ASTOUNDING

SCIENCE-FICTION

A STREET & SMITH PUBLICATION

20¢

NOV. 1939

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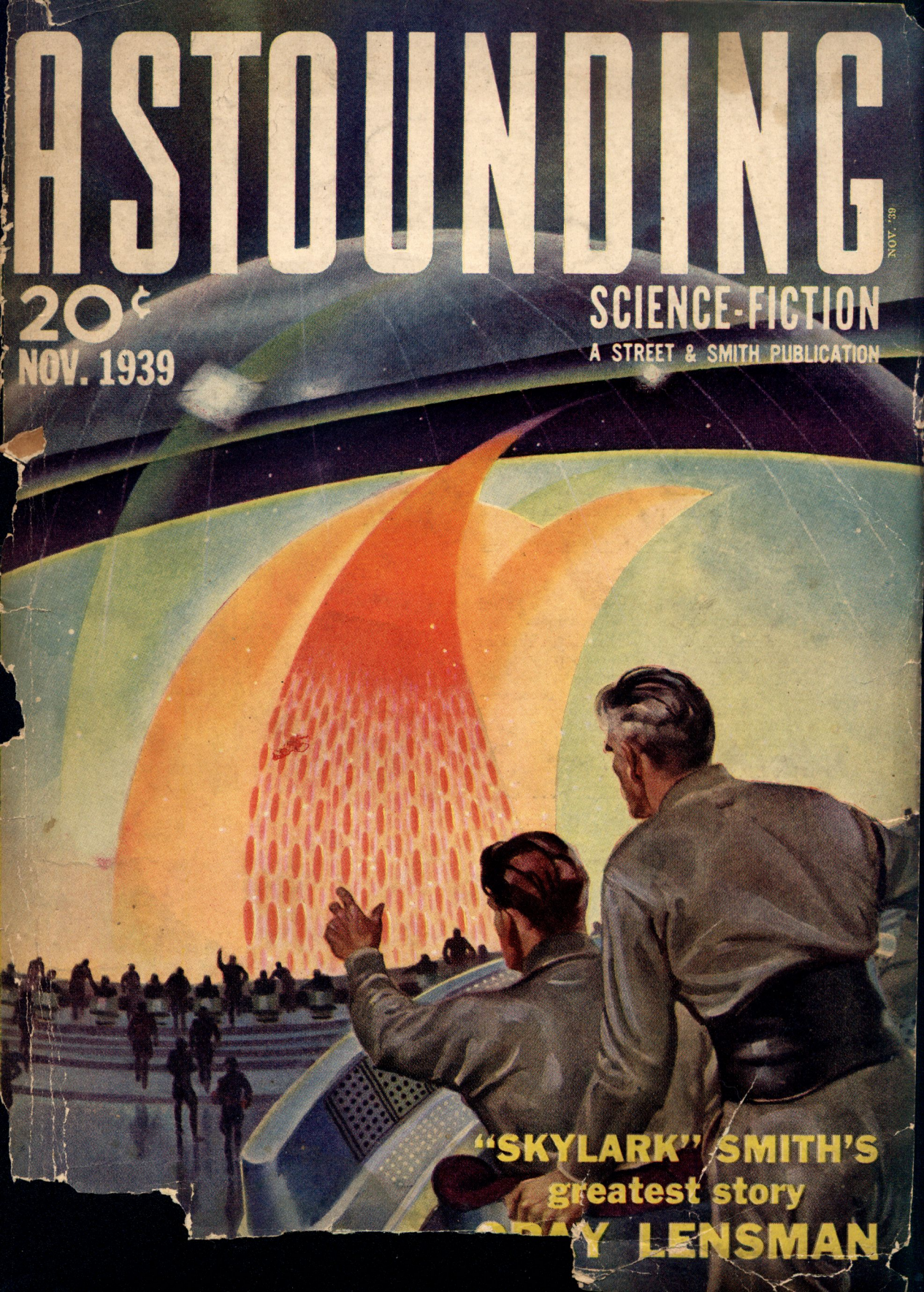

"SKYLARK" SMITH'S
greatest story
GRAY LENSMAN

A YEAR AGO HE WAS SET TO BE FIRED

... NOW HE'S RIGHT-HAND-MAN TO THE BOSS!

"YES sir," continued Joe, "his desk used to be right next to mine—now look where he is."

Half proudly and half enviously he and Frank watched Ed as he swung down the company steps, his arm linked in that of J.P., the head of the firm. Ed is getting $7,500 a year now, while Joe at $5,000 is a long way ahead of Frank, a newcomer.

"Boy, he must be plenty smart," said Frank.

"Plenty smart is right," said Joe. "Ed has a lot on the ball, but in spite of that he was slated to go."

"For what?" Frank wanted to know. "A guy like that . . ."

"Well, maybe you wouldn't believe it, but it was his breath . . ."

"Drank a lot, eh?"

"Not Ed. Never a drop, but most of the time he had a case of halitosis* that would knock you down."

"One of those birds, eh? Didn't he read the Listerine Antiseptic ads. Didn't anybody tip him off?"

"Sure, I tipped him off, but not before he almost got the toss. You see, Ed had to see an awful lot of people—close contact stuff. At first they never said anything about it, but later on that breath of his was getting him in bad with his customers. Finally a few of the crustier ones began to write in, complaining, and at last J. P. himself got on to it."

"You'd think J.P. would say something . . . a good man like Ed."

"I understand he did, Frank. Maybe he didn't make it plain enough. Anyhow Ed never took a tumble—and his job hanging in the balance."

"Chump!"

"You said it. But there's hundreds like him; suspecting everybody but themselves."

"Well," demanded Frank, "what happened?"

"I got Ed out one night. After a couple of drinks, to give me courage, I let him have the bad news about that breath of his. Told him he better get going on Listerine and keep it up if he wanted to stay on with the firm."

"You certainly didn't pull your punches."

"I certainly didn't. And boy, was he sore at first. And then grateful. Worked my hand up and down like it was a pump handle. Since then you never saw a guy so careful about the impression he makes on others."

Frank nodded. "The last place I worked, they were plenty fussy about that sort of thing. I think every firm should have a standing order 'Listerine Antiseptic before you call on a customer.' I guess it pays."

"And how! If you think it didn't, just look at Ed; he sure is going places."

***Nobody is immune!** Everybody probably has halitosis (bad breath) at some time or other without realizing it. That's the insidious thing about this offensive condition. Sometimes halitosis is due to systemic conditions, but usually and fortunately it is caused, say some authorities, by fermentation of tiny food particles in the mouth. Listerine quickly halts such food fermentation and then overcomes the odors it causes. Your breath becomes sweeter, purer, less likely to offend. Always use Listerine before business and social engagements. Lambert Pharmacal Co., *St. Louis, Mo.*

BEFORE YOU GO TO WORK, USE LISTERINE FOR HALITOSIS (BAD BREATH)

MAN AND WIFE WANTED!

to Run a Fine Paying Local COFFEE ROUTE

You Don't Need Experience. No Waiting.

How would you like to have a fine-paying business of your own—a simple-to-run Coffee Route in which you can start making good money your very first day? Here's your big chance if you act now. To honest, reliable persons in open localities I will give—FREE—a complete valuable Display Outfit containing everything needed to operate a profitable neighborhood Coffee Route. **You don't send me a penny.** You can operate alone or in partnership. The Plan is ideal for married couples. If you want to better yourself—want cash to spend—money to save—the means to live in comfort—let me show you your big chance.

Without any previous experience, you can now own a simple, pleasant, dignified Coffee Route—a profitable, all year 'round business of your own, in which your home is your headquarters. No training course required. Furthermore, I am willing to extend ample credit so you can build a splendid business **on my capital.**

Start Earning At Once

Everybody uses Coffee, Tea, Cocoa, Spices, Flavoring Extracts, Toilet Goods, Soaps, and many other similar daily necessities. They MUST buy these things to live. You simply take care of your regular customers right in your locality—just keep them supplied with the things they need from a line of over 200 nationally known, guaranteed products—whose uniform high quality is controlled in our own pure food kitchens and laboratories. You handle all the money and keep a liberal share for yourself. **In fact, your average gross profit is from 30 to 40 cents on every dollar you take in.**

Splendid Cash Profits

You owe it to yourself to write and see what wonderful success so many others have enjoyed with this time-tested, proven money-making Plan. Let me mail you full particulars—then you can judge whether you want to start right in making money at once. You can devote your full time or part time.

Everything You Need—FREE

I will give you FREE a complete, valuable Display Outfit, including a big assortment of regular full-size packages. Without your sending me one penny, I will also give you a simple, sure-fire Plan which anyone can follow. I will give you advertising material and positively everything else you need to make good profits your very first day. I will help you every step of the way.

In addition to your fine cash earnings, you can get many delicious food products and over one hundred other household necessities for your own use at wholesale prices—so you can **save** money as well as **make** money.

Get Full Particulars—NOW!

This is a sincere, bonafide offer made by a big, reliable, old-established company operating from Coast to Coast. Write at once for full particulars. Unless you take advantage of my remarkable Free Outfit Offer now, you may be missing the very money-making opportunity you have been looking for. Strike out for yourself! Be independent! Make money! Enjoy life! Remember—you don't send me a penny. Just fill out and send the coupon and I will mail you full particulars. Do this TODAY!

E. J. MILLS, President

8047 Monmouth Ave., Cincinnati, Ohio

AST—1

Big, Valuable Complete MONEY-MAKING OUTFIT Free

Free Offer COUPON

E. J. MILLS, President
8047 Monmouth Ave., Cincinnati, Ohio.

Please mail me full particulars about your offer of a complete Free Outfit, and tell me how I can start making money at once with a Local Coffee Route of my own.

Name.....

Address.....

.....

(Please Print or Write Plainly)

ASTOUNDING

SCIENCE-FICTION

TITLE REGISTERED U. S. PATENT OFFICE

CONTENTS NOVEMBER, 1939 VOL. XXIV NO. 3

Illustrations by Hatcher, Isip, Jameson, Schneeman and Wesso

COVER BY ROGERS

ON SALE
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Make me Prove

THAT I CAN TRAIN YOU AT HOME FOR A Good Job in Radio

I TRAINED THESE MEN

Clip the coupon and mail it. I'm certain I can train you at home in your spare time to be a Radio Technician. I will send you my first lesson free. Examine it, read it, see how clear and easy it is to understand. Judge for yourself whether my course is planned to help you get a good job in Radio, a young, growing field with a future. You don't need to give up your present job, or spend a lot of money to become a Radio Technician. I train you at home in your spare time.

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Radio broadcasting stations employ engineers, operators, station managers. Radio manufacturers employ testers, inspectors, foremen, servicemen in good-pay jobs. Radio jobbers, dealers, employ installation and service men. Many Radio Technicians open their own Radio sales and repair businesses and make $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 a week fixing Radios in spare time. Automobile, police, aviation, commercial Radio; loudspeaker systems, electronic devices, are other fields offering opportunities for which N. R. I. gives the required knowledge of Radio. Television promises to open good jobs soon.

Many Make $5, $10 a Week Extra in Spare Time While Learning

The day you enroll, I start sending you Extra Money Job Sheets which start showing you how to do Radio repair jobs. Throughout your training I send plans and directions which have helped many make $200 to $500 a year in spare time while learning. I send special Radio equipment to conduct experiments and build circuits. This 50-50 training method makes learning at home interesting, fascinating, practical. I ALSO GIVE YOU A MODERN, PROFESSIONAL ALL-WAVE, ALL-PURPOSE SET SERVICING INSTRUMENT to help you make more money fixing Radios while learning and equip you for full time work after you graduate.

Find Out What Radio Offers You

Act today. Mail the coupon for Sample Lesson and my 64-page Book, "Rich Rewards in Radio." They point out Radio's spare time and full time opportunities and those coming in Television; tell about my course in Radio and Television; show letters from men I have trained telling what they are doing and earning. Read my money back agreement. Find out what Radio offers YOU! MAIL COUPON in an envelope, or paste on a postcard —NOW!

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National Radio Institute, Dept. 9KD
Washington, D. C.

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"I repaired many Radio sets when I was on my tenth lesson and I have made enough money to pay for my Radio course and also my instruments. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 to $20 a week—just spare time."

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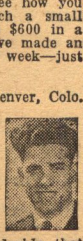

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"Shortly after I started the N.R.I. Course I began teaching Radio classes at the Sparton School of Aeronautics. After five months I was given a chance to join the American Airlines at a salary double that which I received from the school."

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Has Helped Hundreds of Men Make More Money

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON FREE

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Send me FREE, without obligation, Sample Lesson and 64-page book "Rich Rewards in Radio" which tells about Radio's spare time and full time opportunities and how I can train at home for them. (Write Plainly).

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ROBOTS

WITH clanking legs and stiff, mechanical movements, the robots stalk through science-fiction. And, one might add, with a perfectly terrific probability against them. A manlike robot would be made—science-fiction to the contrary notwithstanding—for only one purpose; to be manlike. The world is already full of thousands of robots, working busily and intelligently on their assigned tasks. Naturally, they don't appear manlike, because a man makes a very poor instrument for any given task. A man's a swell design for doing practically everything under the sun, but he simply does not represent good design for doing any one thing. So—why copy bad design?

An article coming in the December issue of our companion magazine, *Air Trails*, tells of initiation stunts pulled on innocent young stewardesses by air-line pilots. Asked if she'd like to see the automatic pilot in action, she presently is summoned to see a flexible hose flopping around busily, like a bony arm attached to an inflated rubber glove which is, in turn, tied onto the control wheel. The untutored are quite willing to accept that as an automatic pilot—a robot whose human-like hand controls the plane. It's precisely as sensible as a manlike robot in general. And it is not the automatic pilot; it's a rubber glove tied onto the pilot's de-icer tube, which gives a stream of hot air under pressure for defrosting the windshield.

The actual robot—a typical example—is as manlike as an automobile engine is leglike. It doesn't, naturally, have eyes. It has sense organs consisting of radio hook-ups, gyroscopes, barometers, compasses and accelerometers. It has no use for eye, ears, nose, or a voice—the senses it has are infinitely superior to man's—*for its duties*. It doesn't have a pair of arms and a pair of legs to work the controls, naturally. It has about a dozen "muscles" doing exactly what's needed, instead of the several hundred a manlike robot would need.

In the more advanced type, which incorporates a blind-landing system, it has several sets of radio-sense organs, plus an electrical sense man doesn't have, plus a sense of absolute altitude. Naturally, it isn't faintly manlike, and, equally naturally, anybody that proposed to make it look manlike would be looked at with a peculiar uncomfortableness.

Then there are telephone switching robots. They do not have queer, jointed arms and fingers that push plugs into jacks, eyes to see signal lights, or ears to hear numbers. But they are most assuredly robots. To make them imitate a human operator—who wasn't evolved for the purpose of operating a telephone switchboard in the first place—would be a retreat to eighteenth-century clockwork robots. When mechanical engineering first started, a century and a half ago, such an idea as the human-shaped and human-acting robot was allowable. Men hadn't yet advanced to the fundamental understanding that a machine is not a man and that there's no reason why it should be.

So they made steamships that were propelled by a series of canoe paddles operated by mechanical hands and arms. When we go back to that, we'll make manlike, man-shaped robots to work the canoe paddles.

THE EDITOR.

BOY—IT'S GREAT TO FEEL LIKE THIS!

DO YOU "feel like a million bucks"? Does your body tingle with glorious glad-to-be-alive zip, tireless energy—smashing strength and driving power surging through every muscle and sinew?

It's GREAT to feel like THAT! And it's great to have—BEHIND IT—a muscular, perfectly-developed body that others envy and admire. There's a personal magnetism that it seems to "send out" too! It *draws* people to you—wins friends—better jobs—respect. It's hard to beat a man—*in anything*—when he FEELS in the PINK OF CONDITION. And when he has a build which broadcasts that fact to *everyone!*

Untouched photo of Charles Atlas, twice winner of title, "World's Most Perfectly Developed Man"

Let Me Prove I Can Make YOU a New Man . . . of Might, Muscle, and Energy

Will you give me a chance to prove I can help you build the strong, evenly-developed body you always wanted. A big, husky chest. A powerful back. Biceps like iron. Tireless arms and legs. A stomach ridged with bands of muscle. A general condition that increases the fun of living.

I know what it means to have a body people pity! I was once a 97 lb. weakling! Self-conscious. Embarrassed. Ashamed to strip for sports or swim. Only HALF-ALIVE!

Then I discovered *"Dynamic Tension"*. It turned me into twice winner of the title, *"World's Most Perfectly Developed Man."* And now I'd like to prove that my system can make a NEW MAN of YOU!

7-Day Trial Offer

I don't say I can do all this for you in 7 days! But I DO say—and want to *prove*—that I can show you enough results in even THAT short time to convince you that *"Dynamic Tension"* can (right in your home) give you the body you always wanted!

Are you underweight? Let me show you how to add pounds where needed! Are you fat in spots? Put it up to me to pare you down to fighting trim. The purpose of *"Dynamic Tension"* is simple. It is a natural way developed by me—to distribute added pounds of powerful muscle—to get rid of surplus fat—to give you the strength and build that will win everyone's envy, respect. And for those with systems sluggish from lack of exercise—to help them tone up their entire body, inside and out.

Silver Cup Being Given Away

This cup, 14" high, on a mahogany base, will be awarded to pupil who makes greatest physical improvement in the next 3 months.

48-Page Book FREE

It tells about *"Dynamic Tension"*, how it has made big-muscled men of others; shows, by actual photos, how I have developed pupils to perfectly balanced proportions.

If not satisfied with your present development—if you want to know more about *"Dynamic Tension"* and what I want to prove it can do for *your* body, get my free book, *"Everlasting Health and Strength."* Mail coupon or postcard today. CHARLES ATLAS, Dept. 38L, 115 E. 23 St., New York, N. Y.

FREE BOOK

This book tells about my 7 DAY TRIAL OFFER. Mail coupon TODAY! No obligation.

CHARLES ATLAS, Dept. 38L,
115 East 23rd Street, New York, N. Y.

I want the proof that your system of **Dynamic Tension** will help make me a New Man—give me a healthy, husky body and big muscle development. Send me your FREE book, "Everlasting Health and Strength" and full details about your 7-DAY Trial Offer.

Name .....
(Please print or write plainly)

Address .....

City ..... State .....

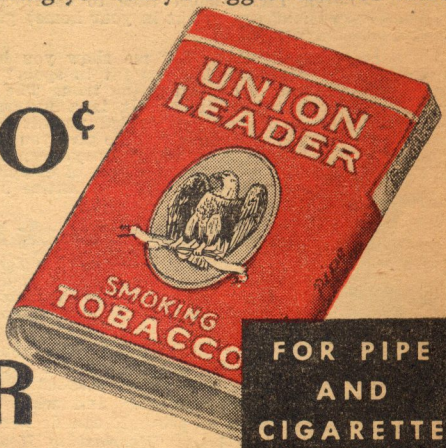
Just one thing comes between 'em!

SO often you see Dad and Son helping themselves from the same big red tin of Union Leader. Dad tamping it into his pipe. Son rolling it into crisp, fresh cigarettes.

Dad's tried 'em all—but for sheer, downright mellowness and soul-satisfying flavor, he always comes back to Union Leader's hill-grown Kentucky Burley! Son, though he's new to smoking, likes the bland mildness and freedom from bite that are due to Union Leader's long-aging and special processing.

Well, they're *both* right! Union Leader *is* packed with flavor—yet tolerant to your tongue. Try a tin today and see how one small dime can bring you today's biggest tobacco value!

10¢

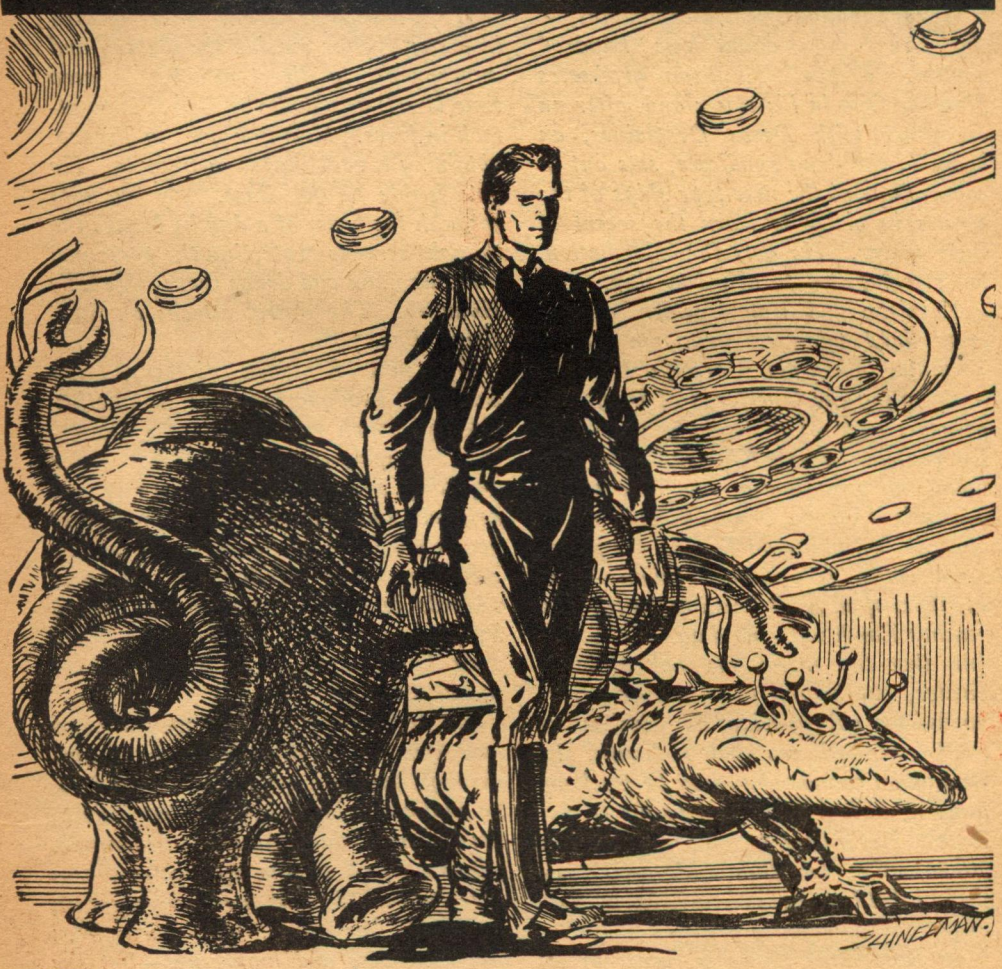


FOR PIPE AND CIGARETTE

UNION LEADER

THE GREAT AMERICAN SMOKE

GRAY LENSMAN



PART II

By E. E. SMITH, Ph. D.

SYNOPSIS:

Law enforcement lagged behind crime because the police were limited in their spheres of action, while criminals were not. Therefore, when the inertialess drive was perfected and commerce throughout the Galaxy became commonplace, crime became so rampant as to threaten Civilization. Then came into being the Galactic Patrol, an organization whose highest members, the Lensmen, are of unlimted authority and scope.

Each is identified by wearing the Lens, a pseudo-living telepathic jewel matched to the ego of its owner by those master philosophers, the Arisians. The Lens cannot be counterfeited, since it glows with color when worn by its owner and kills any other who attempts to wear it.

Of each million selected candidates for the Lens, only about one hundred qualify. Kimball Kinnison graduates Number One in his class; and, after an encounter with Dessa Desplaines, an agent of the drug syndicate, sets out to capture one of the new-type ships of the pirates in order to learn the secret of their power. He gets the information, but is compelled to abandon ship.

Kinnison and Van Buskirk, a Valerian, land upon an unknown planet, Velantia. They aid Worsel, a scientist, in defeating the Overlords of Delgon, a parasitic race of a neighboring planet. En route to Earth Kinnison's Bergenholm, the generator of the force which neutralized inertia, breaks down; and he lands for repairs upon Trenco, the planet upon which is produced thionite—the deadliest of all habit-forming drugs. He reaches Earth with his data. He is certain that the enemy are not ordinary pirates, but belong to a culture—Boskonia—as galaxy-wide as Civilization itself. He believes that Helmuth, the Boskonian commander, may be Boskone himself; and sets out to find his Grand Base. He scouts a minor base upon Aldebaran I. In a fight with the Wheelmen of that base he is wounded very seriously, but manages to get back to Earth.

In Base Hospital he is cared for by Surgeon General Lacy and by Chief Nurse Clarrissa MacDougall. Lacy and Port Admiral Haynes, chief of staff of the entire Patrol, connive to promote a romance between the two. Recovering, Kinnison goes back to Arisia for advanced mental training. Using the new power of his mind to control the minds of others, he invades a base upon Boyssia II.

He discovers the location of Helmuth's Grand Base. A hospital ship, of which MacDougall is chief nurse, is captured by the enemy and brought in to the Boyssian base. Kinnison blows up the base and engineers the escape of the nurses in their own ship.

He investigates Grand Base; located in a star cluster outside the Galaxy and impregnable to direct attack. A zero time is set, at which the Patrol is to attack in force. Kinnison goes to Trenco, obtaining a vast supply of thionite. He gets inside Grand Base. By working through the brain of a dog he breaks the thought-screens protecting the personnel from his mind and drugs them. He kills Helmuth. The Patrol attacks on time. Grand Base falls.

But now Kinnison discovers that Boskon's headquarters are in another Galaxy, which he visits in the Dauntless, *a superpowerful warship. After defeating a squadron of enemy vessels he lands upon the planet Medon, whose people are fighting a losing battle against Boskone. The Medonians, electrical wizards who have been able to install Bergenholms and space-drives upon their planet, move the entire world over to our Galaxy.*

He decides that the best way to get a line upon Boskone is to work upward through the drug syndicate. Disguised, he captures a beautiful, and particularly hard and dangerous Aldebaranian woman agent of the syndicate, Dessa Desplaines. He cuts the thought-screen to reach her mind, and learn from her associates and higher-ups—but she slumps bonelessly just as the Narcotics men of the planet Radelix, where he has been operating, come up.

VI.

"SUICIDE? Or did you—" Gerrond paused, delicately. Winstead, the Lensman of Narcotics, said nothing, but looked on intently.

"Neither," Kinnison replied, still studying. "I would have had to, but she beat me to it."

"What d'you mean, 'neither'? She's dead, isn't she? How did it happen?"

"Not yet, and unless I'm more cock-eyed even than usual, she won't be. She isn't the type to rub herself out—ever, under any conditions. As to 'how,' that was easy. A hollow false tooth. Simple, but new—and clever. But why? WHY?" Kinnison was thinking to himself more than addressing his companions. "If they had killed her, yes. As it is, it doesn't make any kind of sense—any of it."

"But the girl's dying!" protested Gerrond. "What're you going to *do?*"

"I wish to Klono I knew." The Tellurian was puzzled, groping. "No hurry doing anything about her—what was done to her has been done, and no one this side of Hades can undo it—unless I can fit these pieces together into some kind of a pattern I'll never know what it's all about—none of it makes sense—" He shook himself and went on: "One thing is plain. She won't die. If they had intended to kill her, she would have died almost instantly. They figure she's worth saving; in which I agree with them. At the same time, they certainly are not planning on letting me tap her knowledge. They may be planning on taking her away from us. Therefore, as long as she stays alive—or even not dead, the way she is now—guard her so heavily that an army can't get her. If she should happen to die, don't leave her body unguarded for a second until she's been autopsied, and you know she'll *stay* dead. The minute she recovers, day or night, call me. Might as well take her to the hospital now, I guess."

The call came soon that the patient had indeed recovered.

"She's talking, but I haven't answered her," Gerrond reported. "There's something strange here, Kinnison."

"There would be—bound to be. Hold everything until I get there," and he hurried to the hospital.

"Good morning, Dessa," he greeted her in Aldebaranian. "You are feeling better, I hope?"

Her reaction was surprising. "You really know me?" she almost shrieked, and flung herself into the Lensman's arms. Not deliberately; not with her wonted, highly effective technique of bringing into play the s. a. equipment with which she was so overpoweringly armed. No; this was the utterly innocent, the wholly unselfconscious abandon of a very badly frightened young girl. "What happened?" she sobbed, frantically, "Where am I? Why are all these strangers here?"

Her wide, childlike, tear-filled eyes sought his; and as he probed them, deeper and deeper into the brain behind them; his face grew set and hard. Mentally, she now *was* a young and innocent girl! Nowhere in her mind, not even in the deepest recesses of her subconscious, was there the slightest inkling that she had even existed since her fifteenth year. It was staggering; it was unheard of; but it was indubitably a fact. For her, now, the intervening time had lapsed instantaneously—five or six years of her life had disappeared so utterly as never to have been!

"You have been very ill, Dessa," he told her gravely, "and you are no longer a child." He led her into another room and up to a triple mirror. "See for yourself."

"But that isn't I?" she protested. "It can't be! Why, she's beautiful!"

"You're all of that," the Lensman agreed, casually. "You've had a bad shock. Your memory will return shortly, I think. Now you must go back to bed."

She did so, but not to sleep. Instead, she went into a trance; and so, almost, did Kinnison. For over an hour he lay intensely asprawl in an easy-chair, the while he engraved, day by day, a memory

of missing years into that bare storehouse of knowledge. And finally the task was done.

"Sleep, Dessa," he told her then. "Sleep. Waken in eight hours; whole."

"Lensman, you're a *man!*" Gerrond realized vaguely what had been done. "You didn't give her the truth, of course?"

"Far from it. Only that she was married and is a widow. The rest of it is highly ficticious—just enough like the real thing so that she can square herself with herself, if she meets old acquaintances. Plenty of lapses, of course, but they're covered by shock."

"But the husband?" queried the curious Radeligian.

"That's her business," Kinnison countered, callously. "She'll tell you, if she ever feels like it. One thing I did do, though—they'll never use her again. The next man that tries to hypnotize her will be lucky if he gets away alive."

THE ADVENT of Dessa Desplaines, however, and his curious adventure with her, had altered markedly the Lensman's situation. No one else in the throng had worn a screen, but there might have been agents—anyway, the observed facts would enable the higher-ups to link Fordyce up with what had happened—they would know, of course, that the real Fordyce hadn't done it—he could be Fordyce no longer.

Wherefore the real Chester Q. Fordyce took over and a strange Unattached Lensman appeared. A Posenian, supposedly, since against the air of Radelix he wore that planet's unmistakable armor. No other race of even approximately human shape could "see" through a helmet of solid, opaque metal.

And in this guise Kinnison continued his investigations. That place and that man must be on this planet somewhere; the sending outfit worn by the Desplaines woman could not possibly reach any other. He had a good picture of the room and a fair picture—several pictures, in fact—of the man. The room was an actuality; all he had had to do was to fill in the details which definitely, by unmistakable internal evidence, belonged there. The man was different. How much of the original picture was real, and how much of it was the girl's impression?

