about giving up?" Lea asked. Brion realized that she had stopped talking to Ulv some time ago, and had been listening to his conversation with Krafft. He shrugged, trying to put his feeling into words.

"We've tried—and almost succeeded. But if they won't listen what can we do? What can one man possibly do against a fleet loaded with H-bombs?"

As if in answer to his question Ulv's voice drowned him out. The harsh Disan words slashing the silence of the room.

"Kill you, the enemy!" he said. "Kill you *umedvirk!*"

He shouted the last word and his hand flashed to his belt. In a single swift motion he lifted his blowgun and placed it to his lips. A tiny dart quivered in the already dead flesh of the creature in the magter's skull. The action had all the symbolism of a broken lance, the declaration of war.

"Ulv understands it a lot better than you might think," Lea said. "He knows things about symbiosis and mutualism that would get him a job as a lecturer in any university on Earth. He knows just what the brain-symbiote is and what it does. They even have a word for it, one that never appeared in our Disan lan-

guage lessons. A life form that you can live with or co-operate with is called *medvirk.* One that works to destroy you is *umedvirk.* He also understands that life forms can change, and be *medvirk* or *umedvirk* at different times. He has just decided that the brain symbiote is *umedvirk* and is out to kill it. So will the rest of the Disans as soon as he can show them the evidence and explain."

"You're sure of this," Brion asked, interested in spite of himself.

"Positive. The Disans have a very absolute attitude towards survival, you should realize that. Not the same as the magter, but not much different in the results. They will kill the brain-symbiote, even if it means killing every magter who harbors one."

"If that is the case, we can't leave now," Brion said. With these words it suddenly became very clear what he had to do. "The ship is coming down now from the fleet. Get in it and take the body of the magter. I won't go."

"Where will you be?" she asked.

"Fighting the magter. My presence on the planet means that Krafft won't keep his threat to drop the bombs any earlier than the midnight deadline. That would be deliberately murdering me. I doubt if my presence past midnight will stop him, but it should keep the bombs away at least until then."

"What will you accomplish besides committing suicide?" Lea pleaded. "You just told me how a single man can't stop the bombs. What will happen to you at midnight?"

"I'll be dead—but in spite of that I can't run away. Not now. I must do everything possible right up until the last instant. Ulv and I will go to the magter tower, try to find out if the bombs are there. He will fight on our side now. He may even know more about the bombs, things that he didn't want to tell me before. We can get help from his people. Some of them must know where the bombs are, being native to this planet." Lea started to say something, but he rushed on, drowning out her words.

"You have just as big a job. Show the magter to Krafft, explain the significance of the brain-parasite to him. Try and get him to talk to Hys about the last raid. Try to get him to hold off the attack. I'll keep the radio with me and as soon as I know anything I'll call in. This is all last resort, finger in the dike kind of stuff, but it is all we can do.

"Because if we do nothing it means the end of Dis."

Lea tried to argue with him, but he wouldn't listen to her. He only kissed her, and with a lightness he did not feel tried to convince her that everything would be all right. In their hearts they both knew it wasn't, yet they left it that way because it was the least painful solution.

A sudden rumbling shook the building and the windows darkened as a ship settled in the street outside. The Nyjord crew came in with guns pointed, alert for anything. With a little convincing they took the cadaver, as well as Lea, when they lifted

ship. Brion watched the spacer become a pinpoint in the sky and vanish. He shrugged his shoulders, trying to shake off the feeling that this was the last time he would see any of them.

"Let's get out of here fast," he told Ulv, picking up the radio. "Before anyone comes around to see why the ship landed."

"What will you do," Ulv asked, as they went down the street towards the desert. "What can we do in the few hours we have left?" He pointed at the sun, nearing the horizon. Brion shifted the weight of the radio to his other hand before replying.

"Get to the magter tower we raided last night, that's the best chance. The bombs might be there. Unless you know where the bombs are?"

Ulv shook his head. "I do not know, but some of my people may. We will capture a magter then kill him so they can all see the *umedvirk*. Then they will tell us everything they know."

"The tower first then, for bombs or a sample magter. What's the fastest way we can get there?"

Ulv frowned in thought. "If you can drive one of the cars the offworlders use, I know where there are some locked in buildings in this city. None of my people know how they are made to move."

"I can work them—let's go."

Chance was with them this time. The first sandcar they found still had the keys in the lock. It was battery powered, but contained a full charge. Much quieter than the heavy atomic cars it sped smoothly out of the city and across the sand. Ahead of them the sun sank in a red wave of color and it was six o'clock. By the time they reached the tower it was seven and Brion's nerves felt as if they were writhing under his skin.

Even though it looked like suicide, attacking the tower brought blessed relief. It was movement and action, and for moments at a time he forgot the bombs hanging over his head.

The attack was nerve-wrackingly anticlimactic. They used the main entrance, Ulv ranging soundlessly ahead. There was no one in sight. Once inside they crept down towards the lower rooms where the radiation had been detected. Only gradually did they realize that the magter tower was completely empty.

"Everyone gone," Ulv grunted, sniffing the air in every room that they passed. "Many magter were here earlier, they are gone now."

"Do they often desert their towers?" Brion asked.

"Never. I have never heard of it happening before. I can think of no reason why they should do a thing like this."

"Well I can," Brion told him. "They would leave their home if they took something with them of greater value. The bombs. If the bombs were hidden here, they might move them after the attack." Sudden fear hit him. "Or they might move them because it is time to take them—to the launcher! Let's get out of here, the quickest way we can."

"I smell air from outside," Ulv

said, "coming from down there. This cannot be, because the magter have no entrances this low in their towers."

"We blasted one in earlier—that could be it. Can you find it?"

Moonlight shone ahead as they turned an angle of the corridor, and stars were visible through the gaping opening in the wall.

"It looks bigger than it was," Brion said, "as if the magter enlarged it." He looked through and saw the tracks on the sand outside. "As if they enlarged it to bring something bulky up from below—and carried it away in whatever made those tracks!"

Using the opening themselves they ran back to the sandcar. Brion ground it fiercely around and turned the headlights on the tracks. There were the marks of a sandcar's treads, half obscured by thin, unmarked wheel tracks. He turned off the lights and forced himself to move slowly and to do an accurate job. A quick glimpse of his watch showed him there were four hours left to go. The moonlight was bright enough to illuminate the tracks. Driving with one hand he turned on the radio transmitter, already set for Krafft's wave length.

When the operator acknowledged his signal Brion reported what they had discovered and his conclusions. "Get that message to Commander Krafft now. I can't wait to talk to him—I'm following the tracks." He killed the transmission and stamped on the accelerator. The sandcar churned and bounced down the track.

"They are going to the mountains," Ulv said half an hour later, as the tracks still pointed straight ahead. "There are caves here and many magter have been seen near them, that is what I have heard."

The guess was correct. Before nine o'clock the ground humped into a range of foothills and the darker masses of mountains could be seen behind them, rising up to obscure the stars.

"Stop the car here," Ulv said, "The caves begin not too far ahead. There may be magter watching or listening, so we must go quietly."

Brion followed the deep-cut grooves, carrying the radio. Ulv came and went on both sides, silently as a shadow, scouting for hidden watchers. As far as he could discover there were none.

By nine-thirty Brion realized they had deserted the sandcar too soon. The tracks wound on and on, and seemed to have no end. They passed some caves, Ulv pointed them out to him, but the tracks never stopped. Time was running out and the nightmare stumbling through the darkness continued.

"More caves ahead," Ulv said. "Go quietly."

They came cautiously to the crest of the hill, as they had done so many times before, and looked into the shallow valley beyond. Sand covered the valley floor, and the light of the setting moon shone over the tracks at a flat angle, setting them off sharply

as lines of shadow. They ran straight across the sandy valley and disappeared into the dark mouth of a cave on the far side.

Sinking back behind the hilltop, Brion covered the pilot light with his hand and turned on the transmitter. Ulv stayed above him, staring at the opening of the cave.

"This is an important message," Brion whispered into the mike, "Please record." He repeated this for thirty seconds, glancing at his watch to make sure of the time, since the seconds of waiting stretched to minutes in his brain. Then, clearly as possible without raising his voice above a whisper, he told of the discovery of the tracks and the cave."

". . . The bombs may or may not be in here, but we are going in to find out. I'll leave my personal transmitter here with the broadcast power turned on, so you can home on its signal. That will give you a directional beacon to find the cave. I'm taking the other radio in, it has more power. If we can't get back to the entrance, I'll try a signal from inside. I doubt if you will hear it because of the rock, but I'll try. End of transmission. Don't try to answer me because I have the receiver turned off. There are no earphones on this set and the speaker would be too loud here."

He switched off, held his thumb on the button for an instant, then flicked it back on.

"Good-by, Lea," he said, and killed the power for good.

They circled and reached the rocky wall of the cliff. Creeping silently in the shadows here they slipped up on the dark entrance of the cave. Nothing moved ahead and there was no sound from the entrance of the cave. Brion glanced at his watch and was instantly sorry.

Ten-thirty.

The last shelter concealing them was five meters from the cave. They started to rise, to rush the final distance when Ulv suddenly waved Brion down. He pointed to his nose, then to the cave. He could smell the magter there.