She was, he knew, physically fastidious almost to an extreme. He knew that no possible hypnotism could nullify completely the basic, the fundamental characteristics of the subconscious. The intrinsic ego could not be changed. Was the man really such a monster, or was the picture in the girl's mind partially or largely the product of her physical revulsion?

For hours he had sat at a recording machine, covering yard after yard of tape with every possible picture of the man he wanted. Pictures ranging from a man almost of normal build up to a thing duplicating in every detail the woman's mental image.

Now he ran the tape again, time after time. The two extremes, he concluded, were highly improbable. Somewhere in between—the man *was* fat, he guessed. Fat, and had a mean pair of eyes. And, no matter how Kinnison changed the man's physical shape he had found it impossible to eradicate a personality that was definitely bad.

"The guy's a louse," Kinnison decided, finally. "Needs killing. Glad of that—if I have to keep on fighting women much longer I'll go completely nuts. Got enough dope to identify him now, I think."

And again the Tellurian Lensman set out to comb the planet, city by city. Since he was not now dealing with Lensmen, every move he made had to be carefully planned and as carefully concealed. It was heartbreaking; but at long last he found a bartender who had once seen his quarry. He *was* fat, Kinnison discovered, and he was a bad

egg. From that point on, progress was rapid. He went to the indicated city, which was, ironically enough, the very Ardith from which he had set out; and, from a bit of information here and a bit there, he tracked down his man. He found the room first, and then the man. The girl wasn't so far wrong, at that. Her aversion was somewhat worse than the actuality, but not too much.

Now what to do? The technique he had used so successfully upon Boyssia II and in other bases could not succeed here; there were thousands of people instead of dozens, and someone would certainly catch him at it. Nor could he work at a distance. He was no Arisian, he had to be right beside his job. He would have to turn dock-walloper.

Therefore a dock-walloper he became. Not like one, but actually one. He labored prodigiously, his fine hands and his entire being becoming coarse and hardened. He ate prodigiously, and drank likewise. But, wherever he drank, his liquor was poured from the bartender's own bottle or from one of similarly innocuous contents; for then, as now, bartenders did not themselves imbibe the corrosively potent distillates in which they dealt. Nevertheless, Kinnison became intoxicated—boisterously, flagrantly, and pugnaciously so, as did his fellows.

He lived scrupulously within his dock-walloper's wages. Eight credits per week went to the company, in advance, for room and board; the rest he spent over the fat man's bar or gambled away at the fat man's crooked games—for Bominger, although engaged in vaster commerce far, nevertheless, allowed no scruple to interfere with his esurient rapacity. Money was money, whatever its amount or source or however despicable its means of acquirement.

The Lensman knew that the games were crooked, certainly. He could see, however they were concealed, the crooked mechanisms of the wheels. He could see the crooked workings of the dealers' minds as they manipulated their crooked decks. He could read as plainly as his own the cards his crooked opponents held. But to win or to protest would have set him apart, hence he was always destitute before pay day. Then, like his fellows, he spent his spare time loafing in the same saloon, vaguely hoping for a free drink or for a stake at cards, until one of the bouncers threw him out.

BUT in his every waking hour, working, gambling, or loafing, he studied Bominger and Bominger's various enterprises. The Lensman could not pierce the fat man's thought-screen, and he could never catch him without it. However, he could and did learn much. He read volume after volume of locked account books, page by page. He read secret documents, hidden in the deepest recesses of massive vaults. He listened in on conference after conference; for a thought-screen of course, does not interfere with either sight or sound. The Big Shot did not own—legally—the saloon, nor the ornated, almost palatial back room which was his office. Nor did he own the dance hall and boudoirs upstairs, nor the narrow, cell-like rooms in which addicts of twice a score of different noxious drugs gave themselves over libidinously to their addictions. Nevertheless, they were his; and they were only a part of that which was his.

Kinnison detected, traced, and identified agent after agent. With his sense of perception he followed passages, leading to other scenes, utterly indescribable here. One comparatively short gallery, however, terminated in a different setting altogether; for there, as here and perhaps everywhere, ostentation and squalor lie almost back to back. Nalizok's Café, the high-life hot-spot of Radelix! Downstairs was innocuous enough; nothing rough—that is, too rough—was ever pulled there. Most of

the robbery there was open and aboveboard, plainly written upon the checks. But there were upstairs rooms, and cellar rooms, and back rooms. And there were addicts, differing only from those others in wearing finer raiment and being of a self-styled higher stratum. Basically they were the same.

Men, women, girls ever were there, in the rigid muscle-lock of thionite. Teeth hard-set, every muscle tense and staring, eyes jammed closed, fists clenched, faces white as though carved from marble, immobile in the frenzied emotion which characterized the ultimately passionate fulfillment of every suppressed desire; in the release of their every inhibition crowding perilously close to the dividing line beyond which lay death from sheer ecstasy. That was the technique of the thionite-sniffer—to take every microgram that he could stand, to come to, shaken and too weak even to walk; to swear that he would never so degrade himself again; to come back after more as soon as he had recovered strength to do so; and finally, with an irresistible craving for stronger and ever stronger thrills, to take a larger dose than his rapidly-weakening body could endure, and so to cross the fatal line.

There also were the idiotically smiling faces of the hadive smokers, the twitching members of those who preferred the Centralian nitrolabe-needle, the helplessly stupefied eaters of bentlam—but why go on? Suffice it to say that in that one city block could be found every vice and every drug enjoyed by Radeligians and the usual run of visitors; and if perchance you were an unusual visitor, desiring something unusual, Bominger could get it for you—at a price.

Kinnison studied, perceived, and analized. Also, he reported, via Lens, daily and copiously, to Narcotics, under Lensman's Seal.

"But Kinnison!" Winstead protested one day. "How much longer are you going to make us wait?"

"Until I get what I came after or until they get onto me," Kinnison replied, flatly. For weeks his Lens had been hidden in the side of his shoe, in a flat sheath of highly charged metal, proof against any except the most minutely searching spy ray inspection; but this new location did not in any way interfere with its functioning.

"Any danger of that?" the Narcotics head asked, anxiously.

"Plenty—and getting worse every day. More actors in the drama. Some day I'll make a slip—I can't keep this up forever."

"Let us go, then," Winstead urged. "We've got enough now to blow this ring out of existence, all over the planet."

"Not yet. Youre making good progress, aren't you?"

"Yes, but considering—"

"Don't consider it yet. Your present progress is normal for your increased force. Any more would touch off an alarm. You could take this planet's drug personnel, yes, but that isn't what I'm after. I want big game, not small fry. So sit tight until I give you the g. a. QX?"

"Got to be QX if you say so, Kinnison. Be careful!"

"I am. Won't be long now, I'm sure. Bound to break very shortly, one way or the other. If possible, I'll give you and Gerrond warning."

KINNISON had everything lined up except the one thing he had come after. This was, in fact, the headquarters of the drug syndicate for the entire planet of Radelix. He knew where the stuff came in, and when, and how. He knew who received it, and the principal distributors of it. He knew almost all of the secret agents of the ring, and not a few even of the small-fry peddlers. He knew where the remittances went, and how much, and what for. But every

lead had stopped at Bominger. Apparently the fat man was the absolute head of the drug syndicate; and that appearance didn't make sense—it *had* to be false. Bominger and the other planetary lieutenants—themselves only small fry if the Lensman's ideas were only half right—*must* get orders from, and send reports and, in probability, payments to some Boskonian authority; of that Kinnison felt certain, but he had not been able to get even the slightest trace of that higher-up.

That the communication would be established upon a thought-beam the Tellurian was equally certain. The Boskonian would not trust any ordinary, tappable communicator beam, and he certainly would not be such a fool as to send any written or taped or otherwise permanently recorded message, however coded. No, that message, when it came, would come as thought, and to receive it the fat man would have to release his screen. Then, and not until then, could Kinnison act. Action at that time might not prove simple—judging from the precautions Bominger was taking already, he would not release his screen without taking plenty more—but until then the Lensman could do nothing.

That screen had not yet been released, Kinnison could swear to that. True, he had had to sleep at times, but he had slept in a very hair-trigger, with his subconscious and his Lens set to guard that screen and to give the alarm at its first sign of weakening.

As the Lensman had foretold, the break came soon. Not in the middle of the night, as he had half-thought that it would come; nor yet in the quiet of the daylight hours. Instead, it came well before midnight, while revelry was at its height. It did not come suddenly, but was heralded by a long period of gradually increasing tension, of a mental stress very apparent to the mind of the watcher.

Agents of the drug baron came in, singly and in groups, to an altogether unprecedented number. Some of them were their usual viciously self-contained selves, others were slightly but definitely ill at ease. Kinnison, seated alone at a small table, playing a game of Radeligian solitaire, divided his attention between the big room as a whole and the office of Bominger; in neither of which was anything definite happening.

Then a wave of excitement swept over the agents as five men wearing thought-screens entered the room and, sitting down at a reserved table, called for cards and drinks; and Kinnison thought it time to send his warning.

"Gerrond! Winstead! Three-way! It's going to break soon, now, I think—tonight. Agents all over the place—five men with thought-screens here on the floor. Nervous tension high. Lots more agents outside, for blocks. General precaution, I think, not specific. Not suspicious of me, at least not exactly. Afraid of spies with a sense of perception—Rigellians or Posenians or such. Just killed an Ordovik on general principles, over on the next block. Get your gangs ready, but don't come too close—just close enough so that you can be here in thirty second after I call you."

"What do you mean 'not exactly suspicious'? What have you done?"

"Nothing that I know of—any one of a million possible small slips I may have made. Nothing serious, though, or they wouldn't have let me hang around this long."

"You're in danger. No armor, no DeLameter, no anything. Better come out while you can."

"And miss what I've spent all this time building up? Not a chance; I'll be able to take care of myself, I think—Here comes one of the boys in a screen, to talk to me. I'll leave my Lens open, so that you can sort of look on."

JUST THEN Bominger's screen went down and Kinnison invaded his mind;

Kinnison looked up at the stranger blearily. "Drink that, bum, and drink it quick—or burn!" the gunman snapped.

taking complete possession of it. Under his domination the fat man reported to the Boskonian, reported truly and fully. In turn, he received orders and instructions. Had any inquisitive stranger been around, or anyone on the planet using any kind of a mind ray machine since that quadruply-accursed Lensman had held that trial? (Oh, that was what had touched them off! Kinnison was glad to know it.) No, nothing unusual at all—

And just at that critical moment, when the Lensman's mind was so busy with its task, the stranger came up to his table and stared down at him dubiously, questioningly.

"Well, what's on *your* mind?" Kinnison growled. He could not spare much of his mind just then, but it did not take much of it to play his part as a dock-walloper. "You another of these smoking house-numbers, snooping around to see if I'm trying to run a

blazer on myself? By the devil and his imps, if I hadn't lost so much money here already I'd tear up this deck and go over to Croleo's and *never* come near this crummy joint again—his rotgut can't be any worse than yours is."

"Don't burn out a jet, pal." The agent, apparently reassured, adopted a conciliatory tone.

"Who in hell ever said you was a pal of mine, you Radelig-gig-gigian pimp?" The supposedly three quarters drunken, certainly three quarters naked, Lensman got up, wobbled a little, and sat down again, heavily. "Don't 'pal' me, ape—I'm partic-hic-hicular about who I pal with."

"That's all right, big fellow; no offense intended," soothed the other. "Come on, I'll buy you a drink."

"Don't want no drink until after I've finished this game," Kinnison grumbled, and took an instant to flash a thought via Lens. "All set, boys? Thing's moving fast. If I have to take this drink—it's doped, of course—I'll bust this bird wide open. When I yell, shake the lead out of your pants!"

"Of course you want a drink!" the pirate urged. "Come and get it—it's on me, you know."

"And who are you to be buying me, a Tellurian gentleman, a drink?" the Lensman roared, flaring into one of the sudden, senseless rages of the character he had cultivated so assiduously. "Did I ask you for a drink? I'm educated, I am, and I've got money, I have. I'll buy myself a drink when I want one." His rage mounted higher and higher, visibly. "Did I *ever* ask you for a drink, you—" (unprintable here for the space of two long breaths).

This was the blow-off. If the fellow was even half honest, there would be a fight, which Kinnison could make as long as necessary. If he did not start slugging after what Kinnison had just called him, he was not what he seemed and the Lensman was surely suspected; for the Earthman had dredged out the noisomest depths of the foulest vocabularies in space for the terms he had just employed.

"If you weren't drunk I'd break every bone in your laxlo-soaked carcass." The other man's anger was sternly suppressed, but he looked at the dock-walloper with no friendship in his eyes. "I don't ask lousy space-port bums to drink with me every day, and when I do, they do—or else. Do you want to take that drink now or do you want a couple of the boys to work you over first? Barkeep! Bring two glasses of laxlo over here!"

Now the time was short, indeed, but Kinnison would not—could not—act yet. Bominger's conference was still on; the Lensman didn't know enough yet. The fellow wasn't very suspicious, certainly, or he would have made a pass at him before this. Bloodshed meant less than nothing to these gentry; the stranger did not want to incur Bominger's wrath by killing a steady customer. The fellow probably thought the whole mind ray story was hocus-pocus, anyway—not a chance in a million of it being true. Besides, he needed a machine, and Kinnison couldn't hide a thing, let alone anything as big as that mind ray machine had been, because he didn't have clothes enough on to flag a handcar with. But that free drink was certainly doped—Oh, they wanted to question him. It would be a truth-dope in the laxlo, then—he certainly couldn't take *that* drink!

Then came the all-important second; just as the bartender set the glasses down Bominger's interview ended. At the signing off, Kinnison got additional data, just as he had thought that he would; and in that instant, before the drugmaster could restore his screen, the fat man died—his brain literally blasted. And in that same instant Kinnison's Lens fairly throbbed with the power of the call he sent out to his allies.

But not even Kinnison could hurl such

a mental bolt without some outward sign. His face stiffened, perhaps, or his eyes may have lost their drunken, vacant stare, to take on momentarily the keen, cold ruthlessness that was for the moment his. At any rate, the enemy agent was now definitely suspicious.

"Drink that, bum, and drink it quick —or burn!" he snapped, DeLameter out and poised.

The Tellurian's hand reached out for the glass, but his mind also reached out, and faster by a second, to the brains of two nearby agents. Those worthies drew their own weapons and, with wild yells, began firing. Seemingly indiscriminately, yet in those blasts two of the thought-screened minions died. For a fraction of a second even the hard-schooled mind of Kinnison's opponent was distracted, and that was long enough for the Gray Lensman's instantaneous nervous reactions and his mighty muscles.

A QUICK FLICK of the wrist sent the potent liquor into the Boskonian's eyes; a lightning thrust of the knee sent the little table hurtling against his gun-hand, flinging the weapon afar. Simultaneously, the Lensman's hamlike fist, urged by all the strength and all the speed of his two hundred and sixteen pounds of rawhide and whalebone, drove forward. Not for the jaw. Not for the head or the face. Lensmen know better than to mash bare hands, break fingers and knuckles, against bone. For the solar plexus. The big Patrolman's fist sank forearm-deep. The stricken zwilnik uttered one shrieking grunt, doubled up, and collapsed; never to rise again. Kinnison leaped for the fellow's DeLameter—too late, he was already hemmed in.

One—two—three—four of the nearest men died without having received a physical blow; again and again Kinnison's heavy fists and far heavier feet crashed deep into vital spots. One thought-screened enemy dived at him bodily in a Tomingan donganeur, to fall with a broken neck as the Lensman opposed instantly the only possible parry —a savage chop, edge-handed, just below the base of the skull; the while he disarmed the surviving thought-screened stranger with an accurately-hurled chair. The latter, feinting a swing, launched a vicious French kick. The Lensman, expecting anything, perceived the foot coming. His big hands shot out like striking snakes, closing and twisting savagely in the one fleeting instant, then jerking upward and backward. A hard and heavy dock-walloper's boot crashed thuddingly to a mark. A shriek rent the air and that foeman, too, was done.

Not fair fighting, no; nor cluvvy. Lensmen did not and do not fight according to the tenets of the late Marquis of Queensberry. They use the weapons provided by Mother Nature only when they must; but they can, and do use them with telling effect indeed, when body-to-body brawling becomes necessary. For they are skilled in the art—every Lensman has a completely detailed knowledge of all the lethal tricks of foul combat known to all the dirty fighters of ten thousand planets for twice ten thousand years.

And then the doors and windows crashed in, admitting those whom no other bifurcate race has ever faced willingly in hand-to-hand combat—full-armed Valerians, swinging their space-axes!

The gangsters broke then, and fled in panic disorder; but escape from Narcotics' fine-meshed net was impossible. They were cut down to a man.

"QX, Kinnison?" came two hard, sharp thoughts. The Lensmen did not see the Tellurian, but Lieutenant Peter van Buskirk did. That is, he saw him, but did not look at him.

"Hi, Kim, you little Tellurian wart!" That worthy's thought was a yell. "Ain't we got fun?"

"QX fellows—thanks," to Gerrond and to Winstead, and—

"Ho, Bus! Thanks, you big, Valerian ape!" to the gigantic Dutch-Valerian with whom he had shared so many experiences in the past. "A good clean-up, fellows?"

"One hundred per cent, thanks to you. We'll put you—"

"Don't, please. You will probably clog my jets if you do. I don't appear in this anywhere—it's just one of your good, routine jobs of mopping up. Clear ether, fellows, I've got to do a flit."

"Where?" all three wanted to ask, but they didn't—the Gray Lensman was gone.

VII.

KINNISON did start his flit, but he did not get far. In fact, he did not even reach his squalid room before cold reason told him that the job was only half done—yes, less than half. He had to give Boskone credit for having brains, and it was not at all likely that even such a comparatively small unit as a planetary headquarters would have only one string to its bow. They certainly would have been forced to install duplicate controls of some sort or other by the trouble they had had after Helmuth's supposedly impregnable Grand Base had been destroyed.

There were other straws pointing the same way. Where had those five strange thought-screened men come from? Bominger hadn't known of them apparently. If that idea was sound, the other headquarters would have a spy ray on the whole thing. Both sides used spy rays freely, of course, and to block them was, ordinarily, worse than to let them come. The enemies' use of the thought-screen was different. They realized that it made it easy for the unknown Lensman to discover their agents, but they were forced to use it because of the deadliness of the supposed mind ray. Why hadn't he thought of this sooner, and had the whole area blocked off? Too late to cry about it now, though.

Assume the idea correct. They certainly knew now that he was a Lensman; probably were morally certain that he was *the* Lensman. His instantaneous change from a drunken dock-walloper to a cold-sober, deadly-skilled rough-and-tumble brawler—and the unexplained deaths of half-a-dozen agents, as well as that of Bominger himself—this was bad. Very, *very* bad—a flare lit tip-off, if there ever was one. Their spy rays would have combed him, millimeter by plotted cubic millimeter: they knew exactly where his Lens was, as well as he did himself. He had put his tail right into the wringer—wrecked the whole job right at the start—unless he could get that other headquarters outfit, too, and get them before they reported in detail to Boskone.

In his room, then, he sat and thought, harder and more intensely than he had ever thought before. No ordinary method of tracing would do. It might be anywhere on the planet, and it certainly would have no connection whatever with the thionite gang. It would be a small outfit; just a few men, but under smart direction. Their purpose would be to watch the business end of the organization, but not to touch it save in an emergency. All that the two groups would have in common would be recognition signals, so that the reserves could take over in case anything happened to Bominger—as it already had. They had him, Kinnison, cold— What to do? *What to do?*

The Lens. That must be the answer—it *had* to be. The Lens—what was it, really, anyway? Simply an aggregation of crystalloids. Not really alive; just a pseudolife, a sort of a reflection of his own life—he wondered—great Klono's brazen teeth and tail, could *that* be it? An idea had struck him, an idea so stupendous in its connotations and ramifications that he gasped, shuddered, and

almost went faint at the shock. He started to reach for his Lens, then forced himself to relax and shot a thought to Base.

"Gerrond! Send me a portable spy ray block, quick!"

"But that would give everything away!" protested the vice-admiral. "That's why we haven't been using them."

"Are you telling me?" the Lensman demanded. "Shoot it along—I'll explain while it's on the way." He went on to tell the Base commander everything that he thought it well for him to know, concluding: "So you see, it's a virtual certainty that I am already as wide open as intergalactic space, and that nothing but fast and sure moves will do us a bit of good."

The block arrived, and as soon as the messenger had departed Kinnison set it going. He was now the center of a sphere into which no spy ray beam could penetrate. He was also an object of suspicion to anyone using a spy ray, but that fact made no difference, then. He snatched off his shoe, took out his Lens, and tossed that ultra-precious fabrication across the room. Then, just as though he still wore it, he directed a thought at Winstead.

"All serene, Lensman?" he asked, quietly.

"Everything's on the beam," came instant reply. "Why?"

"Just checking, is all." Kinnison did not specify exactly what it was that he was checking!

He then did something which, so far as he knew, no Lensman had ever before even thought of doing. Although he felt stark naked without his Lens, he hurled a thought three quarters of the way across the Galaxy to that dread planet Arisia; a thought narrowed down to the exact pattern of that gigantic, fearsome Brain who had been his mentor and his sponsor.

"Ah, 'tis Kimball Kinnison, of Earth," that entity responded, in precisely the same modulation it had employed once before. "You have perceived, then, youth, that the Lens is not the supremely important thing you have supposed it to be?"

"I . . . you . . . I mean—" The flustered Lensman, taken completely aback, was cut off by a sharp rebuke.

"Stop! You are thinking muddily—conduct ordinarily inexcusable! Now, youth, to redeem yourself, you will explain the phenomenon to me, instead of asking me to explain it to you. I realize that you have just discovered another facet of the Cosmic Truth, I know what a shock it has been to your immature mind; hence for this once it may be permissible for me to overlook your crime. But strive not to repeat the offense; for I tell you again in all possible seriousness—I cannot urge upon you too strongly the fact—that in clear and precise thinking lies your only safeguard through that which you are attempting. Confused, wandering thought will assuredly bring disaster inevitable and irreparable."

"Yes, sir," Kinnison replied meekly; a small boy reprimanded by his teacher. "It must be this way. In the first stage of training the Lens is a necessity; just as is the crystal ball or some other hypnotic object in a séance. In the more advanced stage the mind is able to work without aid. The Lens, however, may be—in fact, it must be—endowed with uses other than that of a symbol of identification; uses about which I as yet know nothing. Therefore, while I can work without it, I should not do so except when it is absolutely necessary, as its help will be imperative if I am to advance to any higher stage. It is also clear that you were expecting my call. May I ask if I am on time?"

"You are—your progress has been highly satisfactory. Also, I note with approval that you are not asking for help

in your admittedly difficult present problem."

"I know that it wouldn't do me any good—and why." Kinnison grinned wryly. "But I'll bet that Worsel, when he comes up for his second treatment, will know on the spot what it has taken me all this time to find out."

"You deduce truly. He did."

"What? He has been back there already? And you told me—"

"What I told you was true and is. His mind is more fully developed and more responsive than yours; yours is of vastly greater latent capacity, capability, and force—" and the line of communication snapped.

Calling a conveyance, Kinnison was whisked to Base, the spy ray block full on all the way. There, in a private room, he put his heavily-insulated Lens and a full spool of tape into a ray-proof container, sealed it, and called in the Base commander.

"Gerrond, here is a package of vital importance," he informed him. "Among other things, it contains a record of everything I have done to date. If I don't come back to claim it myself, please send it to Prime Base for personal delivery to Port Admiral Haynes. Speed will be no object, but safety very decidedly of the essence."

"QX—we'll send it in by special messenger."

"Thanks a lot. Now I wonder if I could use your visiphone a minute? I want to talk to the zoo."

"Certainly."

"Zoological Gardens?" and the image of an elderly, white-bearded man appeared upon the plate. "Lensman Kinnison of Tellus—Unattached. Have you as many as three oglons, caged together?"

"Yes. In fact, we have four of them in one cage."

"Better yet. Will you please send them over here to Base at once? Vice-admiral Gerrond, here, will confirm."

"It is most unusual, sir—" the graybeard began, but broke off at a curt word from Gerrond. "Very well, sir," he agreed, and disconnected.

"Oglons?" the surprised commander demanded. *"Oglons!"*

FOR the oglon, or Radeligian cateagle, is one of the fiercest, most intractable beasts of prey in existence; it assays more concentrated villainy and more sheerly vicious ferocity to the gram than any other creature known to science. It is not a bird, but a winged mammal; and is armed not only with the gripping, tearing, talons of the eagle, but also with the heavy, cruel, needle-sharp fangs of the wildcat. And its mental attitude toward all other forms of life is anti-social to the nth degree.

"Oglons." Kinnison confirmed, shortly. "I can handle them."

"You can, of course. But—" Gerrond stopped. This Gray Lensman was forever doing amazing, unprecedented, incomprehensible things. But, so far, he had produced eminently satisfactory results, and he could not be expected to spend all his time in explanations.

"But you think I'm screwy, huh?"

"Oh, no, Kinnison, I wouldn't say that. I only . . . well . . . after all, there isn't much real evidence that we didn't mop up one hundred percent."

"Much? Real evidence? There isn't any," the Tellurian assented, cheerfully enough. "But you've got the wrong slant entirely on these people. You are still thinking of them as gangsters, desperadoes, renegade scum of our own civilization. They are not. They are just as smart as we are; some of them are smarter. Perhaps I am taking too many precautions; but, if so, there is no harm done. On the other hand, there are two things at stake which, to me at least, are extremely important; this whole job of mine and my life: and remember this—the minute I leave this

Base both of those things are in your hands."

To that, of course, there could be no answer.

While the two men had been talking and while the oglons were being brought out, two trickling streams of men had been passing, one into and one out of the spy ray shielded confines of Base. Some of these men were heavily bearded, some were shaven clean, but all had two things in common. Each one was human in type and each one in some respect or other resembled Kimball Kinnison.

"Now remember, Gerrond," the Gray Lensman said impressively as he was about to leave. "They're probably right here in Ardith, but they may be anywhere on the planet. Keep a spy ray on me wherever I go, and trace theirs if you can. That will take some doing, as the head one is bound to be an expert. Keep those oglons at least a mile—thirty seconds flying time—away from me; get all the Lensmen you can on the job; keep a cruiser and a speedster hot, but not too close. I may need one of them, or all, or none of them, I can't tell; but I do know this—if I need anything at all, I'll need it fast. Above all, Gerrond, by the Lens you wear, do nothing whatever, no matter what happens around me or to me, until I give you the word. QX?"

"QX, Gray Lensman. Clear ether!"

Kinnison took a ground-cab to the mouth of the narrow street upon which was situated his dock-walloper's mean lodging. This was a desperate, a foolhardy trick—but in its very boldness, in its insolubly paradoxical aspects, lay its strength. Probably Boskone could solve its puzzles, but—he hoped—this ape, not being Boskone, couldn't. And, paying off the cabman, he thrust his hands into his tattered pockets and, whistling blithely if a bit raucously through his stained teeth, he strode off down the narrow way as though he did not have a care in the world. But he was doing the finest job of acting of his short career; even though, for all he really knew, he might not have any audience at all. For, inwardly, he was strung to highest tension. His sense of perception, sharply alert, was covering the full hemisphere around and above him; his mind was triggered to jerk any muscle of his body into instantaneous action.

MEANWHILE, in a heavily guarded room, there sat a manlike being, faintly but definitely blue; not only as to eyes, but also as to hair, teeth, and complexion. For two hours he had been sitting at his spy ray plate, studying with ever-growing uneasiness the human beings so suddenly and so surprisingly numerously having business at the Patrol's Base. For minutes he had been studying minutely a man in a ground-cab, and his uneasiness reached panic heights.

"It *is* the Lensman!" he burst out. "It's *got* to be, Lens or no Lens. Who else would have the cold nerve to go back there when he knows that he has exposed himself?"

"Well, get him, then," advised his companion. "All set, aren't you?"

"But it *can't* be!" the chief went on, reversing himself in mid-flight. "A Lensman without a Lens is unthinkable, and invisible Lens is preposterous. And this fellow has not now, and never has had, a mind ray machine. He hasn't got *anything!* And besides, the Lensman we're after wouldn't think of doing a thing like this—he always disappears the instant a job is finished, whether or not there is any chance of his having been discovered."

"Well, drop him and chase somebody else, then," the lieutenant advised, unfeelingly.

"But there's nobody nearly enough like him!" snarled the chief, in desperation. He was torn by doubt and indecision. This whole situation was a mess

—it didn't add up right, from any possible angle. "It's got to be him—it *can't* be anybody else. I've checked and rechecked him. It *is* him, and not a double. He thinks that he's safe enough; he doesn't suspect that we're here at all. Besides, his only good double, Fordyce —and *he's* not good enough to stand the inspection I just gave him—hasn't appeared anywhere."

"Probably inside Base yet. Maybe this is a better double. Perhaps this *is* the real Lensman pretending he isn't, or maybe the real Lensman is slipping out while you're watching the man in the cab," the junior suggested, helpfully.

"Shut up!" the superior yelled. He started to reach for a switch, but paused, hand in air.

"Go ahead. That's it, call District and toss it into their laps, if it's too hot for you to handle. I think myself that whoever did this job is a warm number —plenty warm."

"And get my ears bunted off with that 'your report is neither complete nor conclusive' of his?" the chief sneered. "And get reduced for incompetence besides? No, we've got to do it ourselves, and do it right—but that man there isn't the Lensman—he can't be!"

"Well, you'd better make up your mind—you haven't got all day. And nix on that 'we' stuff. It's *you* that's got to do it—you're the boss, not me," the underling countered, callously. For once, he was really glad that he was not the one in command. "And you'd better get busy and do it, too."

"I'll do it," the chief declared, grimly. "There's a way."

There was a way. One only. He must be brought in alive and compelled to divulge the truth. There was no other way.

The blue man touched a stud and spoke. "Don't kill him—bring him in alive. If you kill him even accidentally, I'll kill both of you, myself."

THE Gray Lensman made his carefree way down the alleylike thoroughfare, whistling inharmoniously and very evidently at peace with the Universe.

It takes something, friends, to walk knowingly into a trap; without betraying emotion or stress even while a blackjack, wielded by a strong arm, is descending toward the back of your head. Something of quality, something of fiber. But whatever it took, Kinnison in ample measure had.

He did not wink, flinch, or turn an eye as the billy came down. Only as it touched his hair did he act, exerting all his marvelous muscular control to jerk forward and downward, with the weapon and ahead of it, to spare himself as much as possible of the terrific blow.