A dark figure separated itself from the greater darkness of the cave mouth. Ulv acted instantly. He stood up and his hand went to his mouth; air hissed faintly through the tube in his hand. Without a noise the magter folded and fell to the ground. Before the body hit Ulv crouched low and rushed in. There was the sudden scuffling of feet on the floor, then silence.

Brion walked in, gun ready and alert, not knowing what he would find. His toe pushed against a body on the ground and from the darkness Ulv whispered. "There were only two. We can go on now."

Finding their way through the cave was a maddening torture. They had no light, nor could they dare use one if they had. There were no wheel marks to follow on the stone floor. Without Ulv's sensitive nose they would have been completely lost. The caves branched and rejoined and they soon lost all sense of direction.

Walking was maddening and al-

most impossible. They had to grope with their hands before them like blind men. Stumbling and falling against the rock, their fingers were soon throbbing and raw from brushing against the rough walls. Ulv followed the scent of the magter that hung in the air where they had passed. When it grew thin he knew they had left the frequently used tunnels and entered deserted ones. They could only retrace their steps and start again in a different direction.

More maddening than the walking was the time. Inexorably the glowing hands crept around the face of Brion's watch until they stood at fifteen minutes before twelve.

"There is a light ahead," Ulv whispered, and Brion almost gasped with relief. They moved slowly and silently until they stood, concealed by the darkness, looking out into a domed chamber brightly lit by glowing tubes.

"What is it," Ulv asked, blinking in the. painful wash of illumination after the long darkness.

Brion had to fight to control his voice, to stop from shouting.

"The cage with the metal webbing is a jump-space generator. The pointed, sliver shapes next to it are bombs of some kind, probably the cobalt bombs. We've found it!"

His first impulse was to instantly send the radio call that would stop the waiting fleet of H-bombers. But an unconvincing message would be worse than no message at all. He had to describe exactly what he saw here so the Nyjorders would know he wasn't lying. What he told them had to fit exactly with the information they already had about the launcher and the bombs.

The launcher had been jury-rigged from a ship's jump-space generator, that was obvious. The generator and its controls were neatly cased and mounted. Cables ran from them to a roughly constructed cage of woven metal straps, hammered and bent into shape by hand. Three technicians were working on the equipment. Brion wondered what sort of bloodthirsty war-lovers the magter had found to handle the bombing for them. Then he saw the chains around their necks and the bloody wounds on their backs. He still found it difficult to have any pity for them. They had been obviously willing to accept money to destroy another planet—or they wouldn't have been working here. They had probably rebelled only when they had discovered how suicidal the attack would be.

Thirteen minutes to midnight.

Cradling the radio against his chest, Brion rose to his feet. He had a better view of the bombs now. There were twelve of them, alike as eggs from the same deadly clutch. Pointed like the bow of a spacer, each one swept smoothly back for its two meters of length, to a sharply chopped off end. They were obviously incomplete, the war heads of rockets. One had its base turned towards him and he saw six projecting studs that could be used to attach it to the

missing rocket. A circular inspection port was open in the flat base of the bomb.

This was enough. With this description the Nyjorders would know he couldn't be lying about finding the bombs. Once they realized this they couldn't destroy Dis without first trying to neutralize them.

Brion carefully counted fifty paces before he stopped. He was far enough from the cavern so he couldn't be heard, and an angle of the cave cut off all light from behind him. With carefully controlled movements he turned on the power, switched the set to transmit and checked the broadcast frequency. All correct. Then, slowly and clearly, he described what he had seen in the cavern behind him. He kept his voice emotionless, recounting facts, leaving out anything that might be considered an opinion.

It was six minutes before midnight when he finished. He thumbed the switch to receive and waited.

There was only silence.

Slowly, the empty quality of the silence penetrated his numbed mind. There were no crackling atmospherics nor hiss of static, even when he turned the power full on. The mass of rock and earth of the mountain above was acting as a perfect grounding screen, absorbing his signal even at maximum output.

They hadn't heard him. The Nyjord fleet didn't know that the cobalt bombs had been discovered before their launching. The attack would go ahead as planned. Even now the bomb-bay doors were opening, armed H-bombs hung above the planet, held in place only by their shackles. In a few minutes the signal would be given and the shackles would spring open, the bombs drop clear . . .

"Killers!" Brion shouted into the microphone. "You wouldn't listen to reason, you wouldn't listen to Hys, or me, or to any voice that suggested an alternative to complete destruction. You are going to destroy Dis and *it's not necessary!* There were a lot of ways you could have stopped it. You didn't do any of them and now it's too late. You'll destroy Dis and in turn this will destroy Nyjord. Ihjel said that and now I believe him. You're just another failure in a galaxy full of failures!"

He raised the radio above his head and sent it crashing into the rock floor. Then he was running back to Ulv, trying to run away from the realization that he, too, had tried and failed. The people on the surface of Dis had less than two minutes left to live.

"They didn't get my message," Brion said to Ulv. "The radio won't work this far underground."

"Then the bombs will fall?" Ulv asked, looking searchingly at Brion's face in the dim reflected light from the cavern.

"Unless something happens that we know nothing about, the bombs will fall."

They said nothing after that, they simply waited. The three technicians

in the cavern were also aware of the time. They were calling to each other and trying to talk to the magter. The emotionless, parasite-ridden brains of the magter saw no reason to stop work, so the men were beaten back to their tasks. In spite of the blows they didn't go, just gaped in horror as the clock hands moved remorselessly towards twelve. Even the magter dimly felt some of the significance of the occasion. They stopped, too, and waited.

The hour hand touched twelve on Brion's watch, then the minute hand. The second hand closed the gap and for a tenth of a second the three black hands were one. Then the second hand moved on.

Brion's immediate sensation of relief was washed away by the chilling realization that he was deep underground. Sound and seismic waves were slow and the flare of atomic explosions couldn't be seen here. If the bombs had been dropped at twelve, they wouldn't know it at once.

A distant rumble filled the air. A moment later the ground heaved under them and the lights in the cavern flickered. Fine dust drifted down from the roof above.

Ulv turned to him, but Brion looked away. He could not face the accusation in the Disan's eyes.

XVIII

One of the technicians was running and screaming. The magter knocked him down and beat him into silence. Seeing this the other two men returned to work with shaking hands. Even if all life on the surface of the planet were dead, this would have no effect on the magter. They would go ahead as planned, without emotion or imagination enough to alter their set course. As they worked the technicians' attitude changed from shocked numbness to anger. Right and wrong were forgotten. They had been killed—the invisible death of radiation must already be penetrating into the caves—but they also had the chance for vengeance. Swiftly they brought their work to completion, with a speed and precision they had concealed before.

"What are those offworlders doing?" Ulv asked.

Brion stirred from his lethargy of defeat and looked across the cavern floor. The men had a wheeled handtruck and were rolling one of the atomic warheads onto it. They pushed it over to the latticework of the jump-field.

"They are going to bomb Nyjord now, just as Nyjord bombed Dis. That machine will hurl the bombs in a special way to the other planet."

"Will you stop them?" Ulv asked. He had his deadly blowgun in his hand and his face was an expressionless mask.

Brion almost smiled at the irony of the situation. In spite of everything he had done to prevent it, Nyjord had dropped the bombs. And this act alone may have destroyed their own planet. Brion had it within his power now to stop the launching in the cavern. Should he? Should he

save the lives of his killers? Or should he practice the ancient blood-oath that had echoed and destroyed down through the ages—*An eye for an eye, a tooth for a tooth.* It would be so simple. He literally had to do nothing. The score would be evened and his and the Disans' deaths avenged.

Did Ulv have his blowgun ready to kill Brion if he should try to stop the launchings? Or had he misread the Disan entirely?

"Will *you* stop them, Ulv?" he asked.

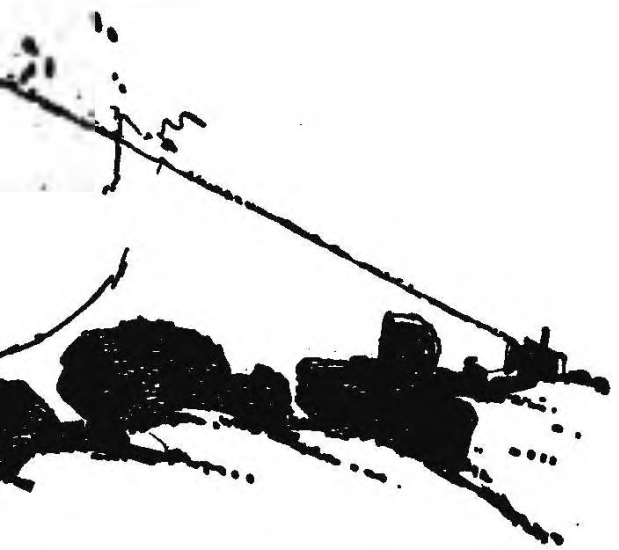
How large was mankind's sense of obligation? The cave man first had this feeling for his mate, then for his family. It grew until men fought and died for the abstract ideas of cities and nations, then for whole planets. Would the time every come when men might realize that the obligation should be to the largest and most encompassing reality of all? Mankind. And beyond that to life of all kinds.

Brion saw this idea not in words, but as a reality. When he posed the question to himself in this way he found that it stated clearly its inherent answer. He pulled his gun out, and as he did he wondered what Ulv's answer might be.