The blackjack crunched against the base of the Lensman's skull in a shower of coruscating constellations. He fell. He lay there, twitching feebly.

VIII.

As has been said, Kinnison rode the blow of the blackjack forward and downward, thus robbing it of some of its power. It struck him hard enough so that the thug did not suspect the truth; he thought that he had all but taken the Lensman's life. And, for all the speed with which the Telurian had yielded before the blow, he was hurt; but he was not stunned. Therefore, although he made no resistance when the two bullies rolled him over, lashed his feet together, tied his hands behind him, and lifted him into a car, he was fully conscious throughout the proceedings.

When the cab was perhaps half an hour upon its way the Lensman struggled back, quite realistically, to consciousness.

"Take it easy, pal," the larger of his thought-screened captors advised, dandling the blackjack suggestively before his eyes. "One yelp out of you, or a signal, if you've got one of them Lenses,

and I bop you another one."

"What the blinding blue hell's coming off here?" demanded the dock-walloper, furiously. "Wha'd'ya think you're doing, you lop-eared—" and he cursed the two, viciously and comprehensively.

"Shut up or he'll knock you kicking," the smaller thug advised from the driver's seat, and Kinnison subsided. "Not that it bothers me any, but you're making too much noise."

"But what's the matter?" Kinnison asked, more quietly. "What'd you slug me for and drag me off? I ain't done nothing and I ain't got nothing."

"I don't know nothing," the big agent replied. "The boss will tell you all you need to know when we get to where we're going. All I know is the boss says to bop you easylike and bring you in alive if you don't act up. He says to tell you not to yell and not to use no Lens. If you yell we burn you out. If you use any Lens, the boss he's got his eyes on all the bases and space-ports and everything, and if any help starts to come this way he'll tell us and we burn you out. Then we buzz off. We can kill you and flit before any help can get near you, he says."

"Your boss ain't got the brains of a fontema," Kinnison growled. He knew that boss, wherever he was, could hear every word. "Hell's hinges, if I was a Lensman you think I'd be walloping junk on a dock? Use your head, cully, if you got one."

"I wouldn't know nothing about that," the other returned, stolidly.

"But I ain't got no Lens!" the dock-walloper stormed, in exasperation. "Look at me—frisk me! You'll see I ain't!"

"All that ain't none of my dish." The thug was entirely unmoved. "I don't know nothing and I don't do nothing except what the boss tells me, see? Now take it easy, all nice and quietlike. If you don't," and he flicked the blackjack lightly against the Lensman's knee, "I'll put out your landing-lights. I'll lay you like a mat, and I don't mean maybe. See?"

Kinnison saw, and relapsed into silence. The automobile rolled along. And, flitting industriously about upon its delivery duties, but never much more or less than one measured mile distant, a panel job pursued its devious way. Oddly enough, its chauffeur was a Lensman. Here and there, high in the heavens, were a few airplanes, gyros, and copters; but they were going peacefully and steadily about their business—even though most of them happened to have Lensmen as pilots.

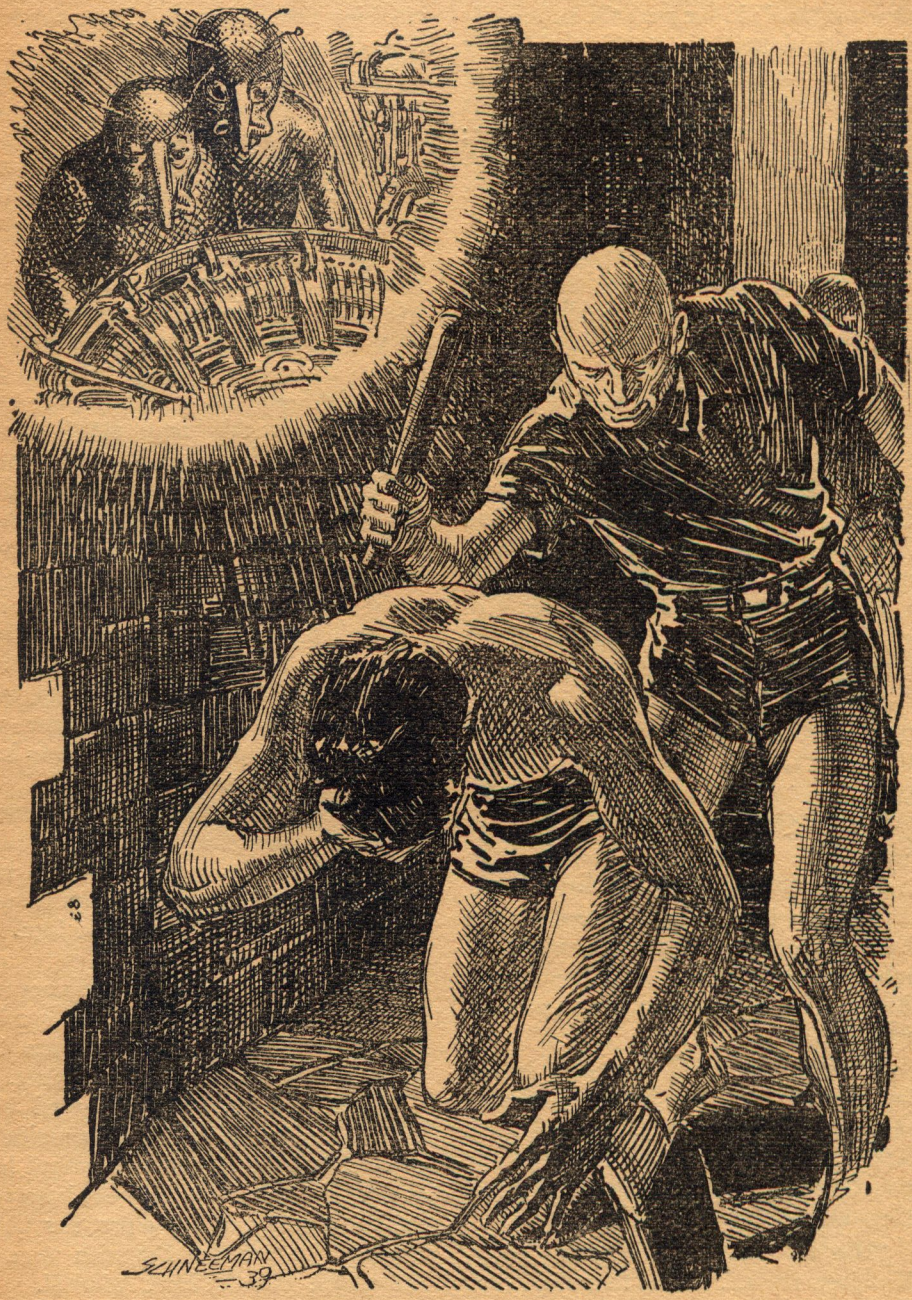
And, not at Base at all, but high in the stratosphere and so throughly screened that a spy ray observer could not even tell that his gaze was being blocked, Base's swiftest cruiser, Lensman-commanded, rode poised upon flare-baffled, softly hissing under jets. And, equally high and as adequately protected against observation, a keen-eyed Lensman sat at the controls of a speedster, jazzing her muffled jets and peering eagerly through a telescopic sight. As far as the Patrol was concerned, everything was on the trips.

The car approached the gates of a suburban estate and stopped. It waited. Kinnison knew that the Boskonian within was working his every beam, alert for any sign of Patrol activity; knew that if there were any such sign the car would be off in an instant. But there was no activity. Kinnison sent a thought to Gerrond, who relayed micrometric readings of the objective to various Lensmen. Still everyone waited. Then the gate opened of itself, the two thugs jerked their captive out of the car to the ground, and Kinnison sent out his signal.

BASE remained quiet, but everything else erupted at once. The airplanes wheeled, cruiser and speedster plum-

meted downward at maximum blast. The panel job literally fell open, as did the cage within it, and four ravening cateagles, with the silent ferocity of their kind, rocketed toward their goal.

Although the oglons were not as fast



The Lensman, fully aware, yet did not wink, flinch, or turn an eye as the billy came down.

as the flying ships they did not have nearly as far to go, wherefore they got there first. The thugs had no warning whatever. One instant everything was under control; in the next the noiselessly arrowing destroyers struck their prey with the mad fury that only a striking cateagle can exhibit. Barbed talons dug viciously into eyes, faces, mouths; tearing, rending, wrenching; fierce-driven fangs tore deeply, savagely into defenseless throats.

Once each the thugs screamed in mad, lethal terror, but no warning was given; for by that time every building upon that pretentious estate had disappeared in the pyrotechnic flare of detonating duodec. The pellets were small, of course—the gunners did not wish either to destroy the nearby residences or to injure Kinnison—but they were powerful enough for the purpose intended. Mansion and outbuildings disappeared, and not even the most thoroughgoing spy ray search revealed the presence of anything animate or structural where those buildings had been.

The panel job drove up and Kinnison, perceiving that the cateagles had done their work, sent them back into their cage. The Radeligian Lensman, after securely locking cage and truck, cut the Earthman's bonds.

"QX, Kinnison?" he asked.

"QX, Barknett—thanks," and the two Lensmen, one in the panel truck and the other in the gangsters' car, drove back to Base. There Kinnison recovered his package.

"This has got me all of a soapy lather, but you have called the turn on every play yet," Winstead told the Tellurian, later. "Is this all of the big shots, do you think, or are there some more of them around here?"

"Not around here, I'm pretty sure," Kinnison replied. "No, two main lines is all they would have had, I think—this time. Next time—"

"There won't be any next time," Winstead declared.

"Not on this planet, no. Knowing what to expect, you fellows can handle anything that comes up. I was thinking then of my next step."

"Oh. But you'll get 'em, Gray Lensman!"

"I hope so"—soberly.

"Luck, Kinnison!"

"Clear ether, Winstead!" and this time the Tellurian really did flit.

As his speedster ripped through the void Kinnison did more thinking, but he was afraid that his Arisian mentor would have considered the product muddy, indeed. He couldn't seem to get to the first check-station. One thing was limpidly clear; this line of attack or any very close variation of it would never work again. He'd have to think up something new. So far, he had got away with his stuff because he had kept one lap ahead of them, but how much longer could he manage to keep up the pace?

Bominger had been no mental giant, of course; but this other lad was nobody's fool and this next higher-up, with whom he had had an interview via Bominger, would certainly prove to be a really shrewd number.

" 'The higher the fewer,' " he repeated to himself the old saying, adding, "and in this case, the smarter." He had to put out some jets, but where he was going to get the fuel he had no idea.

AGAIN the trip to Tellus was uneventful, and the Gray Lensman, the symbol of his rank again flashing upon his wrist, sought interview with Haynes.

"Send him in, certainly—send him in!" Kinnison heard the communicator crackle, and the receptionist passed him along. He paused in surprise, however, at the doorway of the office, for Chief Surgeon Lacy and a Posenian were in conference with the Port Admiral.

"Come in, Kinnison," Haynes invited. "Lacy wants to see you a minute,

too. Dr. Phillips—Lensman Kinnison, Unattached. His name is not Phillips, of course; that is merely one we gave him in self-defense. His real name is utterly unpronounceable."

Phillips, the Posenian, was as tall as Kinnison, and heavier. His figure was somewhat human in shape, but not in detail. He had four arms instead of two, each arm had two opposed hands, and each hand had two thumbs, one situated about where a little finger would be expected. He had no eyes, not even vestigial ones. He had two broad, flat noses and two toothful mouths; one of each in what would ordinarily be called the front of his round, shining, hairless head; the other in the back. Upon the sides of his head were large, volute, highly dirigible ears. And, like most races having the faculty of perception instead of that of sight, his head was relatively immobile, his neck being short, massive, and tremendously strong.

"You look well, very well," Lacy reported, after feeling and prodding vigorously the members which had been in splints and casts so long. "Have to take a picture, of course, before saying anything definite. No, we won't, either, now. Phillips, look at his"—an interlude of technical jargon—"and see what kind of a recovery he has made." Then, while the Posenian was examining Kinnison's interior mechanisms, the Chief Surgeon went on:

"Wonderful diagnosticians and surgeons, these Posenians—can see into the patient without taking him apart. In another few centuries every doctor will have to have the sense of perception. Phillips is doing a research in neurology—more particularly a study of the neural synapse and the proliferation of neural deudrites—"

"La—cy-y-y!" Haynes drawled the word in reproof. "I've told you a thousand times to talk English when you're talking to me. How about it, Kinnison?"

"It might be more comprehensible, althought we must admit that any scientist likes to speak with precision, which he cannot do in the ordinary language of the layman."

"Right, boy—surprisingly and pleasingly right!" Lacy exclaimed. "Why can't you adopt that attitude, Haynes, and learn enough words so that you can understand what a man is talking about? But to reduce it to monosyllabic simplicity, Phillips is studying a thing that has baffled us for centuries—yes, for millennia. The lower forms of cells are able to regenerate themselves; wounds heal, bones knit. Higher types, such as nerve cells, regenerate imperfectly, if at all; and the highest type, the brain cells, do not do so under any conditions." He turned a reproachful gaze upon Haynes. "This is terrible. Those statements are pitiful—inadequate—false. Worse than that—practically meaningless. What I wanted to say, and what I'm going to say, is that—"

"Oh, no you aren't, not in this office," his old friend interrupted. "We got the idea perfectly. The question is, why can't human beings repair nerves or spinal cords, or grow new ones? If such a worthless beastie as a starfish can grow a whole new body to one leg, including a brain, if any, why can't a really intelligent victim of simple infantile paralysis—or a ray—recover the use of a leg that is otherwise in perfect shape?"

"Well, that's something like it, but I hope you can aim closer than that at a battleship," Lacy grunted. "We'll buzz off now, Phillips, and leave these two war horses alone."

"HERE IS my report in detail." Kinnison placed the package upon the Port Admiral's desk as soon as the room was sealed behind the visitors. "I talked to you direct about most of it—this is for the record."

"Of course. Mighty glad you found Medon, for our sake as well as theirs.

They have things that we need, badly."

"Where did they put them? I suggested a sun near Sol, so as to have them handy to Prime Base."

"Right next door—Alpha Centauri. Didn't get to do much scouting, did you?"

"I'll say we didn't. Boskonia owns that Galaxy; lock, stock, and barrel. May be some other independent planets—bound to be, of course; probably a lot of them—but it's too dangerous, hunting them at this stage of the game. But at that, we did enough, for the time being. We proved our point. Boskone, if there is any such being, is certainly in the Second Galaxy. However, it will be a long time before we're ready to carry the war there to him, and in the meantime we've got a lot to do. Check?"

"To nineteen decimals."

"It seems to me, then, that while you are rebuilding our first-line ships, superpowering them with Medonian insulation and conductors, I had better keep on tracing Boskone along the line of drugs. I have proved to my own satisfaction that they are back of almost all of that drug business."

"And in some ways their drugs are more dangerous to Civilization than their battleships. More insidious and, ultimately, more fatal."

"I'm convinced of it. And since I am perhaps as well equipped as any of the other Lensmen to cope with that particular problem—" Kinnison paused, questioningly.

"That certainly is no overstatement," the Port Admiral replied, dryly. "You're the *only* one equipped to cope with it."

"None of the other boys except Worsel, then? I heard that a couple—"

"They thought that they had a call, but they didn't. All they had was a wish. They came back."

"Too bad—but I can see how that would be. A man has to know exactly what he needs, and his brain must be ready to take it, or it burns it out. It almost does, anyway—mind is a funny thing. But that isn't getting us anywhere. Can you take time to let me talk at you a few minutes?"

"I certainly can. You have what is perhaps the most important assignment in the Galaxy, and I would like to know more about it, if it's anything you can pass on."

"Nothing that need be sealed from any Lensman. The main object of all of us, as you know, is to push Boskonia out of this Galaxy. From a military standpoint they practically *are* out. Their drug syndicate, however, is very decidedly in, and getting in deeper all the time. Therefore, we next push the zwilniks out. They have peddlers and such small fry, who deal with distributors and so on. These, as it were, form the bottom layer. Above them are the secret agents, the observers, and the wholesale handlers; runners and importers. All these folks are directed and controlled by one man, the boss of each planetary organization. Thus, Bominger was the boss of all zwilnik activities on the whole planet of Radelix.

"In turn the planetary bosses report to, and are synchronized and controlled by, a Regional Director, who supervises the activities of a couple of hundred or so planetary outfits. I got a line on the one over Bominger, you know—Prellin, the Kalonian. By the way, you knew, didn't you, that Helmuth was a Kalonian, too?"

"I got it from the tape. Smart people, they must be, but not my idea of good neighbors."

"I'll say not. Well, that's all I really *know* of their organization. It seems logical to suppose, though, that the structure is coherent all the way up. If so, the Regional Directors would be under some higher-up, possibly a Galactic Director, who in turn might be under Boskone himself—or one of his cabinet officers, at least. Perhaps the Galactic

Director might even be a cabinet officer in their government, whatever it is?"

"An ambitious program you've got mapped out for yourself. How are you figuring on swinging it?"

"THAT'S the rub—I don't know," Kinnison confessed, ruefully. "But if it's done at all, that's the way I've got to go about it. Any other way would take a thousand years and more men than we'll ever have. This way works fine, when it works at all."

"I can see that—lop off the head and the body dies," Haynes agreed.

"That's the way it works—especially when the head keeps detailed records and books covering the activities of all the members of his body. With Bominger and the others gone, and with full transcripts of his accounts, the boys mopped up Radelix in a hurry. From now on it will be simple to keep it clean, except of course, for the usual bootleg trickle, and that can be reduced to a minimum. Similarly, if we can put this Prellin away and take a good look at his ledgers, it will be easy to clear up his two hundred planets. And so on."

"Very clear, and quite simple—in theory." The older man was thoughtful and frankly dubious. "In practice, difficult in the extreme."

"But necessary," the younger insisted.

"I suppose so," Haynes assented finally. "Useless to tell you not to take chances—you'll have to—but for all of our sakes, if not for your own, be as careful as you can."

"I'll do that, chief. I think a lot of me, really. You know that story about the guy who was all right in his place, but the place hadn't been dug yet? Well, I don't want anybody digging my proper place for a long time to come."

Haynes laughed, but the concern did not leave his features. "Anything special you want done?" he asked.

"Yes, very special," Kinnison surprised him by answering in the affirmative. "You know that the Medonians developed a scrambler for a detector nullifier. Hotchkiss and the boys developed a new line of attack on that—against long-range stuff we're probably safe—but they haven't been able to do a thing on electromagnetics. Well, the Boskonians, beginning with Prellin, are going to start wondering what has been happening. Then, if I succeed in getting Prellin, they are bound to start doing things. One thing they will do will be to fix up their headquarters so that they will have about five hundred percent overlap on their electros. Perhaps they will have outposts, too, close enough together to have the same thing there—possibly two or three hundred even on visuals."

"In that case, I would say that you'd stay out."

"Not necessarily. What do electros work on?"

"Iron, I suppose—they did when I went to school last."

"The answer, then, is to build me a speedster that is inherently indetectable—absolutely non-ferrous. Berylumin and other alloys for all the structural parts—"

"But you've got to have silicon-steel cores for your electrical equipment!"

"I was coming to that. Have you? I was reading in the 'Transactions' the other day that force fields had been used in big units, and were more efficient. Some of the smaller units, instruments and so on, might have to have some iron, but wouldn't it be possible to so saturate those small pieces with a dense field of detector frequencies that they wouldn't react?"

"I don't know. Never thought of it. Would it?"

"I don't know, either—I'm not telling you, I'm just making suggestions. I do know one thing, however. We've got to keep ahead of them—think of things first and oftenest, and be ready

to abandon them for something else as soon as we have used them once."

"Except for those primary projectors." Haynes grinned wryly. "They can't be abandoned—even with Medonian power we haven't been able to develop a screen that will stop them cold. We've got to keep them secret from Boskone—and in that connection I want to compliment you on the suggestion of having Velantian Lensmen as mind readers wherever those projectors are even being thought of."

"You caught spies, then? How many?"

"Not many—three or four in each Base—but enough to have done the damage. Now, I believe, for the first time in history, we can be *sure* of our entire personnel."

"I think so. The Arisian said that the Lens was enough, if we used it properly. That's up to us."

"But how about visuals?" Haynes was still worrying, and to good purpose.

"WELL, we have a black coating now that is ninety-nine percent absorptive, and I don't need ports or windows. At that, though, one percent reflection would be enough to give me away at a critical time. How'd it be to put a couple of the boys on that job? Have them put a decimal point after the ninety-nine and see how many nines they can tack on behind it?"

"That's a thought, Kinnison, and they have lots of time to work on it while the engineers are trying to fill your specifications as to a speedster. But you're right, dead right, in everything you have said. We—or rather, you—have got to outthink them; and it certainly is up to us to do everything that can be done to build the apparatus to put your thoughts into practice. And it is not at some vague time in the future that Boskone is going to start thinking seriously about you and what you have done. It is now; or even more probably, a week or so ago. In fact, if there were any way of learning the truth, I think we should find that they have begun acting already, instead of waiting until you abate the nuisance which is Prellin, the Kalonian. But you haven't said a word yet about the really big job you have in mind."

"I've been putting that off until the last." The Gray Lensman's voice held obscure puzzlement. "The fact is that I simply can't get a tooth into it—can't get a grip in it anywhere. I don't know enough about math or physics. Everything comes out negative for me; not only inertia, but also force, velocity, and even mass itself. Final results always contain an 'i,' too, the square root of minus one. I can't get rid of it, and I don't see how it can be built into any kind of apparatus. It may not be workable at all, but before I give up the idea I would like to call a conference, if it's QX with you and the Council."

"Certainly it is QX with us. You're forgetting again, aren't you, that you're a Gray Lensman?" Haynes' voice held no reproof, he was positively beaming with a super-fatherly pride.

"Not exactly." Kinnison blushed, almost squirmed. "I'm just too much of a cub to be sticking my neck out so far, that's all. The idea may be—probably is—wilder than a Radeligian cat-eagle. The only kind of a conference that could even begin to handle it would cost a young fortune, and I don't want to spend that much money on my own responsibility."

"To date your ideas have worked out well enough so that the Council is backing you one hundred percent," the older man said, dryly. "Expense is no object." Then, his voice changing markedly, "Kim, have you any idea at all of the financial resources of the Patrol?"

"Very little, sir, if any, I'm afraid," Kinnison confessed.

"Here on Tellus alone we have an expendible reserve of over ten thousand

million credits. With the restriction of government to its proper sphere and its concentration into our organization, resulting in the liberation of man-power into wealth-producing enterprise, and especially with the enormous growth of inter-world commerce, world-income increased to such a point that taxation could be reduced to a minimum; and the lower the taxes the more flourishing business became and the greater the income.

"Now the tax rate is the lowest in recorded history. The total income tax, for instance, in the highest bracket, is only three point five nine two percent. At that, however, if it had not been for the recent slump, due to Boskonian interference with inter-systemic commerce, we would have had to reduce the tax rate again to avoid serious financial difficulty due to the fact that too much of the galactic total of circulating credit would have been concentrated in the expendable funds of the Galactic Patrol. So don't even think of money. Whether you want to spend a thousand credits, a million, or a thousand million; go ahead."

"Thanks, chief; glad you explained. I'll feel better now about spending money that doesn't belong to me. Now if you'll give me, for about a week, the use of the librarian in charge of science files and a galactic beam, I'll quit bothering you."

"I'll do that." The Port Admiral touched a button and in a few minutes a trimly attractive blonde entered the room. "Miss Hostetter, this is Lensman Kinnison, Unattached. Please turn over your regular duties to an assistant and work with him until he releases you. Whatever he says, goes; the sky's the limit."

IN THE Library of Science Kinnison outlined his problem briefly to his new aide, concluding:

"I want only about fifty, as a larger group could not co-operate efficiently. Are your lists arranged so that you can skim off the top fifty?"

"Such a group can be selected, I think." The girl stood for a moment, lower lip held lightly between white teeth. "That is not a standard index, but each scientist has a rating upon his card. I can set the acceptor . . . no, the rejector would be better . . . to throw out all the cards above any given rating. If we take out all ratings over seven hundred we will have only the highest of the geniuses."

"How many, do you suppose?"

"I have only a vague idea—a couple of hundred, perhaps. If too many, we can run them again at a higher level, say seven ten. But there won't be very many, since there are only two galactic ratings higher than seven fifty. There will be duplications, too—such people as Sir Austin Cardynge will have two or three cards in the final rejects."

"QX—we'll want to hand-pick the fifth, anyway. Let's go!"

Then for hours, bale after bale of cards went through the machine; thousands of records per minute. Occasionally one card would flip out into a rack, rejected. Finally:

"That's all, I think. Mathematicians, physicists," the librarian ticked off upon pink fingers. "Astronomers, philosophers, and this new classification, which has not been named yet."

"The H. T. T.'s." Kinnison glanced at the label, lightly lettered in pencil, fronting the slim packet of cards. "Aren't you going to run them through, too?"

"No. These are the two I mentioned a minute ago—the only ones rating over seven hundred fifty."

"A choice pair, eh? Sort of a *crème de la crème?* Let's look 'em over," and he extended his hand. "What do the initials stand for?"

"I'm awfully sorry, sir, really," the girl flushed in embarrassment as she relinquished the cards in high reluctance.

"If I'd had any idea, we wouldn't have dared—we call you, among ourselves, the 'High-Tension Thinkers.'"

"Us!" It was the Lensman's turn to flush. Nevertheless, he took the packet and read sketchily the facer: "Class XIX—Unclassifiable at present—lack of adequate methods—minds of range and scope far beyond any available indices—Ratings above high genius (750)—yet no instability—power beyond any heretofore known—assigned rating tentative and definitely minimum."

He then read the cards.

"Worsel, Velantia, eight hundred five."

And:

"Kimball Kinnison, Tellus, nine hundred twenty-five!"

IX.

THE Port Admiral was eminently correct in supposing that Boskone, whoever or whatever he or it might be, was already taking action upon what the Tellurian Lensman had done. For, even as Kinnison was at work in the Library of Science, a meeting which was indirectly to affect him no little was being called to order.

In the immensely distant Second Galaxy was that meeting being held; upon the then planet Jarnevon of the Eich; within that sullen fortress already mentioned briefly. Presiding over it was the indescribable entity known to history as Eichlan; or, more properly, Lan of the Eich.

"Boskone is now in session," that entity announced to the eight other like monstrosities who in some fashion indescribable to man were stationed at the long, low, wide bench of stonelike material which served as a table of State. "Nine days ago each of us began to search for whatever new facts might bear upon the activities of the as-yet-entirely-hypothetical Lensman who, Helmuth believed, was the real force back of our recent intolerable reverses in the Tellurian Galaxy.

"As First of Boskone I will report as to the military situation. As you know, our positions there became untenable with the fall of our Grand Base and all our mobile forces were withdrawn. In order to facilitate reorganization, co-ordinating ships were sent out. Some of these ships went to planets held in toto by us. Not one of these vessels has been able to report any pertinent facts whatever. Ships approaching bases of the Patrol, or encountering Patrol ships of war in space, simply ceased communicating. Even their automatic recorders, tuned to my desk as commander-in-chief, ceased to function without transmitting any intelligible data, indicating complete destruction of those ships. A cascade system, in which one ship followed another at long range and with analytical instruments set to determine the nature of any beam or weapon employed, was attempted. The enemy, however, threw out blanketing zones of tremendous power; and we lost six more vessels without obtaining the desired data. These are the facts, all negative. Theorizing, deduction, summation, and integration will as usual, come later. Eichmil, Second of Boskone, will now report."

"My facts are also entirely negative," the Second began. "As soon as our operations upon the planet Radelix began to be really productive of results, a contingent of Tellurian narcotic agents arrived; which may or may not have included the Lensman—"

"Stick to facts for the time being," Eichlan ordered, curtly.

"Shortly thereafter a minor agent, a female instructed to wear a thought-screen at all times, lost her usefulness by suffering a mental disorder which incapacitated her quite seriously. Then another agent, also a female, this time one of the third order and who had been very useful up to that time, ceased re-

porting. A few days later Bominger, the Planetary Director, failed to report, as did the Planetary Observer; who, as you know, was entirely unknown to, and had no connection with, the operating staff. Reports from other sources, such as importers and shippers—these, I believe, are here admissible as facts—indicate that our entire personnel upon Radelix has been put to death. No unusual developments have occurred upon any other planet, nor has any significant fact, however small, been discovered."

"Eichnor, Third of Boskone."

"Also negative. Our every source of information from within the bases of the Patrol has been shut off. Every one of our representatives—some of whom have been reporting regularly for many years—has been silent, and every effort to reach any of them has failed."

"Eichsnap, Fourth of Boskone."

"Utterly negative. We have been able to find no trace whatever of the planet Medon, or of any one of the twenty-one warships investing it at the time of its disappearance."

And so on, through nine reports, while the tentacles of the mighty First of Boskone played intermittently over the keys of a complex instrument or machine before him.

"We will now reason, theorize, and draw conclusions," the First announced, and each of the organisms fed his ideas and deductions into the machine. It whirred briefly, then ejected a tape, which Eichlan took up and scanned narrowly.

"REJECTING all conclusions having a probability of less than ninety-five percent," he announced, "we have: First, a set of three probabilities of a value of ninety-nine and ninety-nine one-hundredths—virtual certainties—that some one Tellurian Lensman is the prime mover behind what has happened; that he has acquired a mental power heretofore unknown to his race; and that he has been in large part responsible for the development of the Patrol's new and formidable weapons. Second, a probability of ninety-nine percent that he and his organization are no longer on the defensive, but have assumed the offensive. Third, one of ninety-seven percent that it is not primarily Tellus which is an obstacle, even though the Galactic Patrol and Civilization did originate upon that planet, but Arisia; that Helmuth's report was at least partially true. Fourth, one of ninety-five and one half percent that the Lens is also concerned in the disappearance of the planet Medon. There is a lesser probability, but still of some ninety-four percent, that that same Lensman is involved here.

"I will interpolate here that the vanishment of that planet is a much more serious matter than it might appear, on the surface, to be. In situ, it was a thing of no concern—gone, it becomes an affair of almost vital import. To issue orders impossible of fulfillment, as Helmuth did when he said 'Comb Trenco, inch by inch,' is easy. To comb this Galaxy star by star for Medon would be an even more difficult and longer task; but what can be done is being done.

"To return to the conclusions, they point out a state of things which I do no have to tell you is really grave. This is the first major setback which the culture of the Boskone has encountered since it began its rise, thousands of years ago. You are familiar with that rise; how we of the Eich took over in turn a city, a race, a planet, a solar system, a region, a galaxy. How we extended our sway into the Tellurian Galaxy, as a preliminary to the extension of our authority throughout all the populated galaxies of the macrocosmic Universe.