"Nyjord is *medvirk,*" Ulv said,

raising his blowgun and sending a dart across the cavern. It struck one of the technicians who gasped and fell to the floor.

Brion's shots crashed into the control board, shorting and destroying it,



removing the menace to Nyjord for all time.

Medvirk, Ulv had said. A life form that co-operates and aids other life forms. It may kill in self-defense, but is essentially not a killer or destroyer. Ulv had a lifetime of knowledge about the interdependency of life. He grasped the essence of the idea and ignored all the verbal complications and confusions. He had killed the magter, who were his own people, because they were *umedvirk* —against life. And saved his enemies because they were *medvirk.*

With this realization came the painful knowledge that the planet and the people that had produced this understanding were dead.

In the cavern the magter saw the destruction of their plans, and the cave mouth from which the bullets had come. Silently they rushed to kill their enemy. A concerted wave of emotionless fury.

Brion and Ulv fought back. Even the knowledge that he was doomed no matter what happened could not resign Brion to death at the hands of the magter. To Ulv, the decision was much easier. He was simply killing *umedvirk.* A believer in life, he destroyed the anti-life.

They retreated into the darkness, still firing. The magter had lights and ion-rifles, and were right behind them. Knowing the caverns better than the men they chased, pursuers circled. Brion saw lights ahead and dragged Ulv to a stop.

"They know their way through these caves, and we don't," he said. "If we try to run, they'll just shoot us down. Let's find a spot we can defend and settle into it."

"Back here," Ulv gave a tug in the right direction, "there is a cave with only one very narrow entrance."

"Let's go!"

Running as silently as they could in the darkness, they reached the deadend cavern without being seen. What noise they made was lost in other footsteps that echoed and sounded through the connecting caves. Once inside they found cover behind a ridge and waited. The end was certain.

The magter ran swiftly into their cave, flashing his light into all the places of concealment. The beam passed over the two hidden men and at the same instant Brion fired. The shot boomed loudly as the magter fell. Even if his loss was not known, the shot would surely have been heard.

Before anyone else came into the cave, Brion ran over and grabbed the still functioning light. Propping it on the rocks so it shone on the entrance, he hurried back to shelter beside Ulv. They waited for the attack.

It was not long in coming. Two magter rushed in and died. There were more outside, and Brion wondered how long it would be before they remembered the grenades and rolled one into their shelter.

An indistinct murmur sounded outside and some sharp explosions. In their shelter, Brion and Ulv crouched low and wondered why the attack didn't come. Then one of the magter came in and Brion hesitated before shooting.

The man had *backed* in, firing behind him as he came.

Ulv had no compunctions about killing, only his darts couldn't penetrate the magter's thick clothing. As the magter turned Ulv's breath pulsed once and death stung the back of the other man's hand. He collapsed into a crumpled heap.

"Don't shoot," a voice said from outside the cave, and a man stepped through the swirling dust and smoke to stand in the beam from the light.

Brion clutched wildly at Ulv's arm, dragging the blowgun from the Disan's mouth.

The man in the light wore a protective helmet, thick boots and a pouch-hung uniform.

He was a Nyjorder.

This shock of reality was almost impossible to accept. Brion had heard the bombs fall. Yet the Nyjord soldier was here. The two facts couldn't be accepted together.

"Would you keep a hold on his arm, sir, just in case," the soldier said, glancing warily at Ulv's blowpipe. "I know what those darts can do." He pulled a microphone from one of his pockets and spoke into it.

More soldiers crowded into the cave and Professor-Commander Krafft came in behind them. He looked strangely out of place in the dusty combat uniform. The gun was even more grotesque in his blue-veined hand. After relievedly giving the pistol to the nearest soldier, he stumbled quickly over to Brion and took his hand.

"It is a profound and sincere pleasure to meet you in person," he said. "And your friend Ulv as well."

"Would you kindly explain what is going on," Brion said thickly. He was obsessed by the strange feeling that none of this could possibly be happening.

"We will always remember you as the man who saved us from ourselves," Krafft said, once again the professor instead of the commander.

"What he wants are facts, Grandpa, not speeches," Hys said. The bent

form of the leader of the rebel Nyjord army pushed through the crowd of taller men until he stood next to Krafft. "Simply stated, Brion, your plan succeeded. Krafft relayed your message to me—and as soon as I heard it I turned back and met him on his ship. I'm sorry that Telt's dead—but he found what we were looking for. I couldn't ignore his report of radioactive traces. Your girl friend arrived with the hacked up corpse at the same time I did, and we all took a long look at the green leech in its skull. Her explanation of what it is made significant sense. We were already carrying out landings when we had your call about something having been stored in the magter tower. After that it was just a matter of following tracks—and the transmitter you planted."

"But the exlosions at midnight," Brion broke in, "I heard them!"

"You were supposed to," Hys laughed. "Not only you, but the magter in this cave. We figured they would be armed and the cave strongly defended. So at midnight we dropped a few large chemical explosive bombs at the entrance. Enough to kill the guards without bringing the roof down. We also hoped that the magter deeper in would leave their posts or retreat from the imagined radiation. They did. Worked like a charm. We came in quietly and took them by surprise. Made a clean sweep. Killed the ones we couldn't capture."

"One of the renegade jump-space technicians was still alive," Krafft said. "He told us about your stopping the bombs aimed at Nyjord, the two of you."

None of the Nyjorders there could add anything to his words, not even the cynical Hys. Yet Brion could empathize their feelings, the warmth of their intense relief and happiness. It was a sensation he would never forget.

"There is no more war," Brion translated for Ulv, realizing that the Disan had understood nothing of the explanation. As he said it, he realized that there was one glaring error in the story.

"You couldn't have done it," Brion said, astonished. "You landed on this planet *before* you had my message about the tower. That means you still expected the magter to be sending their bombs to Nyjord—and you made the landings in spite of this knowledge."

"Of course," Professor Krafft said, astonished at Brion's lack of understanding. "What else could we do? The magter are sick!"

Hys laughed aloud at Brion's baffled expression. "You have to understand Nyjord psychology," he said. "When it was a matter of war and killing my planet could never agree on an intelligent course. War is so alien to our philosophy that it couldn't even be considered correctly. That's the trouble with being a vegetable eater in a galaxy of carnivores. You're easy prey for the first one that lands on your back. Any other planet would have jumped on the magter with both feet and shaken the bombs

out of them. We fumbled it so long it almost got both worlds killed. Your mind-parasite drew us back from the brink."

"I still don't understand," Brion said. "Why—"

"Simple matter of definition. Before you came we had no way to deal with the magter here on Dis. They really were alien to us. Nothing they did made sense—and nothing we did seemed to have the slightest effect on them. But you discovered that they were *sick,* and that's something we know how to handle. We're united again, my rebel army was instantly absorbed into the rest of the Nyjord forces by mutual agreement. Doctors and nurses are on the way here now. Plans were put under way to evacuate what part of the population we could until the bombs were found. The planet is united again and working hard."

"Because the magter are sick, infected by a destructive life form?" Brion asked.

"Exactly so," Professor Krafft said. "We are civilized, after all. You can't expect us to fight a war—and you surely can't expect us to ignore the plight of sick neighbors?"

"No . . . you surely can't," Brion said, sitting down heavily. He looked at Ulv, who knew nothing of the incomprehensible speech. Beyond him Hys wore his most cynical expression as he considered the frailities of his people.

"Hys," Brion called out. "You translate all that into Disan and explain to Ulv. I wouldn't dare."

XIX

Dis was a floating golden ball, looking like a schoolroom globe in space. No clouds obscured its surface, and from this distance it seemed warm and attractive set against the cold darkness. Brion almost wished he were back there now, as he sat shivering inside the heavy coat. He wondered how long it would be before his confused body-temperature controls decided to turn off the summer adjustment.

Delicate as a dream, Lea's reflection swam in space next to the planet. She had come up quietly behind him in the spaceship's corridor, only her gentle breath and mirrored face telling him she was there. He turned quickly and took her hands in his.

"You're looking better," he said.

"Well I should," she said, pushing her hair in an unconscious gesture with the back of her hand. "I've been doing nothing but lie in the ship's hospital, while you were having such a fine time this last week. Rushing around down there shooting all the magter."

"Just gassing them," he told her. "The Nyjorders can't bring themselves to kill any more, even if it does raise their own casualty rate. In fact they are having difficulty restraining the Disans led by Ulv, who are happily killing any magter they see as being pure *umedvirk.*"

"What will they do when they have all those frothing magter madmen?"

"They don't know yet," he said. "They won't really know until they see

what an adult magter is like with his brain-parasite dead and gone. They're having better luck with the children. If they catch them early enough, the parasite can be destroyed before it has done too much damage."

Lea shuddered delicately.

"I hate to think of a magter deprived of his symbiote," she said. "If his system can stand the shock, I imagine there will be nothing left except a brainless hulk. This is one series of experiments I don't care to witness. I rest secure in the knowledge that the Nyjorders will find the most humane solution."

"I'm sure they will," Brion said.

"Now what about us," she said disconcertingly.

This jarred Brion. He didn't have her ability to put past horrors out of the mind by substituting present pleasures. "Well, what about us?" he said with masterful inappropriateness.

She smiled and leaned against him. "You weren't as vague as that, the night in the hospital room. I seem to remember a few other things you said. You can't claim you're completely indifferent to me, Brion Brandd. So I'm only asking you what any outspoken Anvharian girl would. Where do we go from here? Get married?"

There was a definite pleasure in holding her slight body in his arms and feeling her hair against his cheek. They both sensed it, and this awareness made his words sound that much more ugly.

"Lea . . . darling! You know how important you are to me—but you certainly realize that we could never get married."

Her body stiffened and she tore herself away from him.

"Why you great, fat, egotistical slab of meat," she screamed. "What do you mean by that? I like you Lea, we have plenty of fun and games together, but surely you realize that you aren't the kind of girl one takes home to mother!"

"Lea, hold on," he said. "You know better than to say a thing like that. What I said has nothing to do with how I feel towards you. But marriage means children, and you are biologist enough to know about Earth's genes —"

"Intolerant yokel!" she cried, slapping his face. He didn't move or attempt to stop her. "I expected better from you, with all your pretensions of understanding. But all you can think of are the horror stories about the worn out genes of Earth. You're the same as every other big, strapping bigot from the frontier planets. I know how you look down on our small size, our allergies and hemophilia and all the other weaknesses that have been bred back and preserved by the race. You hate—"

"But that's not what I meant at all," he interrupted, shocked, his voice drowning hers out. "Yours are the strong genes, the viable strains—*mine* are the deadly ones. A child of mine would kill itself and you in a natural birth, if it managed to live to term. You're forgetting that you are the original Homo sapiens. I'm a recent mutation."

Lea was frozen by his words. They revealed a truth she had known, but would never permit herself to consider.

"Earth is home, the planet where mankind developed," he said. "The last few thousand years you may have been breeding weaknesses back into the genetic pool. But that's nothing compared to the hundred millions of years that it took to develop man. How many newborn babies live to be a year of age on Earth?"

"Why . . . almost all of them."

"Earth is home," he said gently. "When men leave home they can adapt to different planets, but a price must be paid. A terrible price in dead infants. The successful mutations live, the failures die. Natural selection is a brutally simple affair. When you look at me you see a success. I have a sister—a success too. Yet my mother had six other children who died when they were still babies. And at least fifteen others that never came to term. You know these things, don't you Lea?"

"I know, I know . . ." she said sobbing into her hands. He held her now and she didn't pull away. "I know it all as a biologist—but I am so awfully tired of being a biologist, and top of my class and a mental match for any man. But when I think about you, I do it as a woman, and can't admit any of this. I need someone Brion, and I needed you so much because I loved you." She sniffed and pushed at her eyes. "You're going home, aren't you? Back to Anvhar. When?"

"I can't wait too long," he said, unhappily. "Aside from my personal wants I find myself remembering that I'm a part of Anvhar. When you think of the number of people who suffered and died—or adapted—so that I could be sitting here now. Well, it's a little frightening. I suppose it doesn't make sense logically that I should feel indebted to them. But I do. Whatever I do now, or in the next few years, won't be as important as getting back to Anvhar."

"And I won't be going back with you." It was a flat statement the way she said it, not a question.

"No, you won't be," he said.

Lea was looking out of the port at Dis and her eyes were dry now. "Way back in my deeply buried unconscious I think I knew it would end this way," she said. "If you think your little lecture on the Origins of Man was a novelty, it wasn't. Just reminded me of a number of things my glands had convinced me to forget. In a way I envy you your weightlifter wife-to-be, and your happy kiddies. But not very much. Very early in life I resigned myself to the fact that there was no one on Earth I would care to marry. I always had these teen-age dreams of a hero from space who would carry me off, and I guess I slipped you into the pattern without realizing it."

"Don't we look happy," Hys said, shambling towards them.

"Fall dead and make me even happier then," Lea snapped bitterly.

Hys ignored the acid tone of her answer and sat down on the couch

next to them. Since leaving command of his rebel Nyjord Army he seemed much mellower. "Going to keep on working for the Cultural Relationships Foundation, Brion?" he asked. "You're the kind of man we need."

Brion's eyes widened as the meaning of the last words penetrated. "Are you in the C.R.F.?"

"Field agent for Nyjord," he said. "I hope you don't think those helpless office types like Faussel of Mervv really represented us there? They just took notes and acted as a front and cover for the organization. Nyjord is a fine planet, but a gentle guiding hand behind the scenes is needed, to help them find their place in the galaxy before they are pulverized."

"What's your dirty game, Hys?" Lea asked, scowling. "I've had enough hints to suspect for a long time that there was more to the C.R.F. than the sweetness-and-light-part I have seen. Are you people egomaniacs, power hungry or what?"

"That's the first charge that would be leveled at us, if our activities were publicly known," Hys told her. "That's why we do most of our work under cover. The best fact I can give you to counter the charge is *money.* Just where do you think we get the funds for an operation this size?" He smiled at their blank looks. "You'll see the records later so there won't be any doubt. The truth is that all our funds are donated by planets we have helped. Even a tiny percentage of a planetary income is large—add enough of them together and you have enough money to help other planets. And voluntary gratitude is a perfect test, if you stop to think about it. You can't talk people into liking what you have done. They have to be convinced. There have always been people on C.R.F. worlds who knew about our work, and agreed with it enough to see that we are kept in funds."

"Why are you telling me all this super-secret stuff," Lea asked.

"Isn't that obvious? We want you to keep on working for us. You can name whatever salary you like, as I've said there is no shortage of ready cash." Hys glanced quickly at them both and delivered the clinching argument. "I hope Brion will go on working with us, too. He is the kind of field agent we desperately need, and it is almost impossible to find."

"Just show me where to sign," she said, and there was life in her voice once again.

"I wouldn't exactly call it blackmail," Brion smiled, "yet I suppose if you people can juggle planetary psychologies, you must find that individuals can be pushed around like chess men. Though you should realize that very little pushing is required this time."

"Will you sign on?" Hys asked.

"I must go back to Anvhar," Brion said, "but there really is no pressing hurry."

"Earth," said Lea, "is overpopulated enough as it is."

THE END

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VERNE ON WIDE SCREEN

WALT DISNEY'S admirable production of Jules Verne's "Twenty Thousand Leagues Under the Sea" seems to have set off a chain reaction in the motion picture industry. No other science-fiction writer—if we except Edgar Rice Burroughs by ruling out Tarzan—has had so many books transformed into films in so short a time, and the end is not in sight.

As I write this, two Verne pictures—good ones—are playing in Pittsburgh, and there are rumblings on the entertainment pages about at least two more to come. Ace has brought out an uncut reprint of the two books on which one of these—American-International's "Master of the World"—is based. It is their No. D-504, and was thirty-five cents when I got it. The second is a Czech production, released here as "The Fabulous World of Jules Verne." The American distributor is doing his best to conceal the foreign origin, as has been the case with several of the

Russian-made fantasies shown around the country as part of the cultural exchange program. I don't know whether the press book for the film clears this up; at any rate, some reviewers note the source, others don't.

The reason for this sudden attention to Verne is something about which we can only guess. It's worth remembering that the books themselves don't cost anything—they are in the public domain, and many or most were never copyrighted in the United States. The Verne name is still remembered as standing for "respectable" science fiction. Teachers and librarians know about him, even if the libraries haven't had his books for a generation or so, except in bowdlerized children's editions.

Furthermore, most of Verne's plots are good examples of romantic melodrama—the old corn that never ceases to make money, whether on the small screen or the large, in the women's magazines or the book clubs. Played reasonably straight, they give a producer a chance to use minor players in reasonably cheap costumes.

The two big-budget Vernes that started the whole thing—Disney's "Twenty Thousand Leagues" and Mike Todd's "Around the World in Eighty Days"—illustrate two of the three ways in which his books have been handled. Both, it seems to me, are legitimate, and I think Verne himself would approve.

First, and best, is a reasonably straight translation into the motion picture medium. That was Disney's method, and it is the method of the new "Master of the World." I hope it will be the method of the forthcoming sequel to "Twenty Thousand Leagues Under the Sea," which happens to be the first Verne book I ever read—"The Mysterious Island."

Second is the technique Todd used for "Around the World": an all-out entertainment, propped up by the framework of a Verne story but embellished by tongue-in-cheek "business." I have never seen the scripts of any of the plays Verne himself made from his books, but I think he would understand. This is why I enjoyed the Hollywood version of "Journey to the Center of the Earth," though many of the faithful groaned "Sacrilege!" This was in many ways the "farthest out" of Verne's books, in any case. The dinosaurs, to which many objected, had been put there by Verne himself—in fact, his were better than the film's, and he threw in a gigantic caveman herding mastodons that the producer hadn't the guts to leave in. The "geological" effects during the journey down the volcano were Hollywood at its best, even though they were fantasy rather than reality. I enjoy looking at Arlene Dahl at any time, and I like ducks, so even these two innovations didn't bother me. The picture was a delightful frolic hung on a Verne plot, and I think he'd have liked it.