"You know our creed; to the victor the power. He who is strongest and fittest shall survive and shall rule. This so-called Civilization which is opposing

us, which begun upon Tellus but whose driving force is that which dwells upon Arisia, is a soft, weak, puny-spirited thing indeed to resist the mental and material power of our culture. Myriads of beings upon each planet, each one striving for power and, so striving, giving of that power to him above. Myriads of planets, each, in return for our benevolently despotic control, delegating and contributing power to the Eich. All this power, delegated to the thousands of millions of the Eich of this planet, culminates in and is wielded by the nine of us who comprise Boskone.

"Power! Our forefathers thought that control of one planet was enough. Later it was declared that mastery of a galaxy, if realized, would sate ambition. We of Boskone, however, now know that our power shall be limited only by the bounds of the Material Cosmic All —every world that exists throughout space shall and must pay homage and tribute to Boskone! What, gentlemen, is the sense of this meeting?"

"Arisia must be visited!" There was no need of integrating this thought; it was dominant and unanimous.

"I would advise caution, however," the Eighth of Boskone amended his ballot. "We are an old race, it is true, and able; we have demonstrated our superiority over every other race of our Galaxy, much more conclusively than the Tellurians have shown their supremacy on theirs, I cannot help but believe, however, that in Arisia there exists an unknown quality, an 'x' which we as yet are unable to evaluate. It must be borne in mind that Helmuth, while not of the Eich, was, nevertheless, an able being; yet he was handled so mercilessly there that he could not render a complete or conclusive report of his expedition, then or ever. With these thoughts in mind I suggest that no actual landing be made, but that the torpedo be launched from a distance."

"The suggestion is eminently sound," the First approved. "As to Helmuth, he was, for an oxygen-breather, fairly able. He was however, mentally soft, as are all such. Do you, our foremost psychologist, believe that any existent or conceivable mind could break yours, with no application whatever of physical force or device, as Helmuth's reports seemed to indicate that his was broken? I use the word 'seemed' advisedly, for I do not believe that Helmuth reported the actual truth. In fact, I was about to replace him with an Eich, however unpleasant such an assignment would be to any of our race, because of that weakness."

"No," agreed the Eighth. "I do not believe that there exists in the Universe a mind of sufficient power to break mine. It is a truism that no mental influence, however powerful, can affect a strong, definitely and positively opposed will. For that reason I voted against the use of thought-screens by our agents. Such screens expose them to detection and can be of no real benefit. Physical means were—must have been—used first, and, after physical subjugation, the screens were, of course, useless."

"I AM NOT sure that I agree with you entirely," the Ninth put in. "We have here cogent evidence that there have been employed mental forces of a type or pattern with which we are entirely unfamiliar. While it is the concensus of opinion that the importance of Helmuth's report should be minimized, it seems to me that we have enough corroborative evidence to indicate that this mentality may be able to operate without material aid. If so, rigid screening should be retained, as offering the only possible safeguard from such force."

"Sound in theory, but in practice dubious," the psychologist countered. "If there were any evidence whatever that the screens had done any good I would agree with you. But have they? Screening failed to save Helmuth or his

base; and there is nothing to indicate that the screens impeded, even momentarily, the progress of the suppositious Lensman upon Radelix. You speak of 'rigid' screening. The term is meaningless. Perfectly effective screening is impossible. If, as we seem to be doing, we postulate the ability of one mind to control another without physical, bodily contact—or is the idea at all farfetched, considering what I myself have done to the minds of many of our agents?—the Lensman can work through any unshielded mentality whatever to attain his ends. As you know, Helmuth deduced, too late, that it must have been through the mind of a dog that the Lensman invaded Grand Base."

"Poppycock!" snorted the Seventh. "Or, if not, we can kill the dogs—or screen their minds, too," he sneered.

"Admitted," the psychologist returned, unmoved. "You might conceivably kill all the animals that run and all the birds that fly. You cannot, however, destroy all life in any locality at all extended, clear down to the worms in their burrows and the termites in their hidden retreats; and the mind has not yet existed which is keen enough to draw a line of demarcation and say 'here begins intelligent life.' "

"This discussion is interesting, but futile," put in Eichlan, forestalling a scornful reply. "It is more to the point, I think, to discuss that which must be done; or, rather, who is to do it, since the thing itself admits of only one solution—an atomic bomb of sufficient power to destroy every trace of life upon that accursed planet. Shall we send someone, or shall some of us ourselves go? To overestimate a foe is at worst only an unnecessary precaution; to underestimate this one may well be fatal. Therefore, it seems to me, that the decision in this matter should lie with our psychologist. I will, however, if you prefer, integrate our various conclusions."

Recourse to the machine was unnecessary; it was agreed by all that Eichamp, the Eighth of Boskone, should decide.

"My decision will be evident," that worthy said, measuredly, "when I say that I myself, for one, am going. The situation is admittedly a serious one. Moreover, I believe, to a greater extent than do the rest of you, that there is a certain amount of truth in Helmuth's version of his experiences. My mind is the only one in existence of whose power I am absolutely certain; the only one which I definitely *know* will not give way before any conceivable mental force, whatever its amount or whatever its method of application. I want none with me save of the Eich, and even those I will examine carefully before permitting them aboard ship with me."

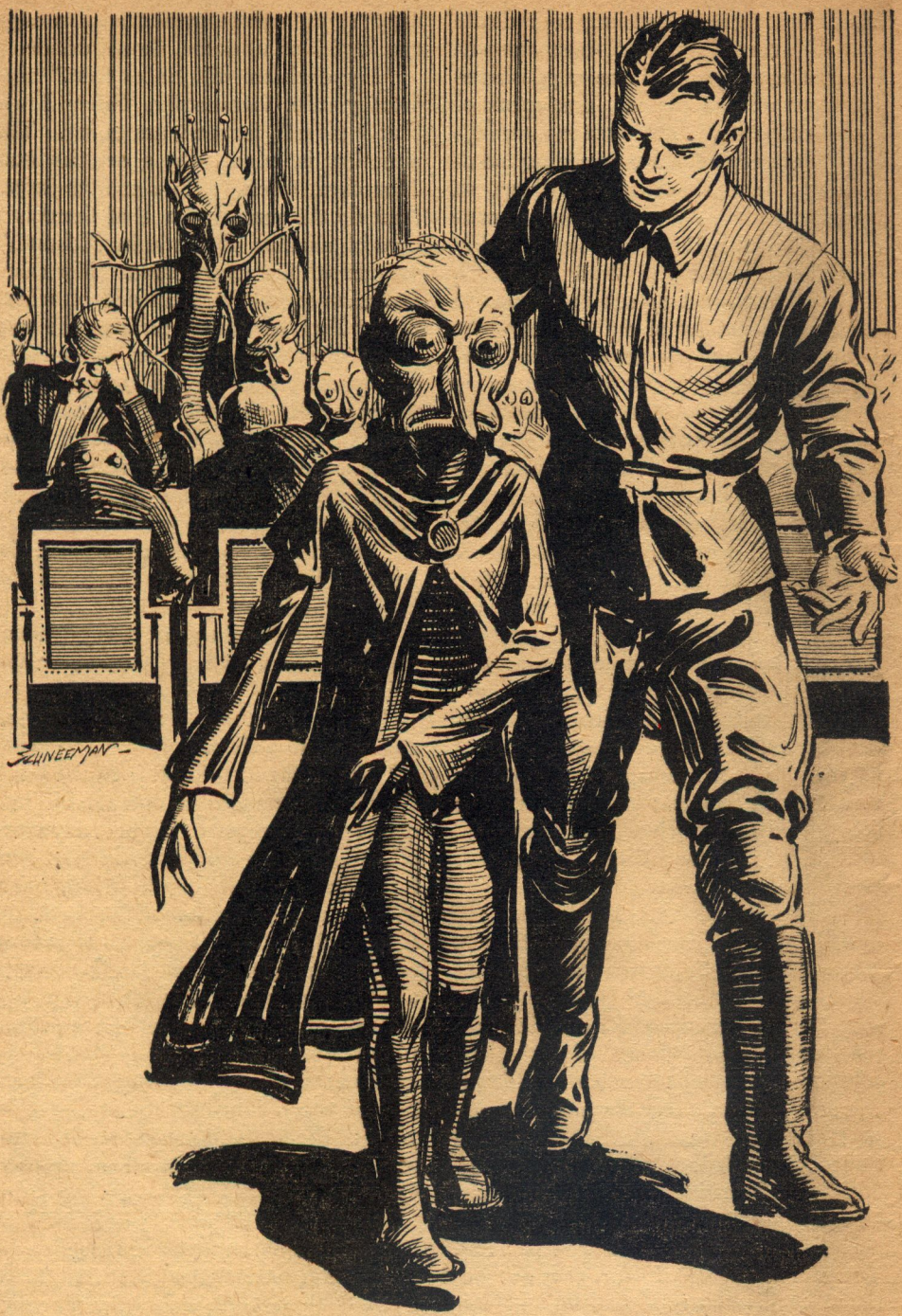
"You decide as I thought," said the First. "I also shall go. My mind will hold, I think."

"It will hold—in your case examination is unnecessary," agreed the psychologist.

"And I! And I!" arose what amounted to a chorus.

"No," came curt denial from the First. "Two are enough to operate all machinery and weapons. To take any more of the Boskone would weaken us here injudiciously; well you know how many are working, and in what fashions, for seats at this table. To take any weaker mind, even of the Eich, might conceivably be to court disaster. We two should be safe; I because I have proven repeatedly my right to hold the title of First of this Council, the rulers and masters of the dominant race of the Universe; Eichamp because of his unparalleled knowledge, of all intelligence. Our vessel is ready. We go."

As has been indicated, none of the Eich were, or ever had been, cowards. Tyrants they were, it is true, and dictators of the harshest, sternest, and most soulless kind; callous and merciless they were; cold as the rocks of their frigid



Time after time some essential scientist stalked off in hugh dudgeon, with Kinnison trailing, soothing ruffled ego.

world and as utterly ruthless and remorseless as the fabled Juggernaut; but they were as logical as they were hard. He, who of them all was best fitted to do anything, did it unquestioningly and, as a matter of course; did it with the calmly emotionless efficiency of the machine which in actual fact he was. Therefore, it was the First and the Eighth of Boskone who went.

Through the star-studded purlieus of the Second Galaxy the black, airless, lightless vessel sped; through the reaches, vaster and more tenuous far, of intergalactic space; into the Tellurian Galaxy; up to a solar system shunned then as now, by all uninvited intelligences—dread and dreaded Arisia.

Not close to the planet did even the two of Boskone venture; but stopped at the greatest distance at which a torpedo could be directed surely against the target. But even so the vessel of the Eich had punctured a screen of mental force; and as Eichlan extended a tentacle toward the firing mechanism of the missiles, watched in as much suspense as they were capable of feeling by the planet-bound seven of Boskone, a thought as penetrant as a needle and yet as binding as a cable tempered steel drove into his brain.

"Hold!" That thought commanded, and Eichlan held, as did also his fellow Boskonian.

Both remained rigid, unable to move any single voluntary muscle; while the other seven of the Council looked on in uncomprehending amazement. Their instruments remained dead—since those mechanisms were not sensitive to thought, to them nothing at all was occurring. Those seven leaders of the Eich knew that something was happening; something dreadful, something untoward, something very decidedly not not upon the program they had helped to plan. They, however, could do nothing about it; they could only watch and wait.

"Ah, 'tis Lan and Amp of the Eich," the thought resounded within the minds of the helpless twain. "Truly, the Elders are correct. My mind is not yet competent, for, although I have had many facts instead of but a single one upon which to cogitate, and no dearth of time in which to do so, I now perceive that I have erred grievously in my visualization of the Cosmic All. You do, however, fit nicely into the now enlarged Scheme, and I am really grateful to you for furnishing new material with which for many cycles of time to come, I shall continue to build.

"Indeed, I believe that I shall permit you to return unharmed to your own planet. You know the warning we gave Helmuth, your minion, hence your lives are forfeit for violating knowingly the privacy of Arisia; but wanton or unnecessary destruction is not conducive to mental growth. You are, therefore, at liberty to depart. I repeat to you the instructions given your underling: do not return, either in person or by any form whatever of proxy."

The Arisian had as yet exerted scarcely a fraction of his power; although the bodies of the two invaders were practically paralyzed, their minds had not been punished. Therefore the psychologist said, coldly:

"You are not now dealing with Helmuth, nor with any other weak, mindless oxygen-breather, but with the *Eich,*" and, by sheer effort of will, he moved toward the controls.

"What boots it?" the Arisian compressed upon the Eighth's brain a searing force which sent shrieking waves of pain throughout all nearby space. Then, taking over the psychologist's mind, he forced him to move to the communicator panel, upon whose plate could be seen the other seven of Boskone, gazing in wonder.

"Set up planetary coverage," he directed, through Eichamp's organs of speech, "so that each individual mem-

ber of the entire race of the Eich can understand what I am about to transmit." There was a brief pause, then the deep, measured voice rolled on:

"I AM Eukonidor of Arisia, speaking to you through this mass of undead flesh which was once your chief psychologist, Eichamp, the Eighth of that high council which you call Boskone. I had intended to spare the lives of these two simple creatures, but I perceive that such action would be useless. Their minds and the minds of all you who listen to me are warped, perverted, incapable of reason. They and you would have misinterpreted the gesture completely; would have believed that I did not slay them only because I could not do so. Some of you would have offended again and again, until you were so slain; you can be convinced of such a fact only by an unmistakable demonstration of superior force. Force is the only thing you are able to understand. Your one aim in life is to gain material power; greed, corruption, and crime are your chosen implements.

"You consider yourselves hard and merciless. In a sense, and according to your abilities you are, although your minds are too callow to realize that there are depths of cruelty and of depravity which you cannot even faintly envision.

"You love and worship power. Why? To any thinking mind it should be clear that such a lust intrinsically is, and forever must by its very nature be, futile. For, even if any one of you could command the entire material Universe, what good would it do him? None. What would he have? Nothing. Not even the satisfaction of accomplishment, for that lust is in fact insatiable—it would then turn upon itself and feed upon itself. I tell you as a fact that there is only one power which is at one and the same time illimitable and yet finite; insatiable yet satisfying; one which, while eternal, yet invariably returns to its possessor the true satisfaction of real accomplishment in exact ratio to the effort expended upon it. That power is the power of the mind. You, being so backward and so wrong of development, cannot understand how this can be, but if any one of you will concentrate upon one single fact, or a small object, such as a pebble or the seed of a plant or other creature, for as short a period of time as one hundred of your years, you will begin to perceive its truth.

"You boast that your planet is old. What of that? We of Arisia dwelt in turn upon a thousand planets, from planetary youth to cosmic old age, before we became independent of the chance formation of such celestial bodies.

"You prate that you are an ancient race. Compared to us you are sheerly infantile. We of Arisia did not originate upon a planet formed during the recent interpassage of these two galaxies, but upon one which came into being in an antiquity so distant that the figure in years would be entirely meaningless to your minds. We were of an age to your mentalities starkly incomprehensible when your most remote ancestors began to wriggle about in the slime of your parent world.

" 'Do the men of the Patrol know—?' I perceive the question in your minds. They do not. None save a few of the most powerful of their minds has the slightest inkling of the truth. To reveal any portion of it to Civilization as a whole would blight that Civilization irreparably. Though Seekers after Truth in the best sense, they are essentially juvenile and their life spans are ephemeral indeed. The mere realization that there is in existence such a race as ours would place upon them such an inferiority complex as would make further advancement impossible. In your case such a course of events is not to be expected. You will close your minds to all that has happened, declaring to yourselves that it was impossible and that

therefore, it could not have taken place and did not. Nevertheless, you will stay away from Arisia henceforth.

"But to resume. You consider yourselves long-lived. Know then, insects, that your life span of a thousand of your years is but a moment. I, myself, have already lived eleven thousand such lifetimes, and I am but a youth—a mere Guardian, not yet to be entrusted with really serious thinking.

"I have spoken overlong; the reason for my prolixity being that I do not like to see the energy of a race so misused, so corrupted to material conquest for its own sake. I would like to set your minds upon the Way of Truth, if perchance such a thing should be possible. I have pointed out that Way; whether or not you follow it is for you to decide. Indeed, I fear that most of you, in your short-sighted pride, have already cast my message aside; refusing point-blank to change your habits of thought. It is, however, in the hope that some few of you will perceive the Way and will follow it by abandoning your planet and its Eich before it is too late, that I have discoursed at such length.

"Whether or not you change your habits of thought, I advise you to heed this, my warning. Arisia does not want and will not tolerate intrusion. As a lesson, watch these two violators of our privacy destroy themselves."

The giant voice ceased. Eichlan's tentacles moved toward the controls. The vast torpedo launched itself.

But instead of hurtling toward distant Arisia it swept around in a mighty circle and struck in direct central impact the great cruiser of the Eich. There was an appalling crash, a space-wracking detonation, a flare of incandescence incredible and indescribable as the energy calculated to disrupt—almost to volatilize—a world expended itself upon the insignificant mass of one Boskonian battleship and upon the unresisting texture of the void.

X.

CONSIDERABLY more than the stipulated week passed before Kinnison was done with the librarian and with the long-range communicator beam, but eventually he succeeded in enlisting the aid of the fifty-three most eminent scientists and thinkers of all the planets of Galactic Civilization. From all over the Galaxy were they selected; from Vandrmar and Centralia and Alsakan; from Chickladoria and Radelix; from the solar systems of Rigel and Sirius and Antares. Millions of planets were not represented at all; and of the few which were, Tellus alone had more than one delegate.

This was necessary, Kinnison explained carefully to each of the chosen. Sir Austin Cardynge, the man whose phenomenal brain had developed a new mathematics to handle the positron and the negative energy levels, was the one who would do the work; he himself was present merely as a co-ordinator and observer. The meeting-place, even, was not upon Tellus, but upon Medon, the newly acquired and hence entirely neutral planet. For the Gray Lensman knew well the minds with which he would have to deal.

They were all the geniuses of the highest rank, but in all too many cases their stupendous mentalities merged altogether too closely upon insanity for any degree of comfort. Even before the conclave assembled it became evident that jealousy was to be rife and rampant; and after the initial meeting, at which the problem itself was propounded, it required all of Kinnison's ability, authority, and drive, and all of Worsel's vast diplomacy and tact, to keep those mighty brains at work.

Time after time, some essential entity, his dignity outraged and his touchy ego infuriated by some real or fancied insult, stalked off in high dudgeon to return to his own planet; only to be

coaxed or bullied, or even mentally manhandled by Kinnison or Worsel, or both, into returning to his task.

Nor were those insults all, or even mostly, imaginary. Quarreling and bickering were incessant, violent flare-ups and passionate scenes of denunciation and vituperation were of almost hourly occurrence. Each of those minds had been accustomed to world-wide adulation, to the unquestioned acceptance as gospel of his every idea or pronouncement, and to have to submit his work to the scrutiny and to the unworshipful criticisms of lesser minds—actually to have to give way, at times, to those inferior mentalities—was a situation quite definitely intolerable.

But at length most of them began to work together, as they appreciated the fact that the problem before them was one which none of them singly had been able even partially to solve; and Kinnison let the others, the most fanatically non-co-operative, go home. The progress began—and none too soon. The Gray Lensman had lost twenty-five pounds of weight, and even the iron-thewed Worsel was a wreck. He could not fly, he declared, because his wings buckled in the middle; he could not crawl, because his belly-plate clashed against his backbone!

And finally the thing was done; reduced to a set of equations which could be written upon a single sheet of paper. It is true that those equations would have been meaningless to almost anyone then alive, since they were based upon a system of mathematics which had been brought into existence at that very meeting, but Kinnison had taken care of that.

No Medonian had been allowed in the Conference—the admittance of one to membership would have caused a massed exodus of the high-strung, temperamental maniacs working so furiously there—but the Tellurian Lensman had had recorded every act, almost every thought, of every one of those geniuses. Those records had been studied for weeks, not only by Wise of Medon and his staff, but also by a corps of the less brilliant, but infinitely better balanced scientists of the Patrol proper.

"Now you fellows can really get to work." Kinnison heaved a sigh of profound relief as the last member of the Conference figuratively shook the dust of Medon off his robe as he departed homeward. "I'm going to sleep for a week. Call me, will you, when you get the model done?"

THIS was sheerest exaggeration, of course, for nothing could have kept the Lensman from watching the construction of that first apparatus. He watched the erection of a spherical shell of loosely latticed truss-work some twenty feet in diameter. He watched the installation, at its six cardinal points, of atomic exciters, each capable of transforming ten thousand pounds per hour of substance into pure energy. He knew that those exciters were driving their intake screens at a ratio of at least twenty thousand to one; that energy equivalent to the annihilation of at least six hundred thousand tons per hour of material was being hurled into the center of that web from the six small mechanisms which were in fact, super-Bergenholms. Nor is that word adequate to describe them. They were engines at whose power the late Dr. Bergenholm himself would have quailed; demons whose fabrication would have been utterly impossible without Medonian conductors and insulation.

He watched the construction of a conveyor and a chute and looked on intently while a hundred thousand tons of refuse—rocks, sand, concrete, scrap iron, loose metal, débris of all kinds—were dropped into that innocuous-appearing sphere, only to vanish as though they had never existed.

"But we ought to be able to see it by

this time, I should think!" Kinnison protested once.

"Not yet, Kim," Master Technician LaVerne Thorndyke informed him. "Just forming the vortex—microscopic yet. I haven't the faintest idea of what is going on in there; but man, dear man, *am* I glad that I'm here to help make it go on!"

"But *when?*" demanded the Lensman. "How soon will you know whether it's going to work or not? I want to do a flit."

"You can flit any time—now, if you like," the technician told him, brutally. "We don't need *you* any more—you've done your bit. It's working now. If it wasn't, do you think we could pack all that stuff into that little space? But we'll have it done long before you'll need it."

"But I want to see it work, you big lug!" Kinnison retorted, only half playfully.

"Come back in three-four days—maybe a week; but don't expect to see anything but a hole."

"That's exactly what I want to see, a hole in space," and that was precisely what, a few days later, the Lensman did see.

The spherical framework was unchanged, the machines were still carrying easily their incredible working load. Material—any and all kinds of stuff—was still disappearing; instantaneously, invisibly, quietly, with no flash or fury to mark its passing.

But at the center of that massive sphere there now hung poised a—a *something.* Or was it a nothing? Mathematically, it was a sphere, or rather a negasphere, about the size of a baseball; but the eye, while it could see something, could not perceive it analytically. Nor could the mind envision it in three dimensions, for it was not essentially three-dimensional in nature. Light sank into the thing, whatever it was, and vanished. The peering eye could see nothing whatever of shape or of texture; the mind behind the eye reeled away before infinite vistas of nothingness.

Kinnison hurled his extra-sensory perception into it and jerked back, almost stunned. It was neither darkness nor blackness, he decided, after he recovered enough poise to think coherently. It was worse than that—worse than anything imaginable—an infinitely vast and yet nonexistent realm of the total absence of everything whatever—*absolute negation!*

"That's it, I guess," the Lensman said then. "Might as well stop feeding it now."

"We would have to stop soon, in any case," Wise replied, "for your available waste material is becoming scarce. It will take the substance of a fairly large planet to produce that which you require. You have, perhaps, a planet in mind which is to be used for the purpose?"

"Better than that. I have in mind the material of just such a planet, but already broken up into sizes convenient for handling."

"Oh, the asteroid belt!" Thorndyke exclaimed. "Fine! Kill two birds with one stone, huh? Build this thing and at the same time clear out the menaces to inert interplanetary navigation? But how about the miners?"

"All covered. The ones actually in development will be let alone. They're not menaces, anyway, as they all have broadcasters. The tramp miners we send—at Patrol expense and grubstake—to some other system to do their mining. But there's one more point before we flit. Are you sure that you can shift to the second stage without an accident?"

"Positive. Build another one around it, mount new Bergs, exciters, and screens on it, and let this one, machines and all, go in to feed the kitty—whatever it is," the technician finished.

"QX. Let's go, fellows!"

Two HUGE Tellurian freighters were at hand; and, holding the small framework between them in a net of tractors and pressors, they set off blithely toward Sol. They took a couple of hours for the journey—and there was no hurry, and in the handling of this particular freight caution was decidedly of the essence.

Arrived at destination, the crews tackled with zest and zeal this new game. Tractors lashed out, seizing chunks of iron—

"Pick out the little ones, men," cautioned Kinnison. "Nothing over about ten feet in section-dimension will go into this frame. Better wait for the second frame before you try to handle the big ones."

"We can cut 'em up," Thorndyke suggested. "What've we got these shear-planes for?"

"QX if you like. Just so you keep the kitty fed."

"We'll feed her!" and the game went on.

Chunks of débris—some rock, but mostly solid meteoric nickle-iron—shot toward the vessels and the ravening sphere, becoming inertialess as they entered a wide-flung zone. Pressors seized them avidly, pushing them through the interstices of the framework, holding them against the voracious screen. As they touched the screen they disappeared; no matter how fast they were driven the screen ate them away, silently and unspectacularly, as fast as they could be thrown against it. A weird spectacle indeed, to see a jagged fragment of solid iron, having a mass of thousands of tons, drive against that screen and disappear! For it vanished, utterly, along a geometrically perfect spherical surface. From the opposite side the eye could see the mirror sheen of the metal at the surface of disintegration! It was as though the material were being shoved out of our familiar three-dimensional space into another universe—which, as a matter of cold fact, may have been the case.

For not even the men who were doing the work made any pretense of understanding what was happening to that iron. Indeed, the only entities who did have any comprehension of the phenomenon—the forty-odd geniuses whose mathematical wizardry had made it possible—thought of it and discussed it, not in the limited, three-dimensional symbols of everyday existence, but only in the language of high mathematics; a language in which few indeed, are able to really and readily to think.

And while the crews became more and more expert at the new technique, so that metal came in faster and faster—huge, hot-sliced bars of iron ten feet square and a quarter of a mile long were being driven into that enigmatic sphere of extinction—an outer framework a hundred and fifty miles in diameter was being built. Nor, contrary to what might be supposed, was a prohibitive amount of metal or of labor necessary to fabricate that mammoth structure. Instead of six there were six cubed—two hundred and sixteen—working stations, complete with generators and super-Bergenholms and screen generators, each mounted upon a massive platform; but, instead of being connected together and supported by stupendous beams and trusses of metal, those platforms were linked by infinitely stronger bonds of pure force. It took a lot of ships to do the job, but the technicians of the Patrol had at call enough floating machine shops and to spare.

When the sphere of negation grew to be about a foot in apparent diameter it had been found necessary to surround it with a screen opaque to all visible light, for to look into it long or steadily then meant insanity. Now the opaque screen was sixteen feet in diameter, nearing dangerously the sustaining framework, and the outer frame was

ready. It was time to change.

The Lensman held his breath, but the Medonians and the Tellurian technicians did not turn a hair as they mounted their new stations and tested their apparatus.

"Ready." "Ready." "Ready." Station after station reported: then, as Thorndyke threw in the master switch, the primary sphere—invisible now, through distance, to the eye, but plain upon the visiplates—disappeared; a mere morsel to those new, gigantic forces.

"Swing into it, boys!" Thorndyke yelled into his transmitter. "We don't have to feed her with a teaspoon any more. Let her have it!"

AND "let her have it" they did. No more cutting up of the larger meteorites; asteroids ten, fifteen, twenty miles in diameter, along with hosts of smaller stuff, were literally hurled through the black screen into the even lusher blackness of that which was inside it, without complaint from the quietly humming motors.

"Satisfied, Kim?" Master Technician Thorndyke asked.

"Uh-*huh!*" the Lensman assented, vigorously. "Nice! Slick, in fact," he commended. "I'll buzz off now, I guess."

"Might as well—everything's on the green. Clear ether, spacehound!"

"Same to you, big fella. I'll be seeing you, or sending you a thought. There's Tellus, right over there. Funny, isn't it, doing a flit to a place you can actually see before you start?"

The trip to Earth was scarcely a hop, even in a supply-boat. To Prime Base the Gray Lensman went, where he found that his new non-ferrous speedster was done; and during the next few days he tested it out thoroughly. It did not register at all, neither upon the regular, long-range ultra-instruments nor upon the short-range emergency electros. Nor could it be seen in space, even in a telescope at point-blank range. True, it occulted an occasional star; but since even the direct rays of a searchlight failed to reveal its shape to the keenest eye—the Lensman chemists who had worked out that ninety-nine point nine nine percent absolute black coating had done a wonderful job—the chance of discovery through that occurrence was very slight.

"QX, Kim?" the Port Admiral asked. He was accompanying the Gray Lensman on a last tour of inspection.

"Fine, chief. Couldn't be better—thanks a lot."

"Sure you're non-ferrous yourself?"

"Absolutely. Not even an iron nail in my shoes."

"What is it, then? You look worried. Want something expensive?"

"You hit the thumb, admiral, right on the nail. The trouble is not only that it's expensive; I'm afraid that probably we'll never have any use for it."

"Better build it, anyway. Then if you want it you'll have it, and if you don't want it we can always use it for something. What is it?"

"A nutcracker. There are a lot of cold planets around, aren't there, that aren't good for anything?"

"Thousands of them—perhaps millions."

"The Medonians put Bergenholms on their planet and flew it from Lundmark's Nebula to here in a few weeks. Why wouldn't it be a sound idea to have the planetographers pick out a couple of useless worlds which, at some points in their orbits, have diametrically opposite velocities, to within a degree or two?"

"You've got something there, my boy. It shall be done, and at once. A thing like that is very much worth having, just for its own sake, if we never have any use for it. Anything else?"

"Not a thing in the universe. Clear ether, chief!"

"Light landings, Kinnison!" and gracefully, effortlessly, the dead-black

sliver of semi-precious metal lifted herself away from Earth.

THROUGH Bominger, the Radeligian Big Shot, Kinnison had had a long and eminently satisfactory interview with Prellin, the Regional Director of all surviving Boskonian activities. Thus he knew where the latter was, even to the address, and knew the name of the firm which was his alias—Ethan D. Wembleson & Sons, Inc., 4627 Boulevard Dezalies, Cominoche, Quadrant Eight, Bronseca. That name was Kim's first shock, for that firm was one of the largest and most conservative houses in galactic trade; one having an unquestioned AA-A1 rating in every mercantile index.

However, that was the way they worked, Kinnison reflected, as his speedster reeled off the parsecs. It wasn't far to Bronseca—easy Lens distance—he'd better call somebody there and start making arrangements. He had heard about the planet, although he'd never been there. Somewhat warmer than Tellus, but otherwise very Earthlike. Millions of Tellurians lived there and liked it.