On the other hand, there is a third approach, typified by what was done to "From the Earth to the Moon." Here a well-known Verne book, and the names of Verne characters, were

used in a typical Hollywood abortion. Instead of the *Columbiad,* Verne's giant cannon, we have a rocket propelled by atomic energy. There is a mad scientist aboard who sabotages the rocket. There are all the cliches of every space picture and none of the really good Verne bits. From all the advance blurbs, exactly the same treatment is going to be given to "Hector Servadac," the novel that Hugo Gernsback used to introduce *Amazing Stories.* Wild as that yarn was, with its community clipped off the Earth by a comet, carried around the solar system, and neatly returned after the voyage, it had nothing in it that would warrant one of the titles I've seen: "Valley of Dragons." If the hero's name has really been changed to Hector "Servador," as the newspapers had it, maybe the producer is working a tie-in with the refrigerator people.

But let's get back to the current fare, which I hope is still around when you see this.

The Ace paperback contains the two short novels that Verne wrote about the man called Robur the Conqueror. They were written many years apart, and an old friend—Richard Matheson—has done a screen treatment that incorporates parts of both books, not at all in the original order, and takes a few other liberties. In the original, the first book consisted of a tour of the world taken by Uncle Prudent, the Philadelphia tycoon, and his rival, Phil Evans. Robur—who at that stage was a conqueror of the air, and nothing more—kidnaped the two balloon enthusiasts after they refused to give him a hearing at a meeting of their Weldon Institute, a more genteel but less level-headed Gun Club. His heavier-than-air ship in that volume was the *Albatross,* a clipper ship suspended from propellers—and the English editions of the book are often called "Clipper of the Clouds." This story ends when the two prisoners and their standard Verne comic servant escape and wreck the *Albatross,* which goes down with all hands somewhere in the Pacific, but appears from the grave at the end.

The second and rather short volume introduces a mysterious craft that is automobile, submarine, speed boat and airplane, all in one. This is presented as a mystery investigated by John Strock, Chief Inspector of the United States Federal Police, who links the appearances of the mysterious craft with strange rumblings and plumes of fire from the Great Eyrie, an unscaled crag in the mountains of North Carolina. Eventually this turns out to be Robur's new craft, and by this time he does seem to have determined to rule the world.

In the film, Matheson has very successfully woven the disparate parts of the two books together without doing violence to Robur's character or Verne's approach and mood. The "eruption" of the Great Eyrie comes first—though that improbable structure is transferred to Pennsylvania, probably so that the

Weldon Institute can logically send its new balloon to investigate. Strock walks into the meeting rather than Robur, and Evans becomes the fiance of Uncle Prudent's niece, rather than the irascible old gentleman's contemporary. The niece, incidentally, is borrowed from another member of the Institute—she and a sister are mentioned two or three times in the book, for no visible reason.

At any rate, the two kidnapings become one: Prudent, Evans, Strock, and our heroine are brought down in the crater of the Eyrie—by rockets that do not have any support from Verne, though I doubt that he'd object to them—and picked up by Robur in the *Albatross*. This is a sort of hybrid between the flying clipper ship of "Robur the Conqueror" and the *Terror* of "Master of the World." It looks rather like Tom Swift's airship, but that was a dirigible and the *Albatross* a super-helicopter.

Robur, handsomely played by Vincent Price, is a cross between the gentleman inventor and the monomaniac of Verne's two books. Again Matheson has handled the contradictions nicely and arrived at a plausible compromise. Robur intends to put an end to war, if he has to destroy the world to do it. His method is to bomb the capitals of the world with what act like atomic bombs, whereas the original Robur merely hung up flags.

Two thirds of the way through, things begin to fall apart. The plot to destroy the *Albatross* is well advanced, Robur is chewing up scenery, and the producer is using old film clips for aerial views of Robur's attacks, that merely make things silly. For example, in 1848, he flies over a London where the Globe Theater is still standing—the opening, I believe of Olivier's "Henry V." Later we get a battle scene from "Three Feathers" or "Beau Geste." The British navy, bombed from the *Albatross*, seems to be composed of galleons from some Elizabethan sea-epic. But even with these shortcomings on the producer's part, "Master of the World" is a good translation of Verne, that hangs together better than the two original books.

"The Fabulous World of Jules Verne," on the other hand, is a pure frolic. According to *Life*, it is based on a book called "A Deadly Invention," which isn't in a set of allegedly complete works of Verne that I have, and isn't mentioned in the bibliography of I. O. Evans' "Jules Verne, Master of Science Fiction." From the introduction to that book, I suspect the plot derives from a novel called, in its English editions, "For the Flag."

This is another master-of-the-world plot, in which the villainous Count Artigas, piratical captain of a submarine much like Captain Nemo's *Nautilus* and master of an island base like Robur's, kidnaps the inventor of an atomic explosive and his young assistant. The joy of the picture, however, is that the Czechs have based their rather short melodrama on the Nineteenth Century woodcuts and engravings with which the original editions of Verne's novels were

illustrated, and have produced their picture in a mixture of cartoons and live action in which even the sets are striped in black and white like the woodcuts on which they are based.

The pre-Iron Curtain Czechs were noted for their humor, and apparently this is still alive even if it can only be used to lampoon a Western author. The picture starts as a gentle pastiche on Verne and his clichés, and grows broader as it goes on, until by the end it is parodying both Verne and itself. We have a well-endowed, demure, and eminently practical heroine who irons her dress with a heated ramrod from Artigas' cannon. We have one-man bicycling helicopters, and a pudgy little dog-paddling submarine that comes to the rescue but is scragged by Artigas' pirate sub in a wild chase. There is a spring-wound machine-pistol, and a troop of camels on roller skates. There is also a highly realistic kraken, a fantastic castle in the crater, and some wonderfully monstrous machinery. The deft combination of the old woodcut style with the stylized sets and acting is a pure delight, especially in the undersea vistas through the picture windows of the pirate sub.

If this ever becomes available on 16-mm film, I hope to see it shown at science-fiction conventions for many years to come. There's a chance that "Mysterious Island," if it is done in the mood of "Master of the World," will be as good. I don't hold out any hope at all for "Hector Servadac"—or "Servador"—and I don't know what other Vernian epics may hit the screens in the neighborhood theaters along with these predicted two.

VULCAN'S HAMMER, by Philip K. Dick.

THE SKYNAPPERS, by John Brunner. Ace Books, New York. No. D-457. 139 + 115 pp. 35¢

Both these yarns are in book form for the first time. You'd read 'em automatically in a magazine, but I don't know why you'd bother to hunt them out on a newsstand book rack.

Philip K. Dick has done so much that is so much better than this tired-formula story, that "Vulcan's Hammer" is more of a letdown than, perhaps, it should be. Earth of the future is a sectioned-up oligarchy dominated by a hidden super-computer, Vulcan III. Vulcan II is still functioning, under a canopy of dust and cobwebs. Vulcan I we never meet. But things are going wrong with the smooth operation of the government. The usual underground is functioning in the usual efficient way. Various venial varlets in high places are plotting among and against each other. And—it eventually appears—Vulcan III has grown impatient and started building himself a law-enforcement squad of flying hammers.

It turns out just as you'd suppose.

Oddly—and I guess this is more than coincidence—the other side of the book gives us another super-computer. This time it's called Solver, and it was built by a Grand Old Race

long since lost in time and the depths of space. But a determined and mild-mannered underground, the Movement, wants Solver to tell them how to overthrow the moribund, corrupt, tyrannical Galactic government. Being too mild to ask warlike questions properly, the leaders dredge up a retired soldier from Earth, a warrior maiden from another barbarian world, and tap a couple of their own oddballs to pry out Solver's secret. It's obvious but colorful, and has a few nice twists.

THE ATLANTIC ABOMINATION, by John Brunner.
THE MARTIAN MISSILE, by David Grinnell. Ace Books, New York. No. D-465. 128 + 127 pp. 35¢

The new half of this book, by English writer John Brunner, reads like something H. P. Lovecraft might have done if he were alive and hypnotized into writing scripts for Hollywood monster movies. The flap half is a reprint of the preposterous Avalon book in which our hero is imprinted with the compulsion to carry a dying Martian's message to Pluto.

John Brunner doesn't link his extraterrestrial monsters of the far past with Lovecraft's Cthulhu, but they have the same approach to humanity, if rather more ordinary powers. Anyway, long, long ago the Earth shook and their resort at the bottom of what is now the Atlantic was submerged. One of the Masters was killed; the other simply holed up in the ruins of a city his human slaves had built for him. Then an oceanographic expedition rouses him, and he moves in to take over Earth again.

Pretty ordinary—both sides.

THE RIM OF SPACE, by A. Bertram Chandler. Avalon Books, New York. 1961. 220 pp. $2.95

As Isaac Asimov chronicled the Foundation . . . as Robert Heinlein built his Future History . . . as L. Sprague de Camp pieced together the empire of the Viagens, and Murray Leinster is even now constructing the universe of the landing grids . . . so A. Bertram Chandler has been constructing the epic of the Rim Worlds and their bristly, pawky, individualistic spacefarers. This book is expanded from a novelette, "To Run the Rim," published here in January 1959.

To city-bred folk, the thought of a starless sky probably has little or no significance: if they want to see stars, they can go to a planetarium. But to a country boy, the vision of a night of total blackness—nothing but emptiness for light-year on light-year—is enough to bring a shiver. And that is the world of the Rim Stars, out at the very edge of our galaxy. Their people have the poverty and the fierce independence of frontiersmen everywhere; they are clannish and suspicious of strangers, generous and loyal, and no fools.

By introducing a cast-off from the Interstellar Transport Commission,

Derek Calver, to this sprawling yet tightly knit culture, the author has a good chance to explore its contradictory characteristics in terms of plot and action. Needless to say, Calver finds his place on the Rim when it is all over.

This is a pleasant adventure that deserves to be built up in other books about the Rim.

PLUTONIA, by Vladimir Obruchev. Criterion Books, N.Y. 1961. 253 pp. $3.95

This is a juvenile adventure story by a Russian geologist, who died in 1956 at the age of ninety-two. The Russian edition came out in 1924, and is one of three science-fiction novels he wrote on exploration of then unknown corners of Asia. In this case, his scientists follow Jules Verne's and Edgar Rice Burroughs' heroes into a world inside the Earth.

Although he confesses that he was inspired by Verne's yarn, and does not mention Burroughs or "Pellucidar," his inner world is much more like the latter. Verne's heroes, after all, went down the throat of a volcano and were never confused as to which was up and which was down. The wonders they saw were in gigantic caverns inside the planet's crust, while Pellucidar and Plutonia are on the inside of a hollow planet with an inner sun.

Quite evidently, what Obruchev was trying to do was to show his young readers the sequence of life forms that have inhabited the Earth, by using an analog to the succession of life zones as one climbs a mountain. As his expedition descends into a great hole in the crust near the eighty-fourth parallel, it comes first to the mammals—and people—of the Pleistocene, then passes back through ever older forms to the dinosaurs, and eventually to colonies of huge, rather highly evolved ants. The illustrations, by a Russian zoologist, are excellent though they don't always match the text: a cave bear turns into a sabertooth, for example.

Good juvenile fare.

MEETING AT INFINITY, by John Brunner.

BEYOND THE SILVER SKY, by Kenneth Bulmer. Ace Books No. D-507. 1961. 155 + 100 pp. 35¢

In all the discussion of the creative editorship of John Campbell, and Horace Gold, and Anthony Boucher, and Robert Mills, and Cele Goldsmith, American fans all too often forget the solid job that has been done in England by John—alias "Ted"—Carnell, editor of *New Worlds, Science-Fantasy,* and *Science Fiction Adventures.* He got no credit at all when an American publisher brought out a short-lived reprint of *New Worlds Science Fiction;* when that folded, he invaded the United States with an American edition of his own. It's been on sale in a smallish town about thirty miles from Pittsburgh, but

never in the city, where a monopolist-distributor seems to feel that he is doing the public a favor when he puts *Life* and *Time* on most of the newsstands.

I suspect it's a moot question whether Carnell discovered the "big names" of British science fiction—Wyndham, Clarke, Russell, Christopher—or whether they discovered him. Whatever the answer, there is no question at all about the "new wave": Tubb, Aldiss, and to get to my point, Kenneth Bulmer and John Brunner. Both have been coming along fast under the Carnell spell, and Ace has done its duty by bringing them to us west of the Atlantic.

John Brunner, in particular, gets better every time 'round, and "Meeting at Infinity" is certainly one of his best stories. He gives us a complexly stratified society, organized around commerce with multiple worlds, with as many clashing and intermeshing forces as van Vogt ever brought into play—and makes them more believable than van Vogt has done in anything since "Slan." He deftly shifts the spotlight of action from character to character, giving us a glimpse of the total situation first from one aspect, then from another. He has one fascinating character in the underworld spider, Jockey Hole, and a cryptic one in the cocooned cripple, Allyn Vage, whose savage hunger for vengeance precipitates the downfall of a universe. He has her secret . . . and that of the mysterious village of Akkilmar . . . and the whereabouts of one man whose memory was not erased. He has the concept of an empire of trade where every shift of power and profit turns society inside out. He has, in short, one of the most fascinating SF intrigues I've read in a long time.

Kenneth Bulmer's story, "Beyond the Silver Sky," comes from *Science Fantasy* No. 43. The concept behind it isn't wholly new, but it is well handled in organization and detail. Some time in the far future, Man has been forced back into the sea—perhaps by atomic war that made the planet's surface uninhabitable, perhaps by an attack from the stars, perhaps for other reasons. He breathes water and fights on shark-back, but ruthlessly kills infants that are born with scales or webbed hands. He looks on the surface of the sea as a silver sky through which strange creatures appear from time to time, but has no memory of ever having lived there. And the sky is coming ever closer to his outposts and cities alike, as—for a reason never explained—the seas shrink.

Keston Ochiltree, trained for the Emperor's shark cavalry, is given an opportunity to join a scientific expedition that is going to see what is beyond the sky. Then the Zammu, hereditary enemies of his people, attack, and he must decide for battle or science. The decision made, he must cope with the discoveries of the strange expedition. Chances are there will be other stories in this series.

The Brunner half of the book is better than many that are coming out in hard covers. The Bulmer half

is good entertainment. The combination is a real bargain.

NIGHTMARES AND GEEZENSTACKS, by Fredric Brown. Bantam Books No. J-2296. 137 pp. 40¢

Fredric Brown has brought the art of the "blackout" story to a point of perfection that it's going to be hard to beat. This plump paperback contains forty-seven typical yarns, most of them only a page or two in length, one only fourteen lines long. Some of them have appeared in various magazines, though no credits are given . . . an unusual oversight for Bantam, which is usually pretty honest about those things.

Practically every story has a snap ending, which may be a pun, a twist of the imagination, or just about anything you can think of. Many are fantasies, some are science fiction, a few are crime stories, and one or two are "straight." None of them can be described without giving away the punch line or gimmick or both.

I can only say that this outrageous potpourri shouldn't be missed, and that it probably shouldn't be read all at one time. If you object to bawdiness, I suppose it shouldn't be read at all, but any attempt to clean up the tales that are "dirty" would destroy their point and their reason for existing at all. Fred Brown has simply dedicated himself to the principle that nothing is too self-important as to be beyond parody or humor. That goes for death, religion, and it goes for sex. It even goes for science fiction.

THE MYSTERY OF ARTHUR GORDON PYM, by Edgar Allan Poe & Jules Verne. Associated Booksellers, Westport, Conn. 1961. 191 pp. $3.00

This is one of the volumes in the Fitzroy edition of Verne, and one of the least known. It is Verne's sequel to Poe's strange novel of the sea and the supernatural, "The Narrative of Arthur Gordon Pym"—which is also available now in the Hill & Wang "American Century Series" of paperbacks, for $1.45.

Verne opens with a condensation of Pym's narrative, then turns the story over to a stranded wanderer in the Pacific, who is picked up by Captain Len Guy of the schooner *Halbrane*. It soon develops that Guy is the brother of the captain of the ship on which Pym sailed into the weird waters near the South Pole, and that he intends to go there himself to find out how the story ends. Then they find evidence that the elder Guy may still be alive . . . and that Pym himself vanished behind the curtain of cloud near the Pole.

The story then proceeds with mutiny, mystery and adventure, ignoring some of the puzzles in Poe's tale, solving others, and winding up with an "explanation" that is based on a superstition still extant in Verne's time. If the current rage for Verne

films continues, this is a natural for a script that departs from both Poe and Verne and re-invents Poe's hypothetical white race at the Pole.

IF THE SOUTH HAD WON THE CIVIL WAR, by MacKinlay Kantor. Bantam Books No. A-2241. 1961. 113 pp. 35¢

This is expanded from the version in *Look* of last November 22nd. It is, in effect, an alternate time-track history of the United States from May 12, 1863 to the present. The event that caused the split in time was the death of Grant, thrown from his horse when a hound chased a kitten across a country road near Vicksburg. The book ends on the centennial of Fort Sumter, as the presidents of the Confederate States, the United States, and Texas meet to consider re-uniting against the threat of a Russia that never sold Alaska.

Some Civil War buffs saw red at the *Look* feature's "perversion" of history. However, it seems to me that the more you know about "our" Civil War, the more you will be able to appreciate the subtle changes the author has introduced in this alternate world, and the logic of the historical changes that follow them.

The classic of this form is Winston Churchill's contribution to the series of essays in "If, or History Rewritten," edited by J. C. Squires, and published by Viking in 1931, after prior publication in *Scribner's*. Its title was: "If Lee Had Not Won the Battle of Gettysburg." Closer to our time is Ward Moore's novel, "Bring the Jubilee." MacKinlay Kantor, whose "Long Remember" is one of the great novels of our Civil War, is in good company with this excursion in "if".

THE RE-REPRINTS

TRIANGLE, by Isaac Asimov. Doubleday & Co., Garden City, N.Y. 1961. 516 pp. $4.95

I believe Doubleday put this out as a book-club bonus, and a bonus it certainly is. Here are three complete novels, and good ones: "Pebble in the Sky," here in 1950; "The Stars, Like Dust," from 1951; and "The Currents of Space," vintage 1952. "Stars" was "Tyrann" in *Galaxy*.

THE BEST FROM FANTASY AND SCIENCE FICTION. FIFTH SERIES, edited by Anthony Boucher. Ace Books No. F-105. 1961. 253 pp. 40¢

Note the new price. I don't know whether it is going to be made retroactive, or not. This is one of the most imposing of the series: Asimov, Brown, Blish, Beaumont, Boucher, Clarke, Clingerman, de Camp, Davidson—his debut, Henderson, Jackson, Walter Miller, Matheson, Oliver, and some more.