His approach to the planet Bronseca was characterized by all possible caution, as was his visit to Cominoche, the capital city. He found that 4627 Boulevard Dezalies was a structure covering an entire city block and some eighty stories high, owned and occupied exclusively by Wembleson's. No visitors were allowed except by appointment. His first stroll past it showed him that an immense cylinder, comprising almost the whole interior of the building, was shielded by thought-screens. He rode up and down in the elevators of nearby buildings—no penetration. He visited a dozen offices in the neighborhood upon various errands, choosing his time with care so that he would have to wait in each an hour or so in order to see his man.

These leisurely scrutinies of his objective failed to reveal a single fact of value. Ethan D. Wembleson & Sons, Inc., did a tremendous business, but every ounce of it was legitimate! That is, the files in the outer offices covered only legitimate transactions, and the men and women busily at work there were all legitimately employed. And the inner offices—vastly more extensive than the outer, to judge by the number of employees entering in the morning and leaving at the close of business—were sealed against his prying, every second of every day.

He tapped in turn the minds of dozens of those clerks, but drew only blanks. As far as they were concerned, there was nothing "queer" going on anywhere in the organization. The "Old Man"——Howard Wembleson, a grandnephew or something of Ethan—had developed a complex lately that his life was in danger. Scarcely left the building—not that he had any need to, as he had always had palatial quarters there—and then only under heavy guard.

A good many thought-screened persons came and went, but a careful study of them and their movements convinced the Gray Lensman that he was wasting his time.

"No soap," he reported to a Lensman at Bronseca's Base. "Might as well try to stick a pin quietly into a cateagle. He's been told that he's the next link in the chain, and he's got the jitters right. I'll bet he's got a dozen loose observers, instead of only one. I'll save time, I think by tracing another line. I have thought before that my best bet is in the asteroid dens instead of on the planets. I let them talk me out of it—it's a dirty job and I've got to establish an identity of my own, which will be even dirtier—but it looks as though I'll have to go back to it."

"But the others are warned, too," suggested the Bronse can. "They'll probably be just as bad. Let's blast it open

and take a chance on finding the data you want."

"No," Kinnison said, emphatically. "Not a chance in the universe that there's anything there that would do me a bit of good on the big hunt. The others are probably warned, yes, but since they aren't on my direct line to the throne, they probably aren't taking it as seriously as this Prellin—or Wembleson—is. Or if they are, they won't keep it up as long. They can't, and get any joy out of life at all.

"And you can't say a word to Prellin about his screens, either," the Tellurian went on in reply to a thought. "They're legal enough; just as much so as spy ray blocks. Every man has a right to privacy. Just one question here, or just one suspicious move, is apt to blow everything into a cocked hat. You fellows keep on working along the lines we laid out and I'll try another line. If it works, I'll come back and we'll open this can the way you want to. That way, we may be able to get the low-down on about four hundred planetary organizations at one haul."

THUS it came about that Kinnison took his scarcely-used indetectable speedster back to Prime Base; and that, in a solar system prodigiously far removed from both Tellus and Bronseca, there appeared another tramp meteor-miner.

Peculiar people, these toilers in the interplanetary voids; flotsam and jetsam; for the most part the very scum of space. Some solar systems contain vastly greater amounts of asteroidal and meteoric débris than did ours of Sol; others somewhat less; but all have at least some. In the main this material is either nickel-iron or rock, but some of these fragments carry prodigious values in platinum, osmium, and other noble metals, and occasionally there are discovered diamonds and other gems of tremendous size and value. Hence, in the asteroid belts of every solar system there are to be found those universally despised, but nevertheless bold and hardy souls who, risking life and limb from moment to moment though they are, yet live in hope that the next lump of cosmic detritus will prove to be a bonanza.

Some of these men are the sheer misfits of life. Some are petty criminals, fugitives from the justice of their own planets, but not of sufficient importance to be upon the "wanted" lists of the Patrol. Some are of those who for some reason or other—addiction to drugs, perhaps, or the overwhelming urge occasionally to go on a spree—are unable or unwilling to hold down the steady jobs of their more orthodox brethren. Still others, and these are many, live that horridly adventurous life because it is in their blood; like the lumberjacks who in ancient times dwelt upon Tellus, they labor tremendously and unremittingly for weeks, only and deliberately to "blow in" the fruits of their toil in a few wild days and still wilder nights of hectic, sanguine, and lustful debauchery in one or another of the spacemen's hells of which every inhabited solar system has its quota.

But, whatever their class, they have much in common. They all live for the moment only, from hand to mouth. They all are intrepid spacemen. They have to be—all others die during their first venture. They all live dangerously, violently. They are men of red and gusty passions, and they have, if not an actual contempt, at least a loud-voiced scorn of the law in its every phase and manifestation. "Law ends with atmosphere" is the galaxy-wide creed of the clan, and it is a fact that no law save that of the ray-gun is even yet really enforced in the badlands of the asteroid belts.

Indeed, the meteor miners as a matter of course, take their innate lawlessness with them into their revels in the crim-

son-lit resorts already referred to. In general the nearby Planetary Police adopt a laissez faire attitude, particularly since the asteroids are not within their jurisdictions, but independent worlds, each with its own world-government. If they kill a dozen or so of each other and of the bloodsuckers who batten upon them, what of it? If everybody in those hells could be killed at once, the Universe would be that much better off!—and if the Galactic Patrol is compelled, by some unusually outrageous performance, to intervene in the revelry, it comes in, not as single policemen, but in platoons or in companies of armed, full-armored infantry going to war!

Such, then, were those among whom Kinnison chose to cast his lot, in a new effort to get in touch with the Galactic Director of the drug ring.

XI.

ALTHOUGH Kinnison left Bronseca, abandoning that line of attack completely—thereby, it might be thought, forfeiting all the work he had theretofore done upon it—the Patrol was not idle, nor was Prellin-Wembleson of Cominoche, the Boskonian Regional Director, neglected. Lensman after Lensman came and went, unobstrusively, but grimly determined. There came Tellurians, Manarkans, Borovans; Lensmen of every human breed, any of whom might have been, as far as the minions of Boskone knew, the one foe whom they had such good cause to fear.

Rigellian Lensmen came also, and Poenians, and Ordoviks; representatives, in fact, of almost every available race possessing any type or kind of extra-sensory perception, came to test out their skill and cunning. Even Worsel of Velantia came, hurled for days his mighty mind against those screens, and departed.

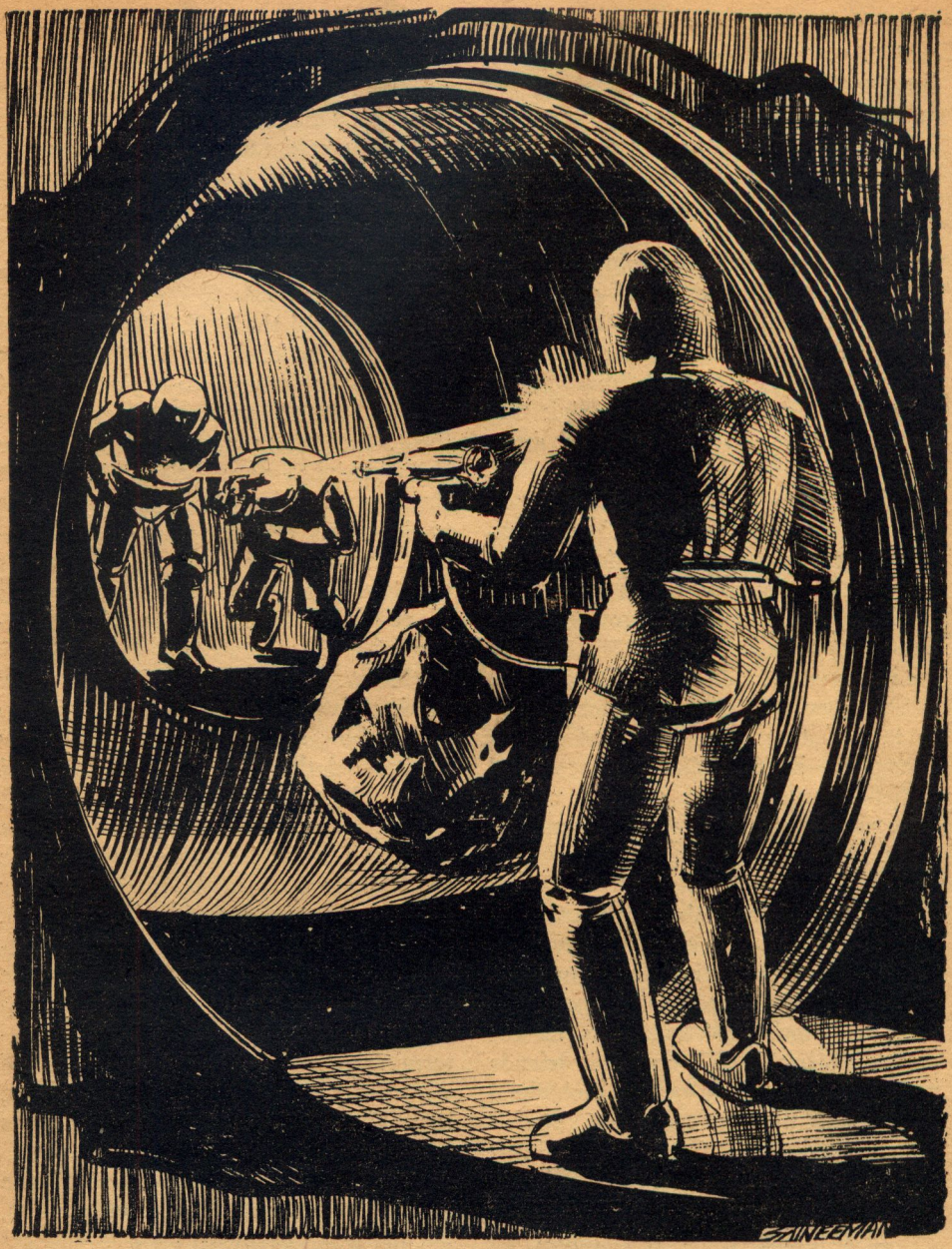
Whether or not business went on as usual no one could say, but the Patrol was certain of three things. First, that while the Boskonians might be destroying some of their records, they were moving none away, by air, land, or tunnel; second, that there was no doubt in any zwilnik mind that the Lensmen were there to stay until they won, in one way or another; and third, that Prellin's life was not a happy one!

And while his brothers of the Lens were so efficiently pinch-hitting for him—even though they were at the same time trying to show him up and thereby win kudos for themselves—in mentally investing the Regional stronghold of Boskone, Kinnison was establishing an identity as a wandering hellion of the asteroid belts.

There would be no slips this time. He would *be* a meteor miner in every particular, down to the last, least detail. To this end he selected his equipment with the most exacting care. It must be thoroughly adequate and dependable, but neither new nor of such outstanding quality or amount as to cause comment.

His ship, a stubby, powerful space-tug with an oversized air lock, was a used job—hard-used, too—some ten years old. She was battered, pitted, and scarred; but it should be noted here, perhaps parenthetically, that when the technicians finished their rebuilding she was actually as stanch as a battleship. His space-armor, Spalding drills, De-Lameters, tractors and pressors, and "spee-gee"—torsion specific-gravity apparatus—were of the same grade. All bore unmistakable evidence of years of hard use, but all were in perfect working condition. In short, his outfit was exactly that which a successful meteor-miner—even such a one as he was going to become—would be expected to own.

He cut his own hair, and his whiskers, too, with ordinary shears, as was good technique. He learned the polyglot of the trade; the language which, made up



In the air lock of the other meteor miner, two men —not one—were going for their DeLameters—

of words from each of hundreds of planetary tongues, was and is the every-day speech of human or near-human meteor miners, wherever found. By "near-human" is meant a six-place classification of A A point A A A A—meaning erect, bifurcate, warm-blooded, oxygen-breathing, bilaterally duo-symmetrical, and possessing eyes. For, even in meteor mining, like has a ten-

dency to run with, and especially to play with, like. Thus, warm-blooded oxygen-breathers find neither welcome nor enjoyment in a pleasure-resort operated by and for such a race, say, as the Trocanthers, who are cold-blooded, quasi reptilian beings who abhor light of all kinds and who breath a gaseous mixture not only paralyzingly cold in temperature but also chemically fatal to man.

Above all, he had to learn how to drink strong liquors and how to take drugs, for he knew that no drink that had ever been distilled, and no drug, with the possible exception of thionite, could enslave the mind he then had. Thionite was out, anyway. It was too scarce and too expensive for meteor miners; they simply didn't go for it. Hadive, heroin, opium, nitrolabe, bentlam—that was it, bentlam. He could get it anywhere, all over the Galaxy, and it was very much in character. Easy to take, potent in results, and not as damaging—if you didn't become a real addict—to the system as most of the others. He would become a bentlam-eater.

BENTLAM, known also to the trade by such nicknames as "benny," "benweed," "happy-sleep," and others, is a shredded, moistly fibrous material of about the same consistency and texture as fine-cut chewing tobacco. Through his friends in Narcotics the Gray Lensman obtained a supply of "the clear quill, first chop, in the original tins" from a prominent bootlegger, and had it assayed for potency.

The drinking problem required no thought; he would learn to drink, and apparently to like, anything and everything that would pour. Meteor miners did.

Therefore, coldly, deliberately, dispassionately, and with as complete a detachment as though he were calibrating a burette or analyzing an unknown solution, he set about the task. He determined his capacity as impersonally as though his physical body were a volumetric flask; he noted the effect of each measured increment of high-proof beverage and of habit-forming drug as precisely as though he were studying a chemical reaction in which he himself was not concerned save as a purely scientific observer.

He detested the stuff. Every fiber of his being rebelled at the sensations evoked—the loss of co-ordination and control, the inflation, the aggrandizement, the falsity of values, the sheer hallucinations—nevertheless he went through with the whole program, even to the extent of complete physical helplessness for periods of widely varying duration. And when he had completed his researches he was thoroughly well informed.

He knew to a nicety, by feel, how much active principle he had taken, no matter how strong, how weak, or how adulterated the liquor or the drug had been. He knew to a fraction how much more he could take; or, having taken too much, almost exactly how long he would be incapacitated. He learned for himself what was already widely known, that it was better to get at least moderately illuminated before taking the drug; that bentlam rides better on top of liquor than vice versa. He even determined roughly the rate of increase with practice of his tolerances. Then, and only then, did he begin working as a meteorite miner.

Working in an asteroid belt of one solar system might have been enough, but the Gray Lensman took no chances at all of having his new identity traced back to its source. Therefore he worked, and caroused, in five; approaching stepwise to the solar system of Borova which was his goal.

Arrived at last, he gave his chunky space-boat the average velocity of an asteroid belt just outside the orbit of

the fourth planet, shoved her down into it, turned on his Bergenholm, and went to work. His first job was to "set up"; to install in the extra-large air lock, already equipped with duplicate controls, his tools and equipment. He donned space-armor, made sure that his DeLameters were sitting pretty—all meteor miners go armed as routine, and the Lensman had altogether too much at stake in any case to forgo his accustomed weapons—pumped the air of the lock back into the body of the ship, and opened the outer port. For meteor miners do not work inside their ships. It takes too much time to bring the metal in through the air locks. It also wastes air, and air is precious; not only in money, although that is no minor item, but also because no small ship, stocked for a six-weeks' run, can carry any more air than is really needed.

Set up, he studied his electros and flicked his tractor beams out to a passing fragment of metal, which flashed up to him, almost instantaneously. Or, rather, the inertialess tugboat flashed across space to the comparatively tiny, but inert, bit of metal which he was about to investigate. With expert ease Kinnison clamped the meteorite down and rammed into it his Spalding drill, the tool which in one operation cuts out and polishes a cylindrical sample exactly one inch in diameter and exactly one inch long. Kinnison took the sample, placed it in the jaw of his spee-gee, and cut his Berg. Going inert in an asteroid belt is dangerous business, but it is only one of a meteor miner's hazards and it is necessary; for the torsiometer is the quickest and simplest means of determining the specific gravity of metal out in space, and no torsion instrument will work upon inertialess matter.

He read the scale even as he turned on the Berg. Seven point nine. Iron. Worthless. Big operators could use it—the asteroid belts had long since supplanted the mines of the worlds as sources of iron—but it wouldn't do him a bit of good. Therefore, tossing it aside, he speared another. Another, and another. Hour after hour, day after day; the back-breaking, lonely labor of the meteor miner. But very few of the bona fide miners had the Gray Lensman's physique or his stamina, and not one of them all had even a noteworthy fraction of his brain. And brain counts, even in meteor-mining. Hence Kinnison found pay-metal; quite a few really good, although not phenomenally dense, pieces.

THEN one day there happened a thing which, if it was not in actual fact premeditated, was as mathematically improbable, almost, as the formation of a planetary solar system; an occurrence that was to exemplify in startling and hideous fashion the doctrine of tooth and fang which is the only law of the asteroid belts. Two tractor beams seized, at almost the same instant, the same meteor! Two ships, flashing up to zone contact in the twinkling of an eye, the inoffensive meteor squarely between them! And in the air lock of the other tug there were two men, not one; two men already going for their guns with the practiced ease of space-hardened veterans to whom the killing of a man was the veriest bagatelle!

They must have been hijackers, killing and robbing as a business, Kinnison concluded, afterward. Bona-fide miners almost never work two to a boat, and the fact that they actually beat him to the draw, and yet were so slow in shooting, argued that they had not been taken by surprise, as had he. Indeed, the meteor itself, the bone of contention, might very well have been a bait.

He could not follow his natural inclination to let go, to let them have it. The tale would have spread far and wide, branding him as a coward and a weakling. He would have had to kill, or been killed by, any number of lesser

bullies who would have attacked him on sight. Nor could he have taken over their minds quickly enough to have averted death. One, perhaps, but not two; he was no Arisian. These thoughts, as has been intimated, occurred to him long afterward. During the actual event there was no time to think at all. Instead, he acted; automatically and instantaneously.

Kinnison's hands flashed to the worn grips of his DeLameters, sliding them from the leather and bringing them to bear at the hip with one smoothly flowing motion that was a marvel of grace and speed. But, fast as he was, he was almost too late. Four bolts of lightning blasted, almost as one. The two desperadoes dropped, cold; the Lensman felt a stab of agony sear through his shoulder and the breath whistled out of his mouth and nose as his spacesuit collapsed. Gasping terribly for air that was no longer there, holding onto his senses doggedly and grimly, he made shift to close the outer door of the lock and to turn a valve. He did not lose consciousness—quite—and as soon as he recovered the use of his muscles he stripped off his suit and examined himself narrowly in a mirror.

Eyes, plenty bloodshot. Nose, bleeding copiously. Ears bleeding, but not too badly; drums not ruptured, fortunately—he had been able to keep the pressure fairly well equalized. Felt like some internal bleeding, but he could see nothing really serious. He hadn't breathed space long enough to do any permanent damage, he guessed.

Then, baring his shoulder, he treated the wound with Zinmaster burn-dressing. This was no trifle, but at that, it wasn't so bad. No bone gone—it'd heal in two or three weeks. Lastly, he looked over his suit. If he'd only had his G-P armor on—but that, of course, was out of the question. He had a spare suit, but he'd rather— Fine, he could replace the burned section easily enough. QX.

He donned his other suit, re-entered the air lock, neutralized the screens, and crossed over; where he did exactly what any other meteor miner would have done. He divested the bloated corpses of their spacesuits and shoved them off into space. He then ransacked the ship, transferring from it to his own, as well as four heavy meteors, every other item of value which he could move and which his vessel could hold. Then inerting her, he gave her a couple of notches of drive and cut her loose, for so a real miner would have done. It was not compunction or scruple that would have prevented any miner from taking the ship, as well as the supplies. Ships were registered, and otherwise were too hot to be handled except by organized criminal rings.

As a matter of routine he tested the meteor which had been the innocent cause of all this strife—or had it been a bait?—and found it worthless iron. Also as routine he kept on working. He had almost enough metal now, even at Miners' Rest prices, for a royal binge, but he couldn't go in until his shoulder was well. And a couple of weeks later he got the shock of his life.

HE HAD BROUGHT in a meteor; a mighty big one, over four feet in its smallest diameter. He sampled it, and as soon as he cut the Berg and flicked the sample experimentally from hand to hand, his skilled muscles told him that that metal was astoundingly dense. Heart racing, he locked the test-piece into the spee-gee; and that vital organ almost stopped beating entirely as the indicator needle went up and up and up—stopping at a full twenty-two, and the scale went only to twenty-four!

"Klono's brazen hoofs and diamond-tipped horns!" he ejaculated. He whistled stridently through his teeth, then measured his find as accurately as he

could. Then, speaking aloud, "Just about thirty thousand kilograms of something noticeably denser than pure platinum—thirty million credits or I'm a Zabriskan fontema's maiden aunt. What to do?"

This find, as well it might, gave the Gray Lensman pause. It upset his calculations. It was unthinkable to take that meteor to such a fence's hide-out as Miners' Rest. Men had been murdered, and would be again, for a thousandth of its value. No matter where he took it, there would be publicity galore, and that wouldn't do. If he called a Patrol ship to take the white elephant off his hands he might be seen; and he had put in too much work on this identity to jeopardize it. He would have to bury it, he guessed—he had maps of the System, and the fourth planet was close by.

He cut off a chunk of a few pounds' weight and made a nugget—a tiny meteor—of it, then headed for the planet, a plainly visible disk some fifteen degrees from the Sun. He had a fairly large-scale chart of the System, with notes. Borova IV was uninhabited, except by low forms of life, and by outposts. Cold. Atmosphere thin—good, that meant no clouds. No oceans. No volcanic activity. Very good! He'd look it over, and the first striking landmark he saw, from one diameter out, would be his cache.

He circled the planet once at the equator, observing a formation of five mighty peaks arranged in a semicircle, cupped toward the world's north pole. He circled it again, seeing nothing as prominent, and nothing else resembling it at all closely. Scanning his plate narrowly, to be sure nothing was following him, he drove downward in a screaming dive toward the middle mountain.

It was an extinct volcano, he discovered, with a level-floored crater more than a hundred miles in diameter. Practically level, that is, except for a smaller cone which reared up in the center of that vast, desolate plain of craggy, tortured lava. Straight down into the cold vent of the inner cone the Lensman steered his ship; and in its exact center he dug a hole and buried his treasure. He then lifted his tugboat fifty feet and held her there, poised on her raving underjets, until the lava in the little crater again began sluggishly to flow, and thus to destroy all evidence of his visit. This detail attended to, he shot out into space and called Haynes, to whom he reported in full.

"I'll bring the meteor in when I come—or do you want to send somebody out here after it? It belongs to the Patrol, of course."

"No, it doesn't, Kim—it belongs to you."

"Huh? Isn't there a law that any discoveries made by any employees of the Patrol belong to the Patrol?"

"Nothing as broad as that, that I know of. Certain scientific discoveries, by scientists assigned to an exact research, yes. But you're forgetting again that you're an Unattached Lensman, and as such are accountable to no one in the Universe. Even the ten percent treasure-trove law couldn't touch you. Besides, your meteor is not in that category, as you are its first owner, as far as we know. If you insist I will mention it to the Council, but I know in advance that the Patrol can claim none of it, even if we wanted to—which we definitely do not."

"QX, chief—thanks," and the connection was broken.

There, that was that. He had got rid of the white elephant, yet it wouldn't be wasted. If the zwilniks got him, the Patrol would dig it up; if he lived long enough to retire to a desk job he wouldn't have to take any more of the Patrol's money as long as he lived. Financially, he was all set.

And physically, he was all set for

his first real binge as a meteor-miner. His shoulder and arm were as good as new. He had a lot of metal; enough so that its proceeds would finance, not only his next venture into space, but also a really royal celebration in any spaceman's resort, even the one he had already picked out.

For the Lensman had devoted a great deal of thought to that item. For his purpose, the bigger the resort the better. The man he was after would not be a small operator, nor would he deal directly with such. Also, the big kingpins did not murder drugged miners for their ships and outfits, as the smaller ones sometimes did. The big ones realized that there was more long-pull profit in repeat business.

Therefore, Kinnison set his course toward the great asteroid Euphrosyne and its festering hell-hole, Miners' Rest. Miners' Rest, to all highly moral citizens the disgrace not only of a solar system but of a sector; the very name of which was—and is—a byword and a hissing to the blue-noses of twice a hundred inhabited and civilized worlds.

TO BE CONTINUED.

"ROTTEN-EGG GAS"

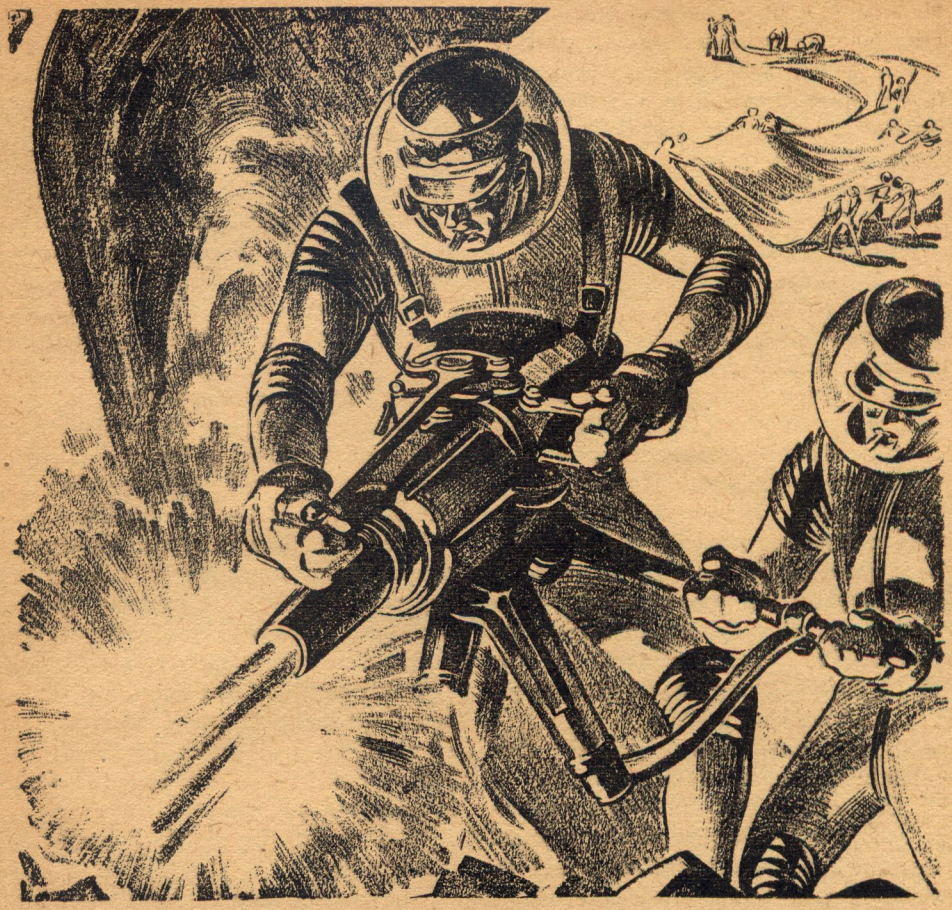
Again the familiar odor of hydrogen sulphide, friend of the high-school and college chemist, perfumes the halls, scorned by the amateur chemist. With deep respect that same chemist regards the deadly, swiftly poisonous hydrogen cyanide—*which is just about one sixth as poisonous as hydrogen sulphide!*

There's a reason, of course. One good sniff of HCN and the sniffer is apt to go down and out as though struck by a sandbag. The cyanide gas is nearly odorless, and a high concentration can be reached unnoticed by the victim. But unless a fatal concentration is reached, no harm is done.

Hydrogen sulphide has a tremendously powerful odor. Extremely small concentrations make its presence abundantly evident. The nose knows, and warns, long before there's any danger. But if an ardent lab worker, carrying on several quantitative analyses in a small room with free use of hydrogen sulphide, becomes accustomed to the odor as a necessary but harmless evil, the gentleman is in danger of a very serious surprise. Six times as deadly as HCN, it has a further streak of savagery; where a nonfatal dose of the cyanide gas leaves the victim unharmed, a dose of H_2S well below the "fatal" limits can bring on nausea and convulsions so violent and prolonged that the victim dies of exhaustion and shock.

Figures on the "deadly concentrations" of gases are deadly liars. The war gasses are particularly bad—because so chosen—in that way. Figures which give the so-called "fatal concentration" are absolutely not to be trusted in the slightest; they usually represent the concenration needed for *immediate* effect. Concentrations far lower are far more dangerous. Nobody lingers around where the sour pungency of mustard gas is present, but when the concentration of the stuff is so low as to be indetectable men may stop. It's a so-called "nonfatal" concentration, all right—but the small amount of gas present, given a chance to dig in, works slowly but just as certainly. In many ways, war gases act like heavy-metal poisons; it takes a fairly large dose of copper or lead or mercury to kill a man. But that does *not* mean that a smaller dose is harmless. A hundredth of the fatal dose repeated again and again over a period of time has just as certain consequences.

Many fairly common "harmless" gases have similar traits. The hydrogen obtained from zinc and acid, if the zinc has considerable bits of solder or impurities in or on it, is apt to be as harmless as a cobra. The impurities are apt to contain arsenic or antimony—the hydrogen, arsene or stibene, two of the most frightfully poisonous substances known to man. Hydrogen is odorless; if the gas smells somewhat fishy—literally—the chances are fair-to-middling it contains a poison so violent that cyanide, carbon monoxide, or chlorine would serve as comparatively inert diluting agents! One single bubble of arsene has been known to kill—and it is, in addition, cumulative.



MISFIT

By Robert Heinlein

Illustrated by Wesso

"—for the purpose of conserving and improving our interplanetary resources, and providing useful, healthful occupations for the youth of this planet."

(Excerpt from the enabling act, H. R. 7118, setting up the Cosmic Construction Corps.)

"ATTENTION to muster!" The parade ground voice of a first sergeant of Space Marines cut through the fog and drizzle of a nasty New Jersey morning. "As your names are called, answer 'Here,' step forward with your baggage, and embark. Atkins!"

"Here!"

"Austin!"

"Hyar!"

"Ayres!"

"Here!"

One by one they fell out of ranks,

shouldered the hundred and thirty pounds of personal possessions allowed them, and trudged up the gangway. They were young—none more than twenty-two—in some cases their luggage outweighed the owner.

"Kaplan!"

"Here!"

"Keith!"

"Heah!"

"Libby!"

"Here!" A thin, gangling, blond lad detached himself from the line, hastily wiped his nose, and grabbed at his belongings. He slung a fat canvas bag over his shoulder, steadied it, and lifted a ponderous composition suitcase with his free hand. He started for the companionway in an unsteady dog trot. As he stepped on the gangway his suitcase swung against his knees. He staggered against a short wiry form dressed in the powder-blue service uniform of the Space Navy. Strong fingers grasped his arm and checked his fall.