THE BODY SNATCHERS, by Jack Finney. Dell Publishing Co., N.Y., No. B-204. 191 pp. 35¢

A re-issue of the thriller that made a pretty good monster movie and

was good enough for *Collier's* back in 1954.

THE SWORDSMAN OF MARS, by Otis Adelbert Kline. Ace Books No. D-516. 1961. 174 pp. 35¢

Reprint of the Avalon edition of the old *Argosy* serial: a pale imitation of Burroughs' "John Carter."

HE OWNED THE WORLD, by Charles Eric Maine. Avon Books No. T-524. 1961. 144 pp. 35¢

H. G. Wells did it better in "When the Sleeper Awakes." From last year's Avalon hardback, and better than most of Maine's.

SKYPORT, by Curt Siodmak. Signet Books No. S-1939. 1961. 159 pp. 35¢

Building of a space station. Crown published the hardback edition in 1959.

NOT WITHOUT SORCERY, by Theodore Sturgeon. Ballantine Books No. 506K. 1961. 160 pp. 35¢

Nine pretty-nearly-classic stories that were published here and in *Unknown* between 1939 and 1947, then collected in the hardback edition in 1948, with comments by the author on how each story was written.

THE SYNTHETIC MAN, by Theodore Sturgeon. Pyramid Books No. G-636. 1961. 174 pp. 35¢

A new paperback edition of "The Dreaming Jewels," one of Sturgeon's strangest early novels.

SLAN, by A. E. van Vogt. Ballantine Books No. 511K. 1961. 159 pp. 35¢

One of the classics of all time—which is why Ballantine is reprinting it again. Incidentally, the Arkham House edition is not credited on the copyright page. This is the rewrite for Simon and Schuster in 1951.

JOURNEY TO THE CENTRE OF THE EARTH, by Jules Verne. Associated Booksellers, Westport, Conn. 1961. 224 pp. $3.00

One of the latest releases in the Fitzroy edition—this time really a new translation by I. O. Evans, himself a geologist. Hardcover, of course.

THE WAR OF THE WORLDS and THE TIME MACHINE, by H. G. Wells. Dolphin Books No. C-304. 1961. 276 pp. 95¢

Here they are again, in a new series of Doubleday paperbacks.

TOMORROW, by Philip Wylie. Popular Library No. PC-1005. 1961. 286 pp. 50¢

Wylie's Civil Defense sermon. When the bombs begin to fall, the Good Little Town is saved; the Bad Little Town really gets it!

BRASS TACKS

Dear Sir:

An H. G. Wells Society has recently been founded, composed of persons interested in the life and work of this distinguished author, who are anxious to encourage a wider understanding of his writings and ideas. The Society publishes a bimonthly journal, *The Wellsian,* has local branches in London and Manchester, and intends to carry out an ambitious programme of study, research and dissemination of the works of one who made such an outstanding contribution to modern thought. I would be most grateful if any of your readers who may be interested in the Society would kindly contact the undersigned, from whom further details can be obtained.—J. R. Hammond, The H. G. Wells Society, 39, Rugby Road, West Bridgford, Nottingham, England.

The Wells of "The Time Machine" or the Wells of "A Study of History"?

Dear Mr. Campbell:

With reference to your editorial in the June issue of *ASFF,* I agree that ideological wars are indeed usually more savage than wars fought for limited political ends. However, I must offer some objections to the naive economic determinism on which your article is based.

It was and is a favorite contention of Southern apologists that the abolitionists were really responsible for the Civil War because of their intransigent attitude toward the problem of slavery. But surely it is a grave distortion of the situation to ignore Southern extremism and in-

transigence. It is hardly likely that the problem of slavery would have disappeared if there had been no abolitionists, since there is no indication that even moderate leaders in the South were willing to make any compromise which would have tended to limit the spread of slavery. The fact is that there were in the North a large number of people who were by no means abolitionists but who believed that some check must be put on slavery to keep it from spreading from the states where it already existed. It is incorrect to state that Lincoln did not take a "firm, four-square stand against slavery." Lincoln was firmly against slavery and determined that it should eventually be ended. What he did *not* believe was that the immediate and universal freeing of slaves was the way to do it. He was willing to compromise on the *means* by which slavery was to be checked, even if it meant guaranteeing its survival in the slave states. He summed up the basic issue in a letter to John A. Gilmer of North Carolina when he said that the only substantial issue of difference between them was that "you think that slavery is right and ought to be extended; we think it is wrong and ought to be restricted." This basic difference could not be compromised.

It is often contended that slavery would have died out naturally if the Civil War had not put an end to it. This is not a fact, however; it is merely a supposition. How do we know that slavery could not have been made to work in the western territories? We think that it is obvious that an industrialized society requires free labor. But again, how do we know that slaves could not have been trained to work in factories? Just because it didn't work out that way, does not mean that it could not have. I'm afraid that your picture of the South emancipating the slaves and accepting full-scale integration by 1910 is nothing but wishful thinking. Human beings and human institutions are much more complicated than you seem to think. Putting all the blame for the Civil War on the abolitionists is oversimplifying things to the point of absurdity.

Anyway, keep up the good work. I enjoy reading your editorials even when you are wrong.—Paul M. Lloyd, 635 Ripley Street, Alexandria, Virginia.

How do I know slaves can't be trained to work factories? Because the whole history of the Industrial revolution shows that, in fact, they never were.

Dear Mr. Campbell:

Here is an other world murder for your Brass Tacks Department.

The landing and greeting of otherworld life has been a concern of writers for years. I do not go along with all the flying saucer jazz, but when the dust settles things may turn out in favor of the believers. Here is a 141 year old account of a man that apparently destroyed a be-

ing from outer space which appeared in the *American Journal of Science & Arts,* pp. 335—337, 1820, by Rufus Graves.

Between eight and nine o'clock August 13, 1819 at Amherst, Massachusetts, an observer saw a meteor fall nearby with a heavy explosion. The next morning he found a "gelatinous meteor."

"This substance when first seen by the writer was entire no part of it having been removed. It was in a circular form, resembling a sauce or salad (sic) dish bottom upwards about eight inches in diameter and something more than one in thickness, of a bright buff colour with a fine nap similar to that on milled cloth which seemed to defend it from the action of the air. On removing the villous coat, a buff coloured pulpy substance of the consistence of good soft soap, of an offensive, suffocating smell appeared; and on a near approach to it, or when immediately over it, the smell became almost insupportable, producing nausea and dizziness. A few minutes exposure to the atmosphere changed the buff into a livid colour resembling venous blood. It was observed to attract moisture readily from the air. A half-pint tumbler was nearly half filled with the substance. It soon began to liquify and form a mucilaginous substance of the consistence, colour, and feeling of starch when prepared for domestic use. The tumbler was then set in a safe place, where it remained undisturbed for two or three days; and when examined afterwards, the substance was found to have all evaporated, except a small dark coloured residuum, adhering to bottom and sides of the glass, which, when rubbed between the fingers, produced a fine ash-coloured powder without taste or smell; the whole of which might have been included in a lady's thimble."

The moral of this account is: if you happen to see a meteor land and something walk out—don't hit it with a stick—Garold S. Beals, 1031 Lakeview Drive, Auburn, Alabama

Cosmonautical Jellyfish, maybe?

Dear Mr. Campbell:

I was extremely interested in the July Issue containing the story by A. W. Orton, "The Four-faced Visitors of Ezekiel," and was sufficiently intrigued to check line by line against my copy of the Bible. This gives many alternative meanings as footnotes, and you may be interested to know that two apparently obscure points have alternative meanings which bear out Mr. Orton's arguments.

In Line 4 ". . . a great cloud, and a fire *infolding itself*" is alternatively given as "a fire *continually flashing,*" and this would certainly apply to a mechanical object, rather than to a natural phenomenon.

Line 22 ". . . and the likeness of the firmament . . . was as the colour of *terrible crystal*" alternatively

reads ". . . the colour of *ice*" and this would confirm the appearance as glassy or a clear solid.

"More power to your elbow!"—F. Spenser, A.C.W.A., F.C.A., 42 The Gardens, Heath Road, Halifax, England.

If I ever get a time-viewer, I'm going to take a look for myself; that's about the only way to know!

Dear Mr. Campbell:

Henry David Thoreau seems to have anticipated your August editorial, "Pie in the Sky." In his essay "On the Duty of Civil Disobedience" he says, ". . . this government never of itself furthered any enterprise, but by the alacrity with which it got out of its way. It does not keep the country free. It does not settle the West. It does not educate. The character inherent in the American people has done all that has been accomplished; and it would have done somewhat more, if the government had not sometimes got in its way. For government is an expedient by which men would fain succeed in letting one another alone; and, as has been said, when it is most expedient, the governed are most let alone by it. Trade and commerce, if they were not made of India rubber, would never manage to bounce over the obstacles which legislators are continually putting in their way; and, if one were to judge these men wholly by the effects of their actions, and not partly by their intentions, they would deserve to be classed and punished with those mischievous persons who put obstructions on the railroads."

Here's at least one thing that hasn't changed which should bring a ray of light to the status quo boys.—Walter Trench, 107 Wheeler Avenue, Westwood, New Jersey.

Creative minds have a tendency to leak through any obstruction—but that doesn't mean Obstructionism is a good thing!

Dear John:

Splitting a microwave beam and recombining it in 180° phase opposition is old stuff in a magic tee or hybrid, or just in a tee, for that matter. In a magic tee, which has four arms, it goes out the other arm. In a three-arm tee it goes right back the way it came—it is "reflected". The same would hold for a laser. Energy and momentum are conserved.—J. R. Pierce

Why didn't they say that years ago!

★ ★ ★ ★ ★

(*Continued from page 6*)

The second stage is beautifully illustrated by Edison's work; Edison did not need a Patron, nor inherited wealth, nor a successful import-export business, because his early inventions earned him money enough to pay for the research that led to further inventions.

The engineering-supporting-science system was quite well under way by 1930; most of the major industrial research laboratories were carrying out—or patronizing!—various programs of basic scientific research. Typically, the Bell Telephone Laboratories first isolated vitamin B-1, which didn't constitute applied research for the Bell Telephone System, except in that it helped keep their customers alive and healthy. Too, Bell Labs men first demonstrated the esoteric bit of data that electrons did indeed behave like waves, rather than particles, when bounced off a nickle crystal. Pure, impractical, consumption-without-profit research.

But it was one part of the data that led, several decades later, to the then-quite-unimaginable transistor.

In summary, then, up to about 1930, Western Culture had developed something new in history—Experimental Science.

The process differed fundamentally from the development of Mysticism, the other great branch of Pure Research of the human mind, in that Science required economic goods for its own existence, not merely for the scientists who worked at it.

The First Stage development was carried out under the Patronage system, where wealthy men, who had gained economic goods in some way, invested them in Science. This process was, essentially, pure whim—pure intuition-hunch, since, as of that time, Science had shown no logical evidence of being economically valuable. The Scientist and the Painter were in precisely the same position; each had an arcane Art that he felt was important. The Painter was somewhat better off; his results at least had aesthetic value, while the Scientist, stewing his concoctions, produced nothing but highly unaesthetic stinks. The closest Science came to producing economic values in that period was gunpowder, and a variety of highly concentrated and effective poisons. These, the Noble Patrons of the Borgia family found of great value.

The Second Period started when chemical engineering began to pay its own way, and pay for what a modern company calls "the R & D department"—process improvement research. Various engineering sciences developed, and began applying some of their profits to engineering science research. In the main, during this period, Pure Science remained the province of Universities and patronized experimenters.

The Third Period grew gradually out of the Second, as great industrial engineering companies attained economic positions strong enough, with enough free profits, to act as Patrons for Pure Science themselves—but

now with a realization that, eventually, Pure Science could be expected to yield on economic value.

Thus, for instance, Bell Labs, which started from Bell's engineering-science discovery of the telephone, General Electric, which started with Edison's engineering-science researches, and du Pont Chemical Company, which began as a successful chemical engineering enterprise, all establish programs of pure science research.

But now let's look at another side of this matter; Science was a product of Western Culture . . . but, by 1930, something new had happened. Western Culture was becoming *a product of Science!*

The simplest and clearest epitomization of that—a clean-cut example of the immense revolution of human history—is simply this: Neither Mary Baker Eddy, nor the W.C.T.U. had as great an effect on the mores and social structure of Western Culture as did the Model T Ford.

Consider one more possibility; the nudity taboo is well over a millennium old in Western Culture. If, tomorrow, someone introduces a transmitterless TV system . . . the nudity taboo will be gone within a decade.

No amount of political orating could do that.

No amount of thundering from the pulpits, or praying at altars could do that.

No philosophizing has ever been able to achieve it.

But introduce one technical device . . . and the taboo goes. A good many millions of individuals will go into complete insanity, of course—the prudes and the paranoids both.

In all the past history of the world, there have been three major forces in civilizations: Popular Mores, Politics and Religion. Now, there is a fourth —Science.

A Mystic's revelation applies only to those who accept it. A Scientist's discovery applies with fine impartiality to those who accept it, and those who violently reject it. Science is the first major force in human cultures that *is not subject to human will and opinion.* Such a thing has never existed before.

Politics *claims* to make laws which regulate the interactions of men. Its complete incompetence to *direct* human affairs is simply and clearly demonstrated by the famous "Noble Experiment" or Prohibition. Politics passed laws . . . and popular Mores remained almost totally uninfluenced, so people continued to do pretty much as before. Introducing a law doesn't change popular Mores.

Religions claim to shape popular Mores. That's equally false. Like Politics, sometimes a particular religious group tries, and tries hard and sincerely . . . but they achieve nothing, unless the popular Mores is willing to accept it.

Popular Mores has, throughout human history, been the ruler; Politics and Religion have, age after age, survived solely by quickly snuggling up to whatever popular Mores may

have decided on, and expressing what the people wanted expressed.

And the people—noble oratory to the contrary notwithstanding—are anything but the type currently popular as the Common Man. They're rather different, as indicated by the things they do in fact choose, when they gain full control, as they did in Imperial Rome.

That period, incidentally, is a fine example of what Politics and Religion do when popular Mores gets going. Popular Mores wanted Corn and Games—free food and free public sadism. The Roman people didn't dispose of Nero and Caligula because of their unprintably foul and obscene practices; those were perfectly normal-acceptable in the then-current popular Mores. Politics, of course, supported the Games, and Religion blessed them. The details should be more widely understood, so that people could better understand the actual nature of what the Common Man can quite happily accept as Social Justice.

In any epoch of human history, "Social Justice" is precisely what the popular Mores says it is.

Then there's the other extreme, when a full-scale, all-out Puritanism comes in, and Social Justice acquires an utterly different cast of insanity.

And in every one of these wild swings, no matter how extreme, or how swift, Politics and Religion have gone along. It's the old game, played the same way, in both fields. If the current politicians won't give us what we want—let's have a revolution. If the current gods won't bless what we want—get new gods who will.

And if, by any chance, you think that *that* sort of thing doesn't happen any more . . . remember not only that the Communists banished all gods, but that the Nazis were busy reintroducing some old gods, since the Christian churches weren't going along with the new Social Justice as applied to Jews.

Social Justice *is*, and always has been, what the popular Mores—however fantastically evil, or fanatically rigid that may be—says it is.

Science is the first force in human history that has absolute, real-world anchors of judgment, based on factors not controlled by human wills and/or opinions.

In other words, Science is cold, inhuman, merciless, dictatorial, authoritarian, unreasonable, evil, amoral . . . all the things human beings say of someone or something that will not yield one iota to the force of their emotional insistence.

Religions have always yielded; Politics yields even more quickly. These are Noble, Spiritual, Human forces—i.e., forces subservient to popular Mores.

Science, that damnable, materialistic, cold and inhuman thing, is absolutely immune to human desire and anger. It is God's Will . . . but the Will of a God who rewards liberally those who accept and apply his basic laws, and who does not yield in the slightest to the screams of outraged Social Justice.

If New Yorkers cease laying burnt offerings in the furnaces of the Con Ed temples to the great God Electricity on the East River . . . the lights go out, the elevators stop, and the services of the city rapidly crumble. And beating the priests won't do a bit of good. And setting up a new god, or an old one like Wotan or Zeus, won't help either.

Science is able to impose changes in cultural Mores—and popular Mores is unable to impose changes on Science. Science changes Mores by offering individual rewards.

Some of you may recall that, during the early '30's, there was a great deal of discussion to the effect that Science should take a ten- or twenty-year holiday—that we should declare a Moratorium on Science, until social systems had a chance to catch up.

The fact was that the culture was becoming aware of a powerful influence that could not be made to yield; they didn't want time to catch up—they wanted time to stop the damnable materialistic . . . and captivating! . . . thing.

They succeeded pretty well during the next decade or so. Social Justice did it.

Science, unlike Mysticism—which includes Politics and Religion—*must* have economic support.

In the name of Social Justice, we can strip away—through corporate and individual income taxes—the funds that would otherwise be available to Science. When all the funds that Science must have to exist are funneled through Politics . . . lo! popular Mores is in control again!

Edison could support his researches by the wealth he earned on his early inventions. Not any more, though! Edison wasn't slugged with a ninety per cent income tax!

You see, these terrific taxes are *necessary* now, because the Government has to pay those huge Scientific Research bills. Nobody else can afford to pay for that research.

Not while the government keeps them from acquiring the money, they can't!

And so long as Politics controls the funds for Science . . . that nasty, infuriating, inhuman, dictatorial force won't be free to interfere with the ancient right of the Common Man to force Politics and Religion to any insane extreme he wants.

There is a type of culture imaginable that no society anywhere has ever tried. A culture based on Free Private Science—not just Free Private Enterprise, but the right of geniuses to advance Science as fast as they can, in whatever direction they can.

Such a culture will be inhuman—it will hold that the Right to your Own Opinion is strictly limited. The right will exist only to the extent you can make it comply with the laws of the Universe. (And note carefully that Newton's Law of Gravity is *not* a Law of the Universe. It's merely Newton's opinion of what that Law is.)

It would be a culture in which, for the first time, human will was truly leashed by Universal Will!

The Editor.

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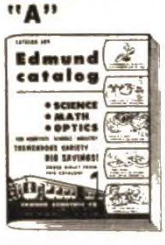

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