"Steady, son. Easy does it." Another hand readjusted the canvas bag.

"Oh, excuse me, uh"—the embarrassed youngster automatically counted the four bands of silver braid below the shooting star—"captain. I didn't—"

"Bear a hand, and get aboard, son."

"Yes, sir."

The passage into the bowels of the transport was gloomy. When the lad's eyes adjusted he saw a gunner's mate wearing the brassard of a master-at-arms, who hooked a thumb toward an open bulkhead door.

"In there. Find your locker, and wait by it."

Libby hurried to obey. Inside he found a jumble of baggage and men in a wide, low-ceilinged compartment. There were no ports, but a line of old-fashioned glow-tubes ran around the junction of bulkhead and ceiling and trisected the overhead, while the soft roar of blowers made a background to the voices of his shipmates. He picked his way through the heaped luggage and located his locker on the far wall outboard. He broke the seal on the combination lock, glanced at the combination, and opened it. The locker was very small, the middle of a tier of three. He considered what he should keep in it.

A loud-speaker drowned out the surrounding voices, and demanded his attention:

"Attention! Man all space details; first section. Raise ship in twelve minutes. Close bulkhead doors. Stop blowers at minus two minutes. Special orders for passengers; place all gear on deck, and lie down on red signal light. Remain down until release is sounded. Masters-at-arms check compliance."

The gunner's mate popped in, glanced around and immediately commenced supervising the rearrangement of the baggage. Heavy items were lashed down. Locker doors were closed. By the time each boy had found a place on the deck and the master-at-arms had checked the pad under his head, the glow-tubes turned red and the loud-speaker brayed out:

"All hands! Up ship! Stand by for acceleration."

The master-at-arms hastily reclined against two cruise bags, and watched the room. The blowers sighed to a stop. There followed two minutes of dead silence—one hundred and twenty seconds.

Libby felt his heart commence to pound as his overexcited adrenal gland poured its drug into his system. It affected his time sense and the two minutes stretched interminably. Then the deck quivered and a roar like escaping high-pressure steam beat at his eardrums. He was suddenly very heavy and a weight lay across his chest and heart.

An indefinite time later the glow-tubes flashed white, and the announcer bellowed:

"Secure all getting underway detail; regular watch, first section."

The blowers droned into life. The master-at-arms stood up, rubbed his hips, and pounded his arms, then said: "O. K., boys." He stepped over and undogged the bulkhead door to the passageway.

Libby got up and blundered into a bulkhead, nearly falling. His arms and legs had gone to sleep, besides which he felt alarmingly light, as if he had sloughed off at least thirty pounds of his inconsiderable mass.

FOR THE next two hours he was too busy to think, or to be homesick. Suitcases, boxes, and bags had to be passed down into the lower hold and lashed against angular acceleration. He found his assigned bunk and learned that it was his only eight hours in twenty-four; two others boys had the use of it, too. Each of the three sections ate in three shifts, nine shifts in all—twenty-four youths and a master-at-arms at one long table which jam-filled a narrow compartment off the galley.

After lunch Libby restowed his locker. He was standing before it, gazing at a photograph which he intended to mount on the inside of the locker door, when a sharp command filled the compartment.

"Attention!"

Standing inside the door was the captain flanked by the master-at-arms. He commenced to speak. "At rest, men. Sit down. McCoy, tell control to shift this compartment to smoke filter."

The gunner's mate hurried to the communicator on the bulkhead and spoke into it in a low tone. Almost at once the hum of the blowers changed in pitch —climbed a half-octave and stayed there.

"Now light up if you like," said the captain. "I'm going to talk to you.

"You boys are headed out on the biggest thing so far in your lives. From now on you're men, with one of the hardest jobs ahead of you that men have ever tackled. What we have to do is part of a bigger scheme. You, and hundreds of thousands of others like you, are being sent out as pioneers to fix up the solar system so that human beings can make better use of it.

"Besides that, and equally important, you are being given a chance to build yourselves into useful and happy citizens of the Federation. For one reason or another every one of you weren't happily adjusted back on Earth. Some of you saw the jobs you were trained for abolished by new inventions. Some of you got into trouble from not knowing what to do with the modern leisure. Maybe you were called bad boys and had a lot of black marks chalked up against you.

"Everyone of you starts even today. The only record you have in this ship is your name at the top of a blank sheet of paper. It's up to you what goes on that page.

"Now about our job: We didn't get one of the easy repair-and-recondition jobs on the Moon, with week ends at Luna City, and all the comforts of home. Nor did we draw a high gravity planet where a man can eat a full meal and expect to keep it down. Instead, we've got to go out to Asteroid HS 5388 and turn it into Space Station E-M 3. She has no atmosphere at all, and only about two percent Earth surface gravity. We've got to play human fly on her for at least six months, no girls to date, no television, no recreation that you don't devise yourselves, and hard work every day. You'll get spacesick, and so homesick you can taste it, and agarophobia. If you aren't careful you'll get rayburnt. Your stomach will act up, and you'll wish to God you'd never enrolled.

"But if you behave yourself, and listen to the advice of the old spacemen, you'll come out of it strong and healthy, with a little credit stored up in the bank, and a lot of knowledge and experience that you wouldn't get in forty years on Earth. You'll be men, and you'll know it."

"One last word. It will take us eleven

days to make the crossing. It will be pretty uncomfortable to those that aren't used to it. Just give the other fellow a little consideration, and you'll get along all right. If you have any complaint and can't get satisfaction any other way, come see me. Otherwise, that's all. Any questions?"

One of the boys put up his hand. "Captain?" he inquired timidly.

"Speak up, lad, and give your name."

"Rogers, sir. Will we be able to get letters from home?"

"Yes, but not very often. Maybe every month or so. The chaplain will carry mail, and any inspection and supply ships."

THE TRIP rapidly became monotonous. After the first thrill of being in space, and of watching the Earth and her moon recede from the view-port in the lower hold, there was not much to do but to kill time. Acey-deucey, other games, and bull sessions only partially filled the time. The master-at-arms found chores enough to occupy a few hours each day; the men polished bright-work, policed the quarters, cleaned their mess billets. But there was little that could be done, and Libby had plenty of time to be miserably homesick.

One day the ship's loud-speaker blatted out: "All hands! Free flight in ten minutes. Stand by to lose weight."

The master-at-arms supervised the rigging of grab-lines. All loose gear was made fast, and little cellulose bags were issued to each man.

Hardly was this done when Libby felt himself get light on his feet—a sensation exactly like that experienced when an express elevator makes a quick stop on an upward trip, except that the sensation continued and became more intense. At first it was a pleasant novelty, then it rapidly became distressing. The blood pounded in his ears, and his feet were clammy and cold. His saliva secreted at an abnormal rate. He tried to swallow, choked, and coughed. Then his stomach shuddered and contracted with a violent, painful, convulsive reflex, and he was suddenly, disastrously nauseated.

After the first excruciating spasm, he heard McCoy's voice shouting:

"Hey! Use your sick-kits like I told you. Don't let that stuff get in the blowers."

Dimly Libby realized that the admonishment included him. He fumbled for his cellulose bag just as a second temblor shook him, but he managed to get the bag over his mouth and nose before the eruption occurred. When it subsided, more or less, he became aware that he was floating near the overhead and facing the door.

The chief master-at-arms slithered in the door and spoke to McCoy. "How are you making out?"

"Well enough. Some of the boys missed their kits."

"O. K. Mop it up. You can use the starboard lock." He swam out.

McCoy touched Libby's arm. "Here, Pinkie, start catching them butterflies."

The gunner's mate handed him a handful of cotton waste, then took another handful himself and neatly dabbed up a globule that floated about the compartment. "Be sure your sick-kit is on tight, Pinkie. When you get sick, just stop and wait until it's over."

Libby imitated him as best he could. In a few minutes the room was free of the worst of the débris.

McCoy looked it over, and spoke, "Now peel off them dirty duds, and change your kits. Three or four of you bring everything along to the starboard lock."

At the starboard spacelock, the kits were put in first, the inner door closed, and the outer opened. When the inner door was opened the kits were gone—blown out into space by the escaping air.

Pinkie addressed McCoy, "Do we have to throw away our dirty clothes, too?"

"Huh uh. We'll just give them a dose of vacuum. Take 'em into the lock and stop 'em to those hooks on the bulkheads. Tie 'em tight."

This time the lock was left closed for about five minutes. When the lock was opened the garments were bone dry—all the moisture boiled out by the vacuum of space. All that remained was a sterile powdery residue.

McCoy viewed them with approval. "They'll do. Take them back to the compartment. Then brush them—hard—in front of the exhaust blowers."

THE NEXT few days were an eternity if misery. Homesickness was forgotten in the all-engrossing wretchedness of spacesickness. The captain granted fifteen minutes of mild acceleration for each of the nine meal periods, but the respite accentuated the agony. Libby would go to a meal, weak, and ravenously hungry. The meal would stay down until free flight was resumed, then the sickness would hit him all over again.

On the fourth day he was seated against a bulkhead, enjoying the luxury of a few remaining minutes of weight while the last shift ate, when McCoy walked in and sat down beside him. The gunner's mate lit a cigarette. He inhaled deeply and started to chat.

'How's it going, bud?"

"All right, I guess. This spacesickness— Say, McCoy, how do you ever get used to it?"

"You get over it in time. Your body acquires some new reflexes, so they tell me. Once you learn to swallow without choking, you'll be all right. You even get so you like it. It's restful and relaxing. Four hours' sleep is as good as ten."

Libby shook his head dolefully. "I don't think I'll ever get used to it."

"Yes, you will. You'd better, anyway. This here asteroid won't have any surface gravity to speak of; the chief quartermaster says it won't run over two percent Earth normal. That ain't enough to cure spacesickness. And there won't be any way to accelerate for meals, either."

Libby shivered and held his head between his hands.

LOCATING one asteroid among a couple of thousand is not as easy as finding Trafalgar Square in London—especially against the star-crowded backdrop of the Galaxy. You take off from terra with its orbital speed of about nineteen miles per second. Then you attempt to plot a composite conoid curve that will not only intersect the orbit of the tiny fast-moving body, but accomplish an exact rendezvous. And be careful not to approach it too rapidly, or you may exceed the critical speed, beyond which the potential energy of your fuel is not sufficient to drive its mass equivalent back into the comfortable clutch of Sol's gravitational field. On and on you drop until madness or starvation or suffocation does for you.

Asteroid HS 5388—"Eighty-eight"—lay about two and two tenths astronomical units out from the Sun, a little more than two hundred million miles. In consequence it had an orbital speed of not quite thirteen miles per second. When the transport took off Eighty-eight lay beyond the Sun better than three hundred million miles away. Captain Doyle instructed the navigator to plot the basic paraboloid to tack in free flight around the Sun through an elapsed distance of some three hundred and forty million miles. They arched high over the plane of the ecliptic in order to avoid the major portion of the cosmic refuse that cluttered up the asteroid belt.

The principle involved is simple, and is identically the same principle used by a hunter to wing a duck in flight by "leading" with his gunsights to allow for the motion of the bird. But suppose that you face directly into the Sun as you shoot; suppose the bird cannot be

seen from where you stand, and you have nothing to aim by but some old reports as to how it was flying when last seen?

On the ninth day of the passage Captain Doyle betook himself to the chartroom and commenced punching keys on the ponderous integral calculator. Then he sent his orderly to present his compliments to the navigator and to ask him to come to the chartroom. A few minutes later a tall heavy-set form swam through the door, steadied himself with a grab-line, and greeted the captain.

"Good morning, skipper."

"Hello, Blackie." The Old Man looked up from where he was strapped in the integrator's saddle. "I've been checking your corrections for the mealtime accelerations."

"It's a nuisance to have a bunch of ground-lubbers on board, sir."

"Yes, it is, but we have to give those boys a chance to eat, or they couldn't work when we get there. Now I want to decelerate, starting about ten o'clock ship's time. What's our eight o'clock speed and co-ordinates?"

The navigator slipped a notebook out of his tunic. "Three hundred fifty-eight miles per second; course is right ascension fifteen hours, eight minutes, twenty-seven seconds; declination minus seven degrees, three minutes; solar distance one hundred and ninety-two million four hundred eighty thousand miles. Our radial position is nearly twelve degrees above course, and almost dead on course in R. A. Do you want Sol's co-ordinates?"

"No, not now." The captain bent over the calculator, frowned and chewed the tip of his tongue as he worked the controls. "I want you to kill the acceleration about one million miles inside Eighty-eight's orbit. I hate to waste the fuel, but the belt is full of junk and this damned rock is so small that we will probably have to run a search curve. Use twenty hours on deceleration and commence changing course to port after eight hours. Use normal asymptotic approach. You should have her paralleling her orbit by six o'clock tomorrow morning. I shall want to be called at three."

"Aye, aye, sir."

"Let me see your figures when you get 'em. I'll send up the order book later."

SHORTLY after three the captain entered the control room and blinked his eyes at the darkness. The Sun was still concealed by the hull of the transport and the midnight blackness was broken only by the dim blue glow of the instrument dials, and the crack of light from under the chart hood. The navigator turned at the familiar tread.

"Good morning, captain."

"Morning, Blackie. In sight yet?"

"Not yet. We've picked out half a dozen rocks, but none of them checked."

"Any of them close?"

"Not uncomfortable. We've overtaken a little sand from time to time."

"That can't hurt us—not on a stern chase like this. If pilots would only realize that the asteroids flow in fixed directions at computable speeds nobody would come to grief out here. But no—these sporting pilots have to show off and drive straight through at right angles. No wonder they get their hulls pierced."

He stopped to light a cigarette. "People talk about space being dangerous. Sure, it used to be; but I don't know of a case in the past twenty years that couldn't be charged up to some fool's recklessness."

"You're right, skipper. By the way, there's coffee under the chart hood."

"Thanks. I had a cup down below." He walked over by the lookouts at the stereoscopes and peered out at the star-flecked blackness.

Three cigarettes later, the lookout nearest him called out:

"Light ho!"

"Where away?" asked the captain.

His mate read the exterior dials of the stereoscope. "Plus point two, abaft one point three; slight drift astern."

"Does that check?"

"Could be, captain. What is her disk?" came the navigator's muffled voice from under the hood. The lookout hurriedly twisted the knobs of his instrument, but the captain nudged him aside.

"I'll do this, son." He fitted his face to the double eye guards and surveyed a little silvery sphere, a tiny moon. Carefully he brought two illuminated crosshairs in until they were exactly tangent to the upper and lower limbs of the disk. "Mark!"

The reading was noted and passed to the navigator, who shortly ducked out from under the hood.

"That's our baby, captain."

"Good."

"Shall I make a triangulation?"

"Let the watch officer do that. You go down and get some sleep. I'll ease her over until we get close enough to use the range finder."

"Thanks, I will."

WITHIN a few minutes the word had spread around the ship that Eighty-eight had been sighted. Libby crowded into the starboard hold with a throng of excited messmates and attempted to make out their future home from the viewport. McCoy poured cold water on their excitement.

"By the time that rock shows up big enough to tell anything about it with your naked eye, we'll all be at our grounding stations. She's only about a hundred miles thick, yuh know."

And so it was. Many hours later the ship's announcer shouted, "All hands! Man your grounding stations. Close all bulkhead doors. Stand by to cut blowers on signal."

McCoy forced them to lie down throughout the ensuing two hours. Short sharp shocks of the rocket blasts alternated with nauseating weightlessness. Then the blowers stopped and their check valves clicked into their seats. The ship dropped free for a few moments—a final quick blast—five seconds of falling, and a short, light, grinding bump. A single bugle note came over the announcer, and the blowers took up their hum.

McCoy floated lightly to his feet and poised, swaying, on his toes. "All out, troops—this is the end of the line."

A short chunky lad, a little younger than most of them, awkwardly emulated him, and bounded toward the door, shouting as he went, "Come on, fellows! Let's go outside and explore!"

The master-at-arms quickly squelched such thoughtless enthusiasm. "Not so fast, kid. Aside from the fact that there is no air out there, go right ahead. You'll freeze to death, burn to death, and explode like a ripe tomato. Squad leader, detail six men to break out spacesuits. The rest of you stay here and stand by."

The working party returned shortly loaded down with a couple of dozen bulky packages. Libby let go the four he carried and watched them float gently to the deck. McCoy unzipped the envelope from one suit, and lectured them about it.

"This is a standard service type, general issue, Mark I V, Modification 2." He grasped the suit by the shoulders, and shook it out so that it hung like a suit of long winter underwear with the helmet lolling helplessly between the shoulders of the garment. "It's self-sustaining for eight hours, having oxygen supply for that period. It also has a nitrogen trim tank and a carbon-dioxide-water-vapor cartridge filter."

He droned on, repeating practically verbatim the description and instructions given in training regulations. McCoy knew these suits like his tongue knew the roof of his mouth, and the

knowledge had meant his life on more than one occasion.

"The suit is woven from fine steel wire, and sprayed with non-volatile asbestocellutite. The resulting fabric is flexible, very durable; and will turn all rays normal to solar space outside the orbit of Mercury. It is worn almost skintight, but notice the wire-braced accordion pleats at the major joints. They are so designed as to keep the internal volume of the suit nearly constant when the arms or legs are bent. Otherwise, the gas pressure inside would tend to keep the suit blown up in an erect position, and movement while wearing the suit would be very fatiguing.

"The helmet is molded from transparent duralite, leaded and polarized against too great ray penetration. It may be equipped with external visors of any needed type. Orders are to wear not less than a Number Two amber on this body. In addition a lead plate covers the cranium and extends on down the back of the suit, completely covering the spinal column.

"The suit is equipped with two-way telephony of a half mile radius. If your radio quits, as these have a habit of doing, you can talk by putting your helmets in contact. Any questions?"

"How do you eat and drink during the eight hours?" one of the men asked.

"You don't stay in 'em any eight hours. You can carry sugar balls in a gadget in the helmet, but you boys will always eat at the base. As for water, there's a nipple in the helmet near your mouth which you can reach by turning your head to the left. It's hooked to a built-in canteen."

SUITS were passed out to each lad, and McCoy illustrated how to don one. A suit was spread supine on the deck, the front zipper that stretched from neck to crouch was spread wide and one sat down inside this opening, whereupon the lower part was drawn on like long stockings. Then a wiggle into each sleeve and the heavy flexible gauntlets were smoothed and patted into place. Finally an awkward backward stretch of the neck, with shoulders hunched, enabled the helmet to be placed over the head.

Libby followed the motions of McCoy and stood up in his suit. He examined the zipper which controlled the suit's only opening. It was backed by two soft gaskets which would be pressed together by the zipper and further sealed by internal air pressure. Inside the helmet a composition mouthpiece for exhalation led to the filter.

McCoy bustled around, inspecting them, tightening a belt here and there, instructing them in the use of the external controls. Satisfied, he reported to the conning room that his section had received basic instruction and was ready to disembark. Permission was received to take them out for thirty minutes acclimation.

Six at a time he escorted them through the air lock, and out onto the surface of the planetoid. Libby blinked his eyes at the unaccustomed luster of sunshine on rock. Although the Sun lay more than two hundred million miles away and bathed the little planet with radiation only one fifth as strong as that lavished on mother Earth, nevertheless, the lack of atmosphere resulted in a glare that made him squint. He was glad to have the protection of his amber visor. Overhead the Sun, shrunk to penny size, shone down from a dead black sky in which unwinking stars crowded each other and the very Sun itself.

The voice of one of his messmates sounded in his earphones, "Jeepers! That horizon looks close. I'll bet it ain't more'n a mile away."

Libby looked over the flat bare plain and subconsciously considered the matter. "It's less," he commented, "than a third of a mile away."

Jeering tones answered him. "What

do you know about it, Pinkie? And who asked you, anyway?"

Libby answered defensively, "As a matter of fact, it's one thousand six hundred and seventy feet, figuring that my eyes are five feet three inches above ground level."

"Nuts. Pinkie, you're always trying to show off how much you know."

"Why, I am not," Libby protested. "If this body is a hundred miles thick, and as round as it looks; why, naturally the horizon has to be just that far away."

The answer was scoffing, contempuous.

McCoy cut him short. "Pipe down! The kid's a lot nearer right than you are."

"As a matter of fact, he is exactly right," put in a strange voice. "I had to look it up for the navigator before I left control."

"Is that so?"—McCoy's voice again—"If the chief quartermaster says you're right, Libby, you're right. How did you know?"

Libby flushed miserably. "I . . . I don't know. That's the only way it could be."

The gunner's mate and the quartermaster looked at him for a moment, but dropped the subject.

BY THE END of the "day"—ship's time; Eighty-eight had a period of eight hours and thirteen minutes—work was well underway. The transport had grounded immediately adjacent to a low range of hills that arose sharply from the plain. The captain selected a little bowl-shaped depression in the hills, some thousand feet long and half as broad in which to establish a permanent camp. This was to be roofed over, sealed, and an atmosphere provided.

In the hill between the ship and the valley, quarters were to be excavated; dormitories, mess hall, officers' quarters, sick bay, recreation room, officers, storerooms, and so forth. A tunnel must be bored through the hill, connecting the sides of these rooms, and connecting with a ten-foot airtight metal tube sealed to the ship's portside air lock. Both the tube and tunnel were to be equipped with a continuous conveyor belt for passengers and freight.

Libby found himself assigned to the roofing detail. He helped the metalsmith's mate struggle over the hill with a portable atomic heater, difficult to handle because of a mass of eight hundred pounds, but weighing only sixteen pounds. The rest of the roofing detail were breaking out and preparing to move by hand the enormous translucent tent which was to be the "sky" of the little valley.

The metalsmith located a landmark on the inner slope of the valley, set up his heater, and commenced cutting a deep horizontal groove or step in the rock. He kept it always at the same level by following a chalk mark drawn along the rock wall. Libby inquired how the job had been surveyed so quickly.

"Easy," he was answered, "two of the quartermasters went ahead with a transit, leveled it just fifty feet above the valley floor, and clamped a searchlight to it. Then one of 'em ran like hell around the rim, making chalk marks at the height at which the beam struck."

"Is this roof going to be just fifty feet high?" asked Libby.

"No, it will average maybe a hundred. It bellies up in the middle from the air pressure."

"Earth normal?" persisted Libby.

"Yeah."

Libby concentrated for an instant, then looked puzzled.

"But look—this valley is a thousand feet long and better than five hundred wide. At fifteen pounds per square inch, and allowing for the arch of the roof, that's a load of two and a quarter billion pounds. What fabric can take that kind of a load?"

"Cobwebs."

"Cobwebs?" echoed Libby.

"Yeah, cobwebs. Strongest stuff in the world, stronger than the best steel. Synthetic spider silk. This gauge we're using for the roof has a tensile strength of four thousand pounds a running inch."

Libby hesitated a second, then replied, "I see. With a rim about eighteen hundred thousand inches around, the maximum pull at the point of anchoring would be about twelve hundred and fifty pounds per inch. Plenty safe margin."

The metalsmith leaned on his tool and nodded. "Something like that. You're pretty quick at arithmetic, aren't you, bud?"

Libby looked startled. "Am I? I just like to get things straight."

They worked rapidly around the slope, cutting a clean smooth groove to which the "cobweb" could be anchored and sealed. The white-hot lava spewed out of the discharge vent and ran slowly down the hillside. A brown vapor boiled off the surface of the molten rock, arose a few feet and sublimed almost at once to a white powder which settled to the ground. The metalsmith pointed to the powder.

"That stuff 'u'd cause silicosis if we let it stay there, and breathed it later."

"What do you do about it?" asked Libby.

"Just clean it out with the blowers of the air conditioning plant."

Libby took this opening to ask another question. "Mister—"

"Johnson's my name. No 'Mister' necessary."

"Well, Johnson, where do we get the air for this whole valley, not to mention the tunnels? I figure we must need fifty million cubic feet or more. Do we manufacture it?"

"Naw, that's too much trouble. We brought it with us."

"On the transport?" Libby wanted to know.

"Uh huh, at a hundred atmospheres —fifteen hundred pounds pressure," said Johnson.

Libby considered this. "I see—that way it would go into a space eighty feet on a side."

"Matter of fact, it's in three specially constructed holds—giant air bottles. This transport carried air to Luna City. I was in her then—a recruit, but in the air gang, even then."

IN THREE WEEKS the permanent camp was entirely ready for occupancy, and the transport entirely cleared of its cargo. The storerooms bulged with tools and supplies. Captain Doyle had moved his administrative offices underground, signed over his command to his first officer, and given him permission to "proceed on duty assigned," in this case, to return to terra with a skeleton crew.

Libby watched them take off from a vantage point on the hillside. An overpowering homesickness took possession of him. Would he ever go back? Would he ever see the Sun rise on the Ozark hills again? He honestly believed at the time that he would swap the rest of his life for thirty minutes with his mother.

He started back down the hill toward the tunnel lock. At least the transport carried letters to her, and with any luck the chaplain would be by soon with letters from Earth. He had enjoyed being in the air gang, but tomorrow he went back to his squad. He did not like that much. The boys were all right, he guessed, but he just could not seem to fit in.

Next day this company of the C. C. C. started on its bigger job; to pockmark Eighty-eight with rocket tubes so that Captain Doyle could push this hundred mile marble out of her orbit and herd her into a new orbit between Earth and Mars, to be used as a space station—a refuge for ships in distress, a haven for lifeboats, a fueling stop, a naval outpost.

Libby was assigned to a heater in pit

h-16. It was his business to carve out carefully calculated emplacements in which the blasting crew set off the minute charges which accomplished the major part of the excavating. Two squads were assigned to h-16, under the general supervision of an elderly marine gunner. Libby was free of the immediate supervision of his squad leader, who had been promoted to technical assistant on the strength of a few months' training in an engineering school. The Marine gunner sat on the edge of the pit, handling the plans, and occasionally making necessary calculations on the circular slide rule which hung from a lanyard around his neck.

Libby had just completed a tricky piece of cutting for a three-stage blast, and was waiting for the blasters, when his phones picked up the gunner's instructions concerning the size of the charge. He pressed his transmitter button.

"Mr. Larsen! You've made a mistake!"

"Who said that?"

"This is Libby. You've made a mistake in the charge. If you set off that charge, you'll blow this pit right out of the ground, and us with it."

Marine Gunner Larsen spun the dials on his slide rule before replying, "You're all het up over nothing, son. That charge is correct."

"No, I'm not, sir," Libby persisted, "you've multiplied where you should have divided."

"Have you had any experience at this sort of work?" Johnson queried.

"No, sir."

Larsen addressed his next remark to the blasters. "Set the charge."

They started to comply. Libby gulped, and wiped his lips with his tongue. He knew what he had to do, but he was afraid. Two clumsy stiff-legged jumps placed him beside the blasters. He pushed between them and tore the electrodes from the detonator. A shadow passed over him as he worked, and Larsen floated down beside him. A hand grasped his arm.

"You shouldn't have done that, son. That's direct disobedience of orders. I'll have to report you." He commenced reconnecting the firing circuit.

Libby's ears burned with embarrassment, but he answered back with the courage of timidity at bay. "I had to do it, sir. You're still wrong."

Larsen paused and ran his eyes over the dogged face. "Well—it's a waste of time, but I don't like to make you stand by a charge you're afraid of. Let's go over the calculation together."

CAPTAIN DOYLE sat at his ease in his quarters, his feet on his desk. He stared at a nearly empty glass tumbler.

"That's good beer, Blackie. Do you suppose we could brew some more when it's gone?"

"I don't know, cap'n. Did we bring any yeast?"

"I'll ask the steward later." He turned to the massive man who occupied the third chair. "Well, Larsen, I'm glad it wasn't any worse than it was."

"What beats me, captain, is how I could have made such a mistake. I worked it through twice. If it had been a nitro explosive, I'd have known offhand that I was wrong. If this kid hadn't had a hunch, I'd have set it off."

Captain Doyle clapped the old warrant officer on the shoulder. "Forget it, Larsen. You wouldn't have hurt anybody; that's why I require the pits to be evacuated even for small charges. These micro-explosives are tricky at the best. Look what happened in pit a-9. Ten days' work shot with one charge, and the gunnery officer himself approved that one. But I want to see this boy. What did you say his name was?"

"Libby, A. J."

Doyle touched a button on his desk. A knock sounded at the door. A bellowed "Come in!" produced a stripling

wearing the brassard of corpsman mate-of-the-deck.

"Have Corpsman Libby report to me."

"Aye, aye, sir."

Some few minutes later Libby was ushered into the sanctum sanctorum. He looked nervously around, and noted Larsen's presence, a fact that did not contribute to his peace of mind. He reported in a barely audible voice, "Corpsman Libby, sir."

The captain looked him over. "Well, Libby, I hear that you and Mr. Larsen had a difference of opinion this morning. Tell me about it."

"I . . . I didn't mean any harm, sir."

"Of course not. You're not in any trouble. Tell me, how did you know that the calculation was wrong? Had any mining experience?"

"No, sir. I just saw that he had worked it out wrong."

"But how?" Captain Doyle asked.

Libby shuffled uneasily. "Well, sir, it just seemed wrong—it didn't fit."

"Just a second, captain. I have a hunch you've got a— May I ask this young man a couple of questions?" It was Commander "Blackie" Rhodes who spoke.

"Certainly. Go ahead."

"Are you the lad they call 'Pinkie'?" asked Rhodes.

Libby blushed. "Yes, sir."

"I've heard some rumors about this boy." Rhodes pushed his big frame out of his chair, went over to a bookshelf, and removed a thick volume. He thumbed through it, then with open book before him, started to question the youth.

"What's the square root of ninety-five?"

"Nine, and seven hundred forty-seven thousandths."

"What's the cube root?"

"Four, and five hundred sixty-three thousandths."

"What's its logarithm?"

"Its what, sir?"

"Good lord, can a boy get through school today without knowing?"

THE BOY'S discomfort became more intense. "I didn't get much schooling, sir. My folks didn't accept the Covenant until pappy died, and we had to."

"I see. A logarithm is a name for a power to which you raise a given number, called the base, to get the number whose logarithm it is. Is that clear?"

Libby thought hard. "I don't quite get it, sir."

"I'll try again. If you raise ten to the second power—square it—it gives one hundred. Therefore the logarithm of one hundred to the base ten is two. In the same fashion the logarithm of a thousand to the base ten is three. Now what is the logarithm of ninety-five?"

Libby puzzled for a moment. "I can't make it come out even. It's a fraction."

"That's O. K.," said Rhodes.

"Then it's one, and nine hundred seventy-eight thousandths—just about."

Rhodes turned to the captain. "I guess that about proves it, sir."

Doyle nodded. "Yes, the lad undoubtedly has an intuitive knowledge of all arithmetical relationships. But let's see what else he has."

"I'm afraid we'll have to send him back to Earth to find out properly." Rhodes spoke directly to the captain.

Libby caught the gist of this last remark. "Please, sir, you aren't going to send me home? Maw 'u'd be awful vexed with me."

"No, no, nothing of the sort," said the captain. "When your time is up, I want you to be checked over in the psychometrical laboratories. In the meantime, I wouldn't part with you for a quarter's pay. I'd give up smoking first. But let's see what else you can do."

In the ensuing hour the captain and the navigator heard Libby: one, deduce

the Pythagorean proposition; two, derive Newton's laws of motion and Kepler's laws of ballistics from a statement of the conditions in which they obtained; three, judge length, volumes and masses by eye, with no measurable error. He had jumped into the idea of relativity and non-rectilinear space-time continua, and was beginning to pour forth ideas faster than he could talk, when Doyle held up a hand.

"That's enough, son. You'll be getting a fever. You run along to bed now, and come see me in the morning. I'm taking you off field work."

"Yes, sir," answered Libby.

"By the way, what is your full name?"

"Andrew Jackson Libby, sir."

"No, your folks wouldn't have signed the Covenant. Good night."

"Good night, sir."

After he had gone, the two older men discussed their discovery.

"How do you size it up, captain?"

"Well, he's a genius, of course—one of those wild talents that will show up once in a blue moon," said Doyle. "I'll turn him loose among my books and see how he shapes up. Shouldn't wonder if he were a page-at-a-glance reader, too."

"It beats me what we turn up among these boys—and not a one of 'em any account back on Earth."

Doyle nodded. "That was the trouble with these kids. They didn't feel needed."

EIGHTY-EIGHT swung some millions of miles farther around the Sun. The pockmarks on her face grew deeper, and were lined with durite, that strange close-packed laboratory product which—usually—would confine even atomic disintegration. Then Eighty-eight received a series of gentle pats, always on the side farthest from the Sun. In a few weeks' time the rocket blasts had their effect and Eighty-eight was plunging in a hyperbolic orbit toward the Sun.

When she reached her station, one and three-tenths the distance from the Sun of Earth's orbit, she would have to be coaxed by another series of pats into a circular orbit. Thereafter she was to be known as E-M 3, Earth-Mars Space Station Spot Three.

Hundreds of millions of miles away two other C. C. C. companies were inducing two other planetoids to quit their age-old grooves and slide between Earth and Mars to land in the same orbit as Eighty-eight. One was due to ride this orbit one hundred and twenty degrees ahead of Eighty-eight, the other one hundred and twenty degrees behind. When E-M 1, E-M 2, and E-M 3 were all on station no hard-pushed traveler of the spaceways on the Earth-Mars passage would ever again find himself far from land—or rescue.

During the months that Eighty-eight fell free toward the Sun, Captain Doyle reduced the working hours of his crew and turned them to the comparatively light labor of building a hotel and converting the little roofed-in valley into a garden spot. The rock was broken down into soil, fertilizers applied, and cultures of anerobic bacteria planted. Then plants, conditioned by thirty-odd generations of low gravity at Luna City, were set out and tenderly cared for. Except for the low gravity, Eighty-eight began to feel like home.

But when Eighty-eight approached a tangent to the hypothetical future orbit of E-M 3, the company went back to maneuvering routine, watch on and watch off, with the captain living on black coffee and catching catnaps in the plotting room.

Libby was assigned to the ballistic calculator, three Earth-tons of thinking metal that dominated the plotting room. He loved the big machine with its integrators, three-dimensional cams, its differential gear trains, and silent gyroscopes. The chief fire controlman let him help adjust it, and care for it.

Libby subconsciously thought of it as a person—his own kind of a person.

On the last day of the approach, the shocks were more frequent. Libby sat in the right hand saddle of the calculator, and droned out the predictions for the next salvo, while gloating over the accuracy with which the machine tracked. Captain Doyle fussed around nervously, occasionally stopping to peer over the navigator's shoulder. Of course, the figures were right, but what if it didn't work? No one had ever moved so large a mass before. Suppose it plunged on and on—and on. Nonsense! It couldn't. Still he would be glad when they were past the critical speed.

A marine orderly touched his elbow. "Helio from the Flagship, sir."

"Read it."

"Flag to Eighty-eight; private message, Captain Doyle: Am lying off to watch you bring her in—Kearney."

Doyle smiled. Nice of the old geezer. Once they were on station, he would invite the admiral to ground for dinner and show him the park.

Another salvo cut loose, heavier than before. The room trembled violently. In a moment the reports of the surface observers commenced to trickle in. "Tube nine, clear!" "Tube ten, clear!"

But Libby's drone ceased.

Captain Doyle turned on him. "What's the matter, Libby? Asleep? Call the polar stations. I've got to have a parallax."

"Captain—" the boy's voice was low and shaking.

"Speak up, man!"

"Captain—the machine isn't tracking."

"Spiers!" The grizzled head of the chief fire controlman appeared from behind the calculator.

"I'm already on it, sir. Let you know in a moment."

He ducked back again. After a couple of long minutes he reappeared. "Gyros tumbled. It's a twelve-hour calibration job, at least."

The captain said nothing, but turned away, and walked to the far end of the room. The navigator followed him with his eyes. He returned, glanced at the chronometer, and spoke to the navigator.

"Well, Blackie, if I don't have that firing data in seven minutes, we're sunk. Any suggestions?"

Rhodes shook his head without speaking.

Libby timidly raised his voice. "Captain—"

Doyle jerked around, "Yes?"

"The firing data is tube thirteen, seven point six three; tube twelve, six point nine oh; tube fourteen, six point eight nine."

Doyle studied his face. "You sure about that, son?"

"It *has* to be that, captain."

Doyle stood perfectly still. This time he did not look at Rhodes but stared straight ahead. Then he took a long pull on his cigarette, glanced at the ash, and said in a steady voice, "Apply the data. Fire on the bell."

FOUR HOURS later Libby was still droning out firing data, his face gray, his eyes closed. Once he had fainted but when they revived him he was still muttering figures. From time to time, the captain and the navigator relieved each other, but there was no relief for him.

The salvos grew closer together, but the shocks were lighter.

Following one faint salvo, Libby looked up, stared at the ceiling, and spoke, "That's all, captain."

"Call polar stations!"

The reports came back promptly, "Parallax constant, sidereal-solar rate constant."

The captain relaxed into a chair. "Well, Blackie, we did it—thanks to Libby!" Then he noticed a worried, thoughtful look spread over Libby's

face. "What's the matter, man? Have we slipped up?"

"Captain, you know you said the other day that you wished you had Earth normal gravity in the park?"

"Yes. What of it?"

"If that book on gravitation you lent me is straight dope, I think I know a way to accomplish it," said Libby.

The captain inspected him as if seeing him for the first time. "Libby, you have ceased to amaze me. Could you stop doing that sort of thing long enough to dine with the admiral?"

"Gee, captain, that would be swell!"

The audio circuit from Communications cut in, "Helio from Flagship: 'Well done, Eighty-eight.'"

Doyle smiled around at them all. "That's pleasant confirmation."

The audio brayed again, "Helio from Flagship: 'Cancel last signal, stand by for correction.'"

A look of surprise and apprehension sprang into Doyle's face before self-discipline could prevent it.

The audio continued, "Helio from Flagship: 'Well done, E-M 3.'"

DEADLY METAL

On display at the World's Fair in New York this summer was a series of platinum-metal crucibles, and other chemical ware manufactured from the inert metals. Among them were two crucibles of particular interest, one made of pure osmium, and one of pure iridium. Pure, that is, within reason, for the platinum-group metals are practically inseparable.

Each of those two crucibles was, probably, the only one of its kind in the world. In many ways, iridium might be better than platinum, but it isn't used because, while platinum is now selling at about the price of gold, iridium is several times as costly. Further, iridium is even harder to melt than platinum, and, instead of softening and "working" before fusing, as platinum does, iridium simply, suddenly, relapses into a liquid. Then, on the slightest cooling, it's abruptly hard and unmanageable again. Since an oxy-hydrogen blowtorch in perfect working order will barely melt it, it is not fun to try to weld iridium crucibles together.

Osmium melts more easily, but otherwise has all these difficulties, plus another of its own conceiving. It, unlike most platinum metals, oxidizes readily in the air when heated to a red heat. The oxide breaks down again at a white heat, but since the oxide is volatile, it tends to form and immediately leave the area in a large hurry, carrying away metal worth several hundred dollars an ounce. Yet even that wouldn't be so bad if it weren't for one other thing. Osmium tetroxide, the compound formed, for downright insensate viciousness probably outclasses all other poisons going. It has all the viciousness of mustard gas, plus several original forms of vindictiveness. It blisters the flesh and rots away skin on its way in, poisons the entire system after it gets in, and settles down to a steady and unstoppable program of destruction locally on arrival. It corrodes away the eyes, starts a necrosis and destruction of the jawbone, teeth and bones of the head, then spreads progressively, attacking in succession all over the body.

The troubles and precautions required in making osmium crucibles suggest that they will *not* become a widespread feature of chemical laboratories.

SPACE WAR TACTICS

Expanding on Willy Ley's recent article, Jameson brings out some important details—not the least of which is that a space battle fleet gets one shot at the enemy in months of maneuvering!

By Malcolm Jameson

Illustrated by Malcolm Jameson

I.

Ship to Ship Engagement

A WORKING knowledge of the game of chess is a useful adjunct in understanding the art of war. War is not a series of haphazard encounters but a definite understanding governed by principles that never change, however much the weapons and uniforms and the colors of the flags may. Like chess it is a continuing struggle between two opponents, each trying to estimate the strength of the other and to divine his purposes and most probable objective, and what his next move will be. It is a marshaling and movement of forces, a series of threats and feints, of advances and withdrawals, punctuated by sharp conflict as one or the other forces the issue.

As the rules of chess govern the movement of each piece, so does the field of operations in war, whether it is rocky terrain or swampy, the open sea or the cloud-streaked skies, or the vast reaches of space itself. Tactics, and in a measure the weapons, are rigidly determined by the controlling environment.

We can, therefore, predict with some assurance the general nature of space warfare, for we already know something of the properties of the void and what characteristics ships that traverse it are likely to have. With such ships and in such a theater of operations, we have only to apply the principles of warfare developed by men through centuries of strife to arrive at an approximation of the tactics they will use. We can be fairly certain of the kind of weapons and instruments they will have, for the very advent of spaceships is presumptive of contined advance in science along much the same lines we have already come.

There are two great factors in space warfare that will set it off sharply from anything else in human experience, and those two factors will modify fighting-ship types, strategy and tactics profoundly. They are: (a) the extent of space, and (b) the tremendous speed of the vessels.

At the risk of boring those who have already read and thought a good deal about travel in space and who feel that they long ago formed a satisfactory idea of what the limitless reaches of the void are like, I want to dwell a moment on the subject of the vastness of space. It deserves all the emphasis we can give it.

Psychologists assert that it is boyond the capacity of the human mind to conceive of quantities, extents or durations beyond rather close limits. We may nod understandingly at hearing mention of a billion-dollar appropriation, but we grasp the idea solely because we are thinking of those billion dollars as a

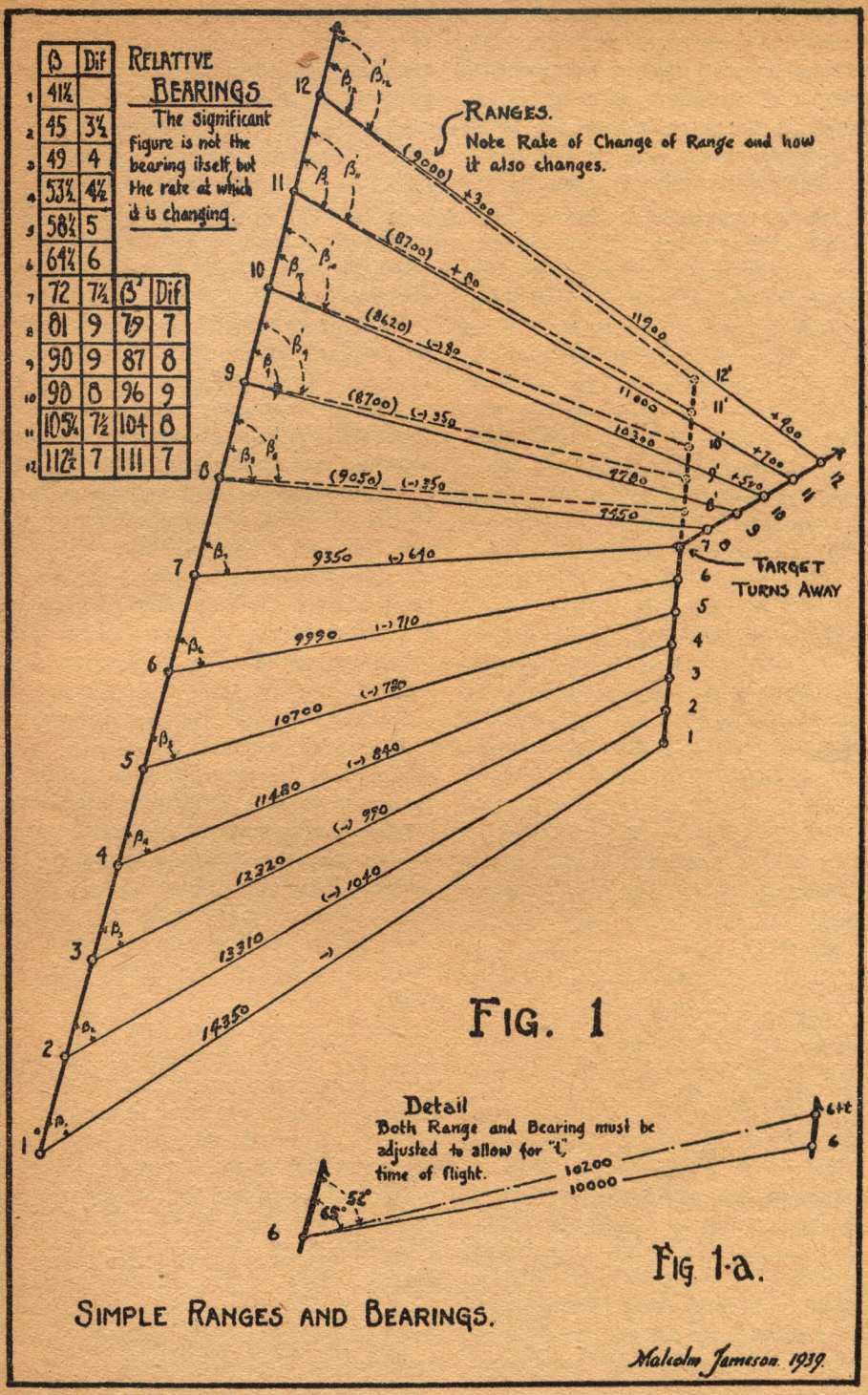


FIG. 1

FIG 1-a.

SIMPLE RANGES AND BEARINGS.

Malcolm Jameson. 1939.

unit sum of money. If we tried to visualize them as coins we would fail utterly. The mind cannot picture ten hundred thousands of thousands of silver disks. "Many" is the best it can do—there are too many dollars there for one mindfull. And so it is with distance.

It has been my good fortune to have traveled extensively; I have crossed oceans as navigator, stepping off the miles made good each day or watching them slide by under the counter. Thus I have a hazy notion of the size of the Earth—it is oppressively huge. What, then, of the two or three milion-mile straightaway covered in a single day's run of a rocketship—represented by a quarter-inch pencil mark on the astragator's chart of the ecliptic? The Earth he left but yesterday has already dwindled to a small bright disk and before the week is over it will be seen only as a brilliant blue star. In that incredibly vast celestial sphere in which he is floating—stretching as it does without limit before, behind and to every side, above and below—where and how can we hope *to find* his enemy?

For even if he passed another ship close aboard, he would not so much as glimpse it. Speeds in space are as stupendous as the spaces they traverse. Needing seven miles per second to escape the Earth and another twenty to make any reasonable progress between the planets, even the slowest vessels will have speeds of twenty-five miles per second. Warships, presumably, according to type, will have correspondingly higher speeds—perhaps as high as fifty miles per second for the faster scouts.

Speeds of that order are as baffling to the imagination as the depths of the void. When we recall that the fastest thing most of us are familiar with is the rifle bullet, whizzing along at a lazy half-mile per second, we see that we do have a yardstick. The ships mentioned above proceed at from fifty to one hundred times that fast—invisible, except under very special circumstances. It is barely possible, we know, for a quick eye to pick up twelve-inch shells in flight if he knows just where, when and how to look, but a momentary glimpse is all he gets.

When we talk of gunfire or any other means of offense, we have to bear these dizzy speeds firmly in mind. The conclusion is irresistible that scouting, tracking, range finding and relative bearings will all be observed otherwise than visually. Even on the assumption of attack from the quarter, the most obvious approach—and for the same reason that aviators "get on the tail"—the overtaking vessel must necessarily have such an excess of speed that the visual contact can last but a few seconds. Each of the combatants must compute the other's course from blind bearings and ranges and lay their guns or point their torpedo tubes by means of a differential calculator.

However, in this blind tracking there is one peculiarity of these ships that while it is in one sense a source of danger to them, is of distinct assistance. In the fleeting minutes of their contact, neither can appreciably alter course or speed! This is a point that writers of fiction frequently ignore for the sake of vivid action, but nevertheles it is an unavoidable characteristic of the ther-borne ship.

The human body can withstand only so much acceleration and the momentum these vessels carry has been built up, hour after hour, by piling increment of speed on top of what had been attained before. In space there is no resistance. Once the rockets are cut, the ship will soar on forever at whatever velocity she had at the moment of cutting. Her master may flip her end over end and reverse his acceleration, but his slowing will be as tedious and cautious as his working up to speed. Jets flung out at right angles merely add

another slight component to the velocity, checking nothing.

Rocket experts have stated that an acceleration of one hundred feet per second per second can be withstood by a human being—perhaps one hundred and fifty in an emergency. The master of a vessel proceeding at forty miles per second applying such an acceleration at right angles would succeed in deflecting his flight about one hundred miles by the end of the first *minute,* during which he will have run twenty-four hundred—a negligible turn, if under fire. Applied as a direct brake, that hundred miles of decreased velocity would slow him by one twenty-fourth—obviously not worth the doing if the emergency is imminent.

WITH these conditions in mind, let us imagine a light cruiser of the future bowling along at forty miles per second on the trail of an enemy. The enemy is also a cruiser, one that has slipped through our screen and is approaching the earth for a fast raid on our cities. He is already decelerating for his prospective descent and is thought to be about one hundred and fifty thousand miles ahead, proceeding at about thirty-five miles per second. Our cruiser is closing on him from a little on his port quarter, and trying to pick him up with its direction finders.

So far we have not "seen" him. We only know from enciphered code messages received several days ago from our scouting force, now fifty millions astern of us, that he is up ahead. It would take too long here to explain how the scouts secured the information they sent us. The huge system of expanding spirals along which successive patrols searched the half billion cubic miles of dangerous space lying between us and the enemy planet is much too intricate for brief description. It is sufficient for our purposes that the scouts did detect the passage of the hostile cruiser through their web and that they kept their instruments trained on him long enough to identify his trajectory. Being neither in a position to attack advantageously nor well enough armed—for their function is the securing of information, and that only—they passed the enemy's coordinates along to us. This information is vital to us, for without it the probability of contact in the void is so remote as to be nonexistent.

The ship in which we are rushing to battle is not a large one. She is a bare hundred meters in length, but highly powered. Her multiple rocket tubes, now cold and dead, are grouped in the stern. We have no desire for more speed, having all that is manageable already, for after the few seconds of our coming brush with the enemy our velocity is such that we will far overrun him and his destination as well. It will require days of maximum deceleration for us to check our flight and be in a position to return to base.

Our ship's armament, judged by today's standards, will at first sight appear strangely inadequate. Our most destructive weapon is the "mine," a simple sphere of meteoric iron about the size of a billiard ball, containing no explosive and not fused. The effectiveness of such mines depends upon the speed with which they are struck by the target ship—no explosive could add much to the damage done by a small lump if iron striking at upward of thirty miles a second. Then there will be torpedo tubes amidships, and perhaps a few guns, but it may be well to postpone a discussion of the armament until we have examined the conditions at the place of battle.

Although we know in a general way where the enemy is and where he is going, before we close with him we must determine his course and speed very accurately, for our ability to hit him at all is going to depend upon extremely nice calculations. Our speeds are such that angular errors of so much as a second of

arc will be fatal, and times must be computed to within hundredths of seconds.

This falls within the province of fire-control, a subject seldom if ever mentioned by fiction writers. There is no blame to be attached to them for that, for the problems of fire-control are essentially those of pure mathematics, and mathematics is notoriously unthrilling to the majority of readers. Yet hitting with guns—or even arrows, though the archer solves *his* difficulties by intuition—requires the solution of intricate problems involving the future positions and movements of at least two bodies, and nothing more elementary than the differential calculus will do the trick. In these problems interior ballistics, for all its interesting physics, boils down to a single figure—the initial velocity of the projectile, while exterior ballistics evaporates for the most part the moment we propel our missile into a gravityless vacuum. In space we are to be concerned with the swiftly changing relationship of two rapidly moving vessels and the interchange of equally swift projectiles between them, the tracks of all of them being complicated curves and not necessarily lying in a plane.

In its simplest statement the problem of long-range gunnery is this: where will the enemy be when my salvo gets there? For we must remember that even in today's battles the time the projectile spends en route to its target is appreciable—fully a minute on occasion, at sea, during which the warship fired upon may move as much as half a mile. Under such circumstances the gunner does not fire directly at his target, *but at the place it is going to be.* That requires very accurate knowledge of where the enemy is headed and how fast he is moving.

At sea that is done by observing successive bearings and ranges and plotting them as polar co-ordinates, bearing in mind that the origin is continuously shifting due to the ship's own motion. This work of tracking—the subsequent range-keeping and prediction of future ranges and bearings—is done in our times in the plotting room. This is the most vital spot in the ship, for if her weapons may be likened to fists and her motive power to legs, her optical and acoustical instruments to eyes and ears, then the plotting room is the counterpart of the brain. There all the information is received, corrected, digested, and distributed throughout the ship. Without that co-ordination and direction the ship would be as helpless as an idiot.

Well, hardly that helpless today. Our individual units, such as turret crews, can struggle on alone, after a fashion. But not so with the ship of the future. There the plotting room is everything, and when it is put out of commission, the ship is blind and paralyzed. It will, of course, be located within the center of the ship, surrounded by an armored shell of its own, and in there will also be the ship control stations.

THE BEST WAY to approach the problems our descendants will have to face is to consider a simple problem in tracking that our own warships deal with daily. It is an absurdly simple one compared to the warped spirals to be handled in space warfare, but it will serve to illustrate the principle. In Fig. 1. it is shown graphically, but in actual practice the elements of the problem are set up on a motor-driven machine which thereupon continuously and correctly delivers the solutions of problems that would take an Einstein minutes to state. As the situation outside changes, corrections are cranked into the machine, which instantly and uncomplainingly alters its calculations.

In the figure we have the tracks of two ships, ours the left-hand one. For the sake of clarity and emphasis I have made the ratio of speeds three to one, but the same trends would be shown at the more usual ratio of, say, 20:19.

At positions "1," "2," "3" and so on, we observe the range and bearing of the target, and plot them. By noting the differences between successive readings and the second differences between those, we soon have an idea of the type of curve the *rates* of changes would plot into. In a short time we can also note that the rates themselves are changing at a certain rate. This is a rough sort of differentiation—by inspection—and to one familiar with such curves these trends have a definite meaning.

For example, it is apparent that the series of observed angles "Beta" are steadily opening, signifying that we are drawing past the target. Any sudden alteration of the second differences, such as occurs at "8," at once indicates a change of condition on the part of the enemy. He has either turned sharply away or slowed to half speed, for the bearing suddenly opens nearly two degrees more than the predicted bearing. We learn which by consulting our ranges. It could be a combination of changed course and changed speed.

The ranges during the first seven time-intervals have been steadily decreasing, although the *rate* of decrease has been slowing up, indicating we are approaching the minimum range. At "8," though, the range not only fails to decrease, but the rate of change actually changes sign. We know without doubt that the enemy has turned away.

The importance of having the machine grind out predicted bearings and ranges, aside from the desirability of speed and accuracy, is that at any moment smoke, a rain squall, or intervening ships may obscure the target. In that event the gunners need never know the difference —their range and bearing indicators are ticking away like taximeters, fed figures by the controlling rangekeeper. It would not have mattered if sight had been lost of the enemy at "4"; the gunfire would have been just as accurate up to the time he changed course as if they had the target in plain sight.

As a matter of fact, the guns are not pointed at the target at all, but in advance of it, as is shown in Fig. 1 (a), both range and bearing being altered to allow for the forward movements of the target while the shells are in the air. The projectiles may be regarded as moving objects launched on a "collision course" with regard to the enemy vessel.

Speaking of collision courses, it is an interesting property of relative bearings that when the bearing remains constant —except in the special case of the vessels being on parallel courses at identical speeds—the vessels will eventually collide, regardless of what their actual courses and speeds are. Hence, from the time the shots of the salvo left their guns—Fig. 1 (a)—until they struck their target, the target bore a constant angle of thirteen degrees to the right of the nose of the shells. (This knowledge has some utility in estimating the penetration of armor at the destination.)

In the example above, all the movement can be regarded as taking place in a plane; the ships follow straight courses and they maintain constant speeds. Our terrestrial problems are in practice much complicated by zigzagging, slowing down and speeding up, but at that they are relatively child's play compared to what the sky-warrior of the future must contend with.

His tracks are likely to be curved in three dimensions, like pieces of wire hacked out of a spiral bedspring, and whether or not they can be plotted in a plane, they will nowhere be straight. Moreover, whatever changes of speeds occur will be in the form of steady accelerations and not in a succession of flat steps linked by brief accelerations such as we know. Computing collision courses between two continually accelerating bodies is a much trickier piece of mathematical legerdemain than finding the unknown quantities in the family of plane trapeziums shown in Fig. 1.

Yet projectiles must be given the course and speed necessary to insure collision.

The gunnery officer of the future is further handicapped by rarely ever being permitted a glimpse of his target, certainly not for the purpose of taking ranges and bearings. In the beginning of the approach the distances between the ships is much too great, and by the time they have closed, their relative speed will generally forbid vision.

SINCE optical instruments are useles except for astragational purposes, his rangefinders and target-bearing transmitters will have to be something else. For bearings, his most accurate instrument will probably be the thermoscope—an improved heat-detector similar to those used by astronomers in comparing the heat emission of distant stars. It will have a spherical mounting with a delicate micro-vernier. A nearby spaceship is sure to radiate heat, for it is exposed constantly to full sunlight and must rid itself of the excess heat or its crew will die. Once such a source of heat is picked up and identified, it can be followed very closely as to direction, although little can be told of its distance unless something is known of its intrinsic heat radiation.

Ranges will probably be determined by sounding space with radio waves, measuring the time interval to the return of reflected waves. It is doubtful whether this means will have a high degree of accuracy much beyond ranges of one light-second on account of the movement of the two vessels while the wave is in transit both ways. At long ranges the need for troublesome corrections is sure to enter.

Such observations, used in conjunction with one another, should give fairly accurate information as to the target's trajectory and how he bears from us and how far he is away. This data will be fed into a tracking and range-keeping machine capable of handling the twisted three-dimensional curves involved, and which will at once indicate the time and distance of the closest point of approach. Both captains will at once begin planning the action. They may also attempt to adjust their courses slightly, but since the rockets evolve great heat, neither can hope to keep his action from the knowledge of the other owing to the sensitiveness of the thermoscopes.

The rangekeeping instrument suggested, while far surpassing in complexity anything we know of today, will represent a much smaller technical advance than the rockets which drive the ships that house them. We already have similar machines, so that their counterparts of the future would seem much less mysterious to us than, say, the Walschaert's valve gear to Hero or Archimedes, or the Jacquard loom to the weavers of the Gobelin tapestries.

Assuming we have, by observation and plotting, full knowledge of the enemy's path and have come almost into position to commence the engagement, we find ourselves confronted once more with the two overwhelming factors of space warfare—great distance and immense speeds—but this time in another aspect. We have come up close to our foe—in fact we are within twenty seconds of intersecting his trajectory—and our distance apart is a mere four hundred miles. It is when we get to close quarters that the tremendous problems raised by these lightninglike speeds manifest themselves most vividly.

Look at Fig. 2.

The elapsed time from the commencement of the engagement until the end is less than twenty seconds. Our ship is making forty miles per second, the other fellow is doing thirty-three. We will never be closer than fifty miles, even if we regard the curves as drawn as being in the same plane. If one rides over or below the other, that minimum range will be greater. What kind of pro-

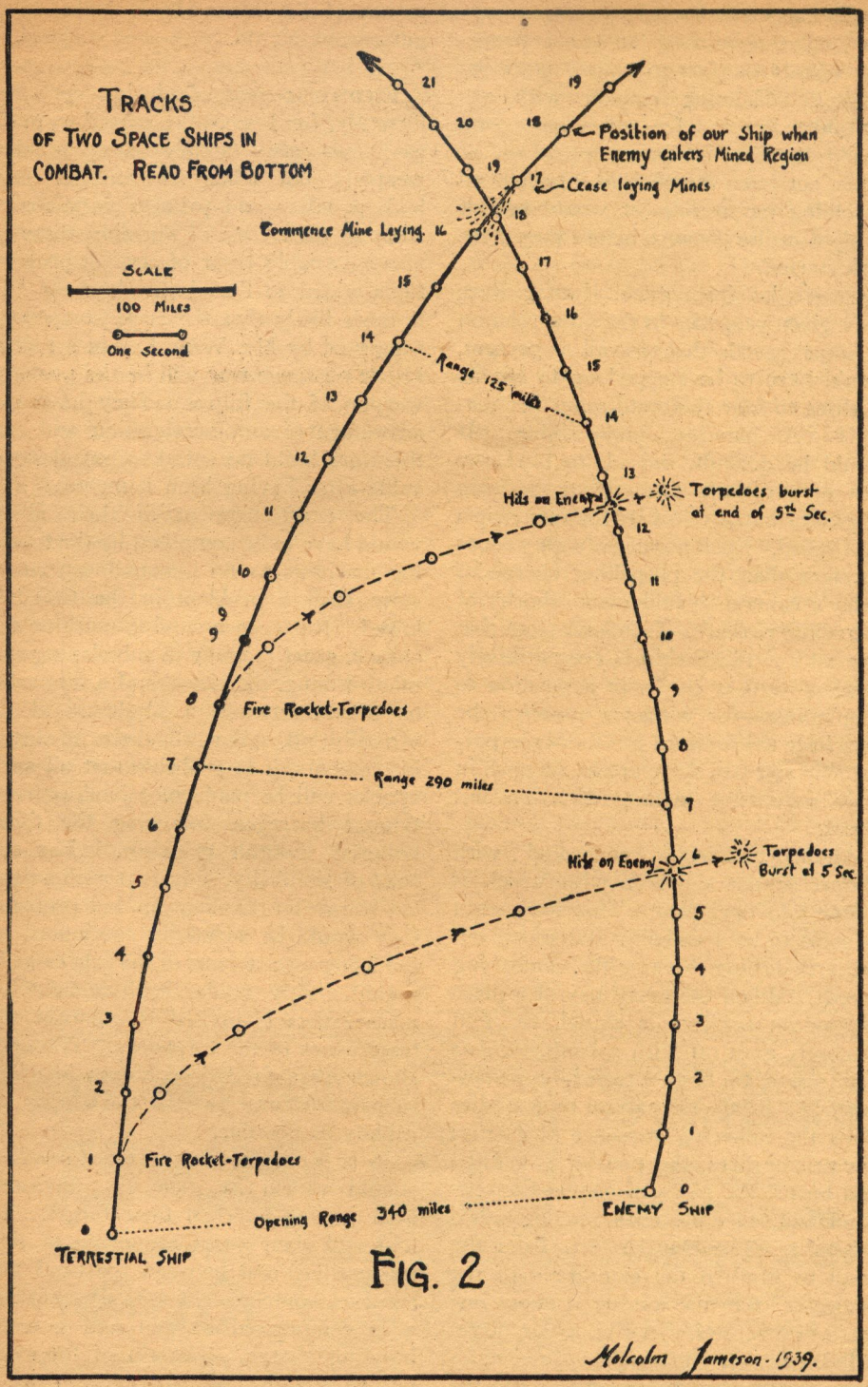

TRACKS
OF TWO SPACE SHIPS IN
COMBAT. READ FROM BOTTOM
SCALE
100 MILES
One Second
Position of our Ship when Enemy enters Mined Region
Cease laying Mines
Commence Mine Laying.
Range 125 miles
Hits on Enemy
Torpedoes burst at end of 5th Sec.
Fire Rocket-Torpedoes
Range 290 miles
Hits on Enemy
Torpedoes Burst at 5 Sec.
Fire Rocket-Torpedoes
Opening Range 340 miles
TERRESTIAL SHIP
ENEMY SHIP
Malcolm Jameson. 1939.

FIG. 2

jectile can cross the two or three hundred miles separating the two converging vessels *in time* to collide with the enemy? Shooting cannon with velocities as low as a few miles per second would be like sending a squadron of snails out from the curb to intercept an oncoming motorcycle—it would be out of sight in the distance before they were well started.

Projectiles from guns, if they were to be given velocities in the same relation to ships' speeds that prevail at present, would have to be stepped up to speeds of three to four thousand miles per second! A manifest impossibility. It would be difficult, indeed, to hurl any sort of projectile away from the ship at greater initial velocities than the ship's own speed. Such impulses, eighty times stronger than the propelling charge of today's cannon, would cause shocks of incredible violence. It follows from that that an overtaken ship is comparatively helpless—unless she is in a position to drop mines—for whatever missiles she fires have the forward inertia of the parent ship and will therefore be sluggish in their movement in any direction but ahead.

Another difficulty connected with gunfire is the slowness with which it comes into operation. This may seem to some to be a startling statement, but we are dealing here with astonishing speeds. When the firing key of a piece of modern artillery is closed, the gun promptly goes off with a bang. To us that seems to be a practically instantaneous action. Yet careful time studies show the following sequence of events: the primer fires, the powder is ignited and burns, the gases of combustion expand and start the shell moving down the tube. The elapsed time from the "will to fire" to the emergence of the projectile from the muzzle is about one tenth of a second. In Fig. 2 our target will have moved more than three miles while our shell is making its way to the mouth of the cannon! It looks as if guns wouldn't do.

I COME to that conclusion very reluctantly, for I am quite partial to guns as amazingly flexible and reliable weapons, but when we consider that both powders and primers vary somewhat in their time of burning, there is also a variable error of serious proportions added to the above slowness. It is more likely that the rocket-torpedoes suggested by Mr. Willy Ley in a recent article on space war will be the primary weapon of the future. They have the advantage of auto-acceleration and can therefore build up speed to any desired value *after* having been launched.

The exact moment of their firing would have to be computed by the tracking machine, as no human brain could solve such a problem in the time allowed. But even assuming machine accuracy, great delicacy in tube-laying and micro-timing, the chances of a direct hit on the target with a single missile is virtually nil. For all their advanced instruments, it is probable that all such attacks will be made in salvos, or continuous barrages, following the time-honored shotgun principle. For the sake of simplicity, only two such salvos are shown on the diagram, but probably they would be as nearly continuous as the firing mechanisms of the tubes would permit. Any reader with a flair for mathematics is invited to compute the trajectories of the torpedoes. The ones shown were fired dead abeam in order to gain distance toward the enemy as rapidly as possible.

It is desirable that these torpedoes should vanish as soon as practicable after having overrun their target. To that end their cases are made of thin magnesium, and between the head and the fuel compartment is a space filled with compressed oxygen and a small bursting charge. The tip of the head is loaded with liquid mercury. Such a

massive projectile would penetrate any spaceship with ease, but if it missed it would burst as soon as the fuel supply was spent and then consume itself in brilliant flame, thus avoiding littering the spaceways with dangerous fragments.

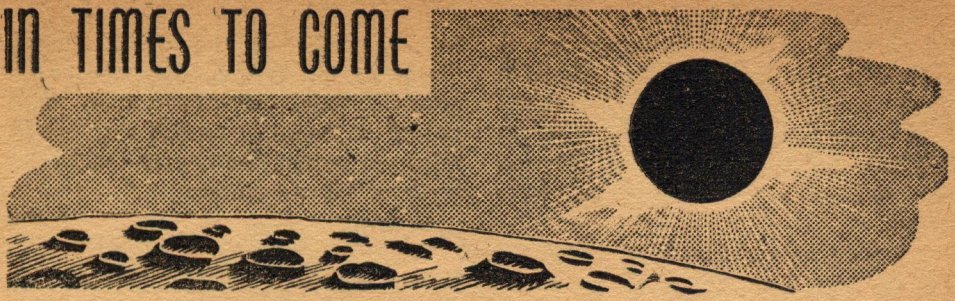
Spotting, as we know it, would be impossible, for the target would be invisible. Hits would have to be registered by the thermoscope, utilizing the heat generated by the impact. The gunnery officer could watch the flight of his torpedoes by their fiery wakes, and see his duds burst; that might give him an idea on which side of the enemy they passed in the event the thermoscopes registered no hits.

If there were guns—and they might be carried for stratosphere use—they could be brought into action at about "15," firing broad on the starboard quarter. The shells, also of self-destroying magnesium, would lose some of their forward velocity and drift along in the wake of the ship while at the same time making some distance toward the oncoming enemy. These guns would be mounted in twin turrets, one on the roof and the other on the keel, cross-connected so that they would be trained and fired together. If the ship's center of gravity lay exactly between them, their being fired would not tend to put the ship into a spin in any direction. What little torque there might be, due to inequalities in the firing charge, would be taken care of by the ship's gyro-stabilizer, an instrument also needed on board to furnish a sphere of reference so that the master could keep track of his orientation.

If upon arriving at point "16" the enemy were still full of fight and desperate measures were called for, we could lay down mines. These hard little pellets would be shot out of mine-laying tubes clustered about the main driving jets. They would be shot out at slight angles from the fore-and-aft line, and given a velocity exactly equal to the ship's speed, so that they would hang motionless where they were dropped. Being cheap and small, they could be laid so thickly that the enemy could not fail to encounter several of them. If she had survived up to this point, the end would come here.

The end, that is, of the cruiser as a fighting unit. Riddled and torn, perhaps a shapeless mass of tangled wreckage, she would go hurtling on by, forever bound to her marauding trajectory. The first duty of our cruiser would be to broadcast warnings to the System, reporting the location of its own minefield, and giving the direction taken by the shattered derelict. Sweepers would be summoned to collect the mines with powerful electromagnets, while tugs would pursue and clear the sky of the remnants of the defeated Martian.

IN TIMES TO COME



This is the first issue of Astounding to be finally assembled since Europe lost its temper. An item of science-fictional interest might be mentioned. Dr. Hahn, discoverer of the uranium fission reaction that lends hope to the possibilities of atomic power, is, of course, a German scientist. Since his announcement was made last January, hundreds of papers prepared by frantically researching American, English, French, and other scientists, particularly including Dr. Fermi, the Italian who first produced but did not then correctly interpret the uranium reaction, have appeared. Dr. Hahn and his co-workers have been publicly silent on the subject.

May we hope that attempts to release the unimaginable energy locked in uranium atoms, on a useful scale, remain complete and unmitigated failures until such time as the family fight in Europe is concluded?

Taking the cover next month—done by Gilmore, incidentally—is another story by A. E. van Vogt, who scored a first-rank position with his "Black Destroyer" in July. "Discord in Scarlet" is something of a sequel, and, I think, as good and unusual as was van Vogt's first yarn.

"There Ain't No Such—," de Camp's article on obviously impossible—but nonetheless existent—animals has a further section coming up next issue, too. Nature, evidently, is a good disciple of the scientific method—she'll try anything once . . . or a thousand times.

ANALYTICAL LABORATORY

Again first place goes to a first-time author. It appears that the new authors cropping up in Astounding will definitely keep the older, more experienced men from peacefully resting on their laurels.

Which is nice for Astounding and the readers, anyway—

1.	Ether Breather	Theodore Sturgeon
2.	Forces Must Balance	Manly Wade Wellman
3.	General Swamp, C. I. C.	Frederick Englehardt
4.	The Last Hope	Don Evans
5.	Atmospherics	Victor Valding

THE EDITOR.

SPACEWRECK

By OSCAR A. BOCH

SPACEWRECK

A very strange drink is poinaud, distillate of a Martian berry—very strange. It distorts the time-sense—and—

By Oscar A. Boch

Illustrated by Schneeman

CAPTAIN GLENN STACIE got a copy of the first news the world had about the Invader while he was coming in for a landing with the *Princess of Mars,* and showed it to Gale who was waiting for him in the Administration Building.

Jim Gale was navigator for Captain Halstead of the *Spacebird II,* which should have been an hour out on the Earth-Ganymede run; instead, Halstead was in Mercy Hospital with a burst appendix, and Gale had waited for Stacie with emergency orders.

While Stacie glanced over his orders, Gale read aloud:

"Strange ship hovering over Ganymede. Making no attempt to land or communicate. Design unfamiliar. Probably from another System. Intentions unknown. Companion headed toward Earth. Will arrive about forty-eight hours."

He looked up, deep concern on his face.

"Whew!" he breathed. "They kinda crack space wide open at that speed, don't they? Hope they're friendly. If not"—he shrugged noncommittally—"anything can happen."

But Stacie hadn't been listening. "Damn!" he grunted, crumpling his orders into a tight ball. "Only married a year, and it's not bad enough that I only see Sonya three weeks at a time between trips, but now they have to pull this on me. Two months more to Ganymede and back without a layover. There goes a grand fishing trip. Well, I'll fix 'em; I'll take Sonya with me, anyway!"

Gale enthused, "Good! I've heard you talk of no one else for so long. Now I'll meet her."

He watched through the glass panel as Stacie's switched on the locker in the phone booth and called his home. And as he watched, he saw the tanned, eager face suddenly change. The kindly, gray eyes became bleak and cold; the friendly mouth tightened into a thin, hard line. Then the square, trim shoulders sagged a little and a limp hand moved vaguely to cut the switch. When Stacie left the booth his step was unsteady, groping.

Gale leaped to his side, steadied him. Only mute, staring eyes answered his concerned query. He shook Stacie's shoulders gently. "Skipper! Snap out of it! What's happened?"

When Stacie spoke his voice rasped: "Gone! Sonya's gone! Maid says Sonya left a note saying she can't stand being married to a . . . to a visitor . . . any longer."

When he finally looked up, his narrowed eyes gleamed a little, and a queer twist to his lips exposed fine, even teeth in a mirthless smile.

Roughly, savagely he jerked out of Gale's grasp and started for the door. "Come on!" he snapped. "Let's go!"

Gale muttered, "Where?" apprehensively, and Stacie gritted, "Ganymede, you fool. Ganymede!"

Almost immediately he aded, "Sorry, Jim. I didn't mean that. I'm the fool!" But the grim, hurt look on his face never changed.

And it hadn't changed when he grated out two words, "Fall up!" and then locked himself in his compartment aboard the *Spacebird II*. That worried Gale, because skippers rarely allowed their second officers to "fall up" from the home port: officials watching critically, and all that sort of thing. Not that Gale or Leeds, the second pilot, weren't capable; it was just further proof of how badly Stacie had cracked.

Leeds noticed Gale's worried, preoccupied manner. Glancing up from a bank of comptometers where the multiple co-ordinates of space travel were handled by one man with an ease that would have put the unaided efforts of a hundred mathematicians to shame, he said, "You getting these figures as I . . . give—" His voice trailed off; it always did.

Gale nodded. The soft hum of the gravitubes, gigantic gravity negators that had rendered rocketry obsolete, made a soothing contrast to the disorder in his mind.

"O. K.," grumbled Leeds. "Lousy 'fall up,' though. I thought we'd never . . . make— Skipper still in . . . his—"

Gale locked the key bank, stood up, stretched. "Yeah," he yawned. "He hasn't unlocked the door, yet. Hope he snaps out of his funk. Damn! That newsflash from Ganymede's got me on edge, too. If there's trouble, we're riding right into it."

Leeds grunted and said, "No use worrying now . . . about— Say, by the way, who were those two that came aboard . . . just . . . as—"

Gale yawned again. "Mr. and Mrs. Stanton Moulene. Always somebody to hold you up at the last minute when you're late for schedule. She's beautiful, though! Him, I didn't like. Used perfume; jasmine, I think. Damn Stacie, anyhow! The officials'd raise hell if they knew— Oh, well, skip it!"

But Stacie had not yet appeared when, long after supper, Gale and Leeds sipped a nightcap at the end of the tiny salon bar. Most of the passengers had retired; a few remained.

The Honorable Gregory Gruthilde, recent appointee to Tellus City-state on Ganymede, continued an interminable harangue to a few chosen satellites and a bored barkeep about the political aspects of beautiful, frozen Ganymede. Frequent refuelings at the bar which held him up, kept him going. Across the salon, the glamorous television star, Renee Reene, having completed a successful season and three unsuccessful marriages, relaxed by crooning a love song to the wealthy playboy, Harvey Crasston. Her low, throaty voice did things to men; and began where her figure left off. Crasston was a rare opportunity. And Renee was an opportunist!

Leeds summed it up in a whisper. "He's a goner, if I ever . . . saw—"

"Who?" Gale was becoming more worried about Stacie.

"Crasston. He's hanging on the ropes now, groggy . . . as . . . a— And slant his missis over there playing . . . bridge . . . with— Huh! She's just trumped her . . . partner's . . . and is . . . she"—Leeds clucked his tongue —"and how!"

Gale looked in the direction of Leeds' bobbing thumb. Mrs. Crasston was indeed proving an impossible bridge partner in one of the two games in progress. Leeds' peculiar unfinished style really left little to the imagination. She was wild with rage.

Gale noted the bent cards, and her angry partner; and he smiled at the annoyed faces of their precious partners who saw a speedy close to this lucrative game. At the other table, four engineers not yet sober from a month's vacation

on Earth played a silent, though ponderous and inaccurate game.

But now, the tension at the neighboring table, the vicious flip of cards, and the occasional muttered imprecations struck harmonics in their blurred minds. Their voices rose belligerently when bidding, and suspicious glares accompanied each card played. Like a disease the fury of one woman spread through the room. Honorable Gregory pounded the bar. His friends in stanch unanimity glared threateningly at the smooth pate of the rotund bartender, as if seeking an answer which would excuse slapping that smoothness.

Then Crasston lit a psychological fuse! Oblivious to the presence of others, he crushed the singer's pale hands to his lips!

Leeds chuckled and whispered: "Here comes . . . the—"

And he was right! Mrs. Crasston, her nostrils flaring, her face dead white, tipped the card table into the spangled paunch of her partner, as she jerked angrily to her feet.

"You—" she choked. "You . . . you . . . oh-h!"

Instantly, the four engineers lurched erect and glared at each other; they had been spoiling for just this. And across the room a battery of glares were momentarily diverted and a harassed barkeep performed a *coup d'état* by brandishing a bottle in either hand; at which, Honorable Gregory and party ducked below the protecting edge of the bar. Crasston opened his mouth, but no sound came out.

And Gale, not too pleased with the way things were going, saw the door directly opposite open slowly—very slowly.

"Stacie!" he breathed.

Mrs. Crasston could not see the door but she sensed the moment was a psychological gem. Drawing herself up to a magnificent five-foot-one she swished around for her dramatic exit—and stopped stockstill.

Seconds ticked by as Stacie took that first step into the salon; more interminable seconds—a second step!

"Poinaud!" The bartender whispered hoarsely, and he did not notice that the contents of one inverted bottle held aloft had run down his sleeve.

Now, *poinaud* is a wine pressed from the *Poine Audutti* berries native to Mars. It is most delicious and soothing to the nerves, being only mildly intoxicating. But when taken in large quantities it cumulatively destroys the time sense, both mentally and physically. It either slows all mental and physical processes and activities down, or speeds them up progressively as more wine is consumed.

And neither condition is always stable. The transition from unbelievable slowness to almost invisible speed can be instantaneous and unpredictable, although either condition *may* endure without change.

To make things merrier, strange psychological disturbances identify themselves with, and invariably accompany each condition. Slowness is accompanied by a vast feeling of inferiority and an unconquerable urge to attempt anything. Failure invariably results. Speed is accompanied by a feeling of great superiority, an egomania that will stop at nothing. All human feeling and conscience disappear; a sense of power, godlike, immortal, takes their place.

When drinking *poinaud* a man should be with others so that movements around him, extraneous to himself, will warn him when to stop by their apparent increase or decrease in relative speed. Stacie was not interested in this angle when he drank alone in his compartment.

Gale looked at Leeds and nodded significantly, and together they moved around the end of the bar toward Stacie.

No one else moved. They all knew what could happen if Stacie ever reached the controls or decided to use the Zeeray tube at his hip, and their thoughts weren't pleasant.

Suddenly Gale clipped, "Now! Get him!" to Leeds, and as one, they leaped upon the drugged man. Gale's powerful arms wrapped around Stacie, pinioning his arms to his sides. "My belt," he grunted. "Fasten his wrists with it. Tie his ankles with yours. Snap it up! The phase might change to fast any minute!"

Leeds moved at feverish speed, even using Stacie's own belt on his elbows. He had hardly caught the last buckle tongue when Stacie metamorphosed from an impossibility of infinite lethargy into a threshing, heaving demon whose motions blended into each other in a blur of blinding speed. So fast did he move that his form became indistinct, like a plucked guitar string. If it hadn't been for his bonds, Gale and Leeds together couldn't have held him. As it was, the three fell to the floor, a whirling mass of flying arms and legs. But it wasn't until the four engineers entered the fray that they finally pinned Stacie down; his face a mask of raging fury, and unintelligible sound pouring as gibberish from his flecked lips.

"Sorry, Stacie," said Gale, and swung a hard fist at a blur that instantly became a motionless jaw.

They lashed Stacie safely in his bunk.

"Think he'll be O. K.—until—" fumbled Leeds, yawning.

"Yeah," said Gale. "Go ahead, turn in."

When Gale re-entered the salon there was only Honorable Gregory standing at the bar earnestly listening to a serious-faced bartender recount anecdotes about *poinaud*. A half-emptied bottle prophesied a long session. The others had retired; the Crasstons, arm in arm. Gale quietly slipped away, too. A little sleep would help.

IN THE MORNING, Gale admitted to Stacie that he was ready to be placed in irons. "Mutiny is punishable by death, skipper," he said, "and what else would you call smacking the captain?"

"Thanks, Jim," said Stacie. "I might have raised a little hell if you hadn't." He flexed his arms a few times and felt gingerly of his jaw. "Some smack!"

"Breakfast in here?" smiled Gale.

Stacie grinned. "No, I'll face the mob."

Breakfast was well under way when they entered the salon. Gale noticed the Moulenes sitting opposite the captain's place and that the Crasstons managed their eating problem very, very nicely, considering they were holding hands under the table. When he looked toward Honorable Gregory, he nearly laughed aloud.

"Get a load of the Honorable Peepers," he nudged.

Stacie followed his glance. Apparently Honorable Gregory's repertoire of anecdotes had been overstuffed. Even two hours' sleep would have improved the appearance of his eyes.

Stacie smiled broadly. "Yeah," he said. "They look like a pair of twin beds that have been well slept in—even the purple footboards looked wrinkled." He weaved a little unsteadily in the glow of a mild hangover—the glow had a bump in it. Honorable Gregory smiled back, making the patchwork coverlets wrinkle a little more.

Then Mrs. Moulene looked up from here breakfast—and blanched!

"Glenn!" Her jaw, suddenly gone limp, formed the soundless word. Quickly, birdlike, her frightened eyes darted left and right as if seeking escape. There was none. With a shuddering sigh, she slumped, burying her face in her napkin.

Stacie drew back his chair to be seated.

Stan Moulene, hearing the sigh,

turned slightly. "Sonya, dear," he murmured, "what is—"

Stacie sat down like a man whose legs had suddenly lost their strength. "Sonya?" he breathed, incredulous.

Moulene jerked around, visibly shaken.

"Stacie!" he gasped. "We thought . . . Captain Halstead—"

Stacie moved a finger vaguely toward the door.

"Get out!" The words were clipped, incisive.

"But—"

Stacie turned his head; and slitted, gray eyes fastened on the heavy face before him. There was a bleakness in them that Gale had seen before. There was torture and pain behind that look —and glittering ice!

Moulene reeled as if he had been slapped. Even his cheeks reddened under that psychic impact. He had looked at death, and he knew it. And there was more than a hint of panic in his manner as he stumbled from the room. Only the odor of jasmine remained.

Sonya looked up. "Oh, Glenn, I—" She stopped. Words were puny things without meaning now. But her soft, frightened eyes were pleading pools of penitent blackness—the universal language of fawns, and dogs, and helpless things.

Silence hung in the air, like a pall—until Renee Reene sniffed! It was only a small sniff, but there was disdain in it. And it exploded the pall! A foot shuffled. Some one breathed audibly.

Stacie closed his eyes, as if closing them would help him to think. After a moment he opened them. More, much more than the bleakness was gone. Sonya shuddered, and rose haltingly to her feet, looked around without seeing, and sat down. A universal language became tinged with despair.

Honorable Gregory coughed a little "Ahem!" and noisily tiptoed out. The rest followed, abashed that they had stayed to stare. Stacie was the last to leave, and *he* groped till he found the door.

Sonya remained, small, huddled, dry-eyed—alone.

AN HOUR later, the stewart addressed the still, pathetic figure for the third time. He had made up the spare compartment for her and was still trying to induce her to go to it. He had tried everything. Thus far she had made no answer. Now as he spoke, a hopeful note crept into his sympathetic voice.

"—so won't you come and see?" he pleaded. "I have brought flowers—from the refrigerator."

After a moment she stirred, Murmuring softly. "I must have been blind—crazy blind, not to see; to hurt him like this. After all, what if I was lonesome, I— Where is he?" She looked up, suddenly alert, tense. "Take me to him! Please! I must see him—"

The steward mumbled something about "orders," then added, brightening. "But the flowers are so awful purty. They're chrysanth—ulp—chrys-s —they're beautiful, mum."

Suddenly the tenseness was gone. She smiled, understanding, and rose, charming, wistful. "I'm sure I'll love them," she said.

Jim Gale slipped quietly into the salon as they left. He had been about to enter when the steward had first spoken, and had waited. Now he stepped to the bar and for a few long minutes stared vacantly at the twinkling array on the backbar. The salon was deserted; the bartender away somewhere. But Gale didn't want a drink, he just wanted a moment of quiet in which to think, before going to Stacie's compartment.

He had disturbing news. News which required a clear head. And he hesitated for fear of how he would find Captain

Stacie. If Stacie had started again on the *poinaud*—well, a serious situation would be made worse. If not—Gale shrugged—there was still the question of emotional balance. Would Stacie be able to submerge himself in this emergency? He had been hit awfully hard. To him there was only one woman; there never had been, nor could there ever be, another. Stacie was like that; loyal, kind, generous; and betrayal had knocked the props out from under everything in which he believed.

Still, Stacie was captain, and, until direct evidence showed him incapable, Gale must abide by his decisions.

Gale started for the door to the sleeping compartments. A typewritten sheet, another newsflash, fluttered in his hand. They typed words, like brands, burned deep in his brain.

Like the beating of a knell they hammered against his skull:

Strange ship over Ganymede hostile. Evacuate Earth cities at once before companion ship arrives. Invader employs disintegrator ray, tractor beam, and radio controlled projectives of Thermite Compound. Man's weapons and defense absolutely useless. Advise suicide ram. Gaynmede will be lifeless in an hour. Thermite fires everywhere. Glassite dome over city gone. Air gone, except in some buildings. Disintegrator ray cutting wide swaths around us now. Here it comes at us. Wait. Jovian ship trying for a suicide ram. He's making it. Ram him. Damn him. Ram him. Damn—

That was the way it ended. The message that stopped!

Gale stopped, too!

In fact he was whirled off his feet when the door he reached for slammed open before his startled eyes. The figure of a man moving at blinding speed swept into the room and out into the corridor leading to the control room, all in one amazing instant.

He was gone before Gale hit the floor. Yes, even before recognition took place. But not before the fleeting impression which identified him. Even as Gale left the floor his nose sent a message to his brain, where it exploded "Jasmine!"

"Well, I'll be—" sputtered Gale, dazed. "Moulene!" Then suddenly realizing where Stan Moulene had gone, he sprang to his feet and raced frantically in the same direction. The typewritten sheet fluttered forgotten to the floor.

As his feet pounded their song of haste on the metal floor of the connecting corridor, his mind seethed around the picture of Mouline, steeped in *poinaud*, at the controls of this mighty metal ball, the power of the gods at his fingertips, not knowing what he was doing. It wasn't like the old anti-gravity screens which built up velocity slowly. With negative gravity, Moulene could slam the *Spacebird II* around in the vastness of space, like a tennis ball in a tournament! Punching those keys would be like punching percussion caps on high explosive.

DESPERATELY he flung forward. For the moment, he had no idea what he would do when he reached the control room, but, with a veritable madman at the controls, he had but little choice. Something had to be done, and quickly, too. Savagely he jerked open the control room door and almost stumbled over a still figure on the floor. Across the room a blur moved from port to port and back to the control panel. Each time it passed the panel the ship shuddered and creaked as it bounded on a new course.

"Oh, God!" he gasped hoarsely. "The gravitators will never stand this!"

As he struggled to regain his balance he could see by the blurred sweep of the stars across the observation ports that maintenance of internal gravity

was approaching the limit, even including the safety factor. If the gravitators ever let go now every living thing on board would be splashed against these unyielding metal walls, like insects on a windshield.

"Moulene, you fool!" he gritted, plowing headlong toward the controls. "Get away from there, or you'll kill us all."

The only answer was a shrill, rasping stream of sound. Moulene spoke in high excitement, but the extreme rapidity of his speech rendered the words unintelligible. But there was no question, however, about their import, or his attitude. From out of nowhere, his fist, moving with invisible speed, crunched with bone-crushing force against Gale's jaw.

The last thing Gale heard, as brilliant bubbles of coruscating color burst amid the crashing roar of a thousand waterfalls in his quivering brain, was a high pitched scream of pain from Mouline. One hand, momentarily motionless, was a flabby mass of shattered bone and bleeding flesh. Moulene had not yet learned to handle his terrific speed.

Gale's jaw twisted to a strange, unnatural angle, and broken teeth spilled with bloody saliva from his torn, crushed lips. But he didn't know about that. Gale was out! His body, flung violently backward by the tremendous impact, was limp, flaccid, when it struck the floor and rolled against the faintly breathing, battered form of Leeds over which he had stumbled coming in.

Gale never knew how long he was unconscious. He certainly couldn't know that Sonya re-entered the salon shortly after he left, picked up the message, and read its epitaphic content. It was only after it was all over that he guessed at what must have transpired while he lay in oblivion.

THAT she went directly to Stacie with it, seems likely. But only she knows what a time she must have had getting him to the control room. At any rate,

Gale was painfully trying to force his aching body erect when she kicked open the door and shoved a dripping, bedraggled figure into the room. Stacie toppled to the floor, like a falling statue. Even an enforced drubbing under a cold shower and a continuous pummelling along the entire way had failed to undo what a broken spirit had acquired seeking solace in *poinaud*. If he moved after he landed, it was so slowly as to be barely perceptible. But Sonya, seeing Gale's face, went to him.

"Whatever—" she started, then, sniffing the air, looked around. "Stan! Mr. Gale, where is he? What has he done?"

Gale gurgled in bloody agony, looked at Stacie and shook his head. No help there. He turned to Leeds who was mumbling dazedly and shook him.

Leeds blinked dully and looked around with vague focus. "What the hell hit—" he muttered thickly and wearily closed his eyes.

Then Sonya saw the blur. "Stan!" she gasped. "Stop it! Are you crazy? You'll wreck—"

Before she could move, the streak that was Moulene flicked across the room, kissed her lightly on her pale cheek, and was back at the controls. Sonya flushed crimson and wheeled angrily to the gaping Stacie, fumbled for the Zeeray tube at his hip, and in a moment had it pointed toward her erstwhile companion. There was something deadly in the determined litheness of her, like a pantheress when its mate is injured. Partly crouched, tense, alert, she addressed Moulene through tight lips.

"Get away from those controls, or I'll—"

A bubbling stream of incoherency interrupted, and simultaneously the tube was slapped from her hand and a supergeared kiss planted this time full on her lips. Sonya drew the back of her hand across her mouth as though she had tasted something vile.

With an oath that mushed through mashed lips and gore, Gale retrieved the fallen weapon. Quickly levelling it at the darting flicker, he depressed the firing clip. As the invisible, lethal proton stream poured from the lensed muzzle, he swept it right and left with feverish, vicious jerks, hoping if by merest chance to touch it to that meteoritic maniac and finish this madness.

But swift and savage as his thrusts were, they were far too slow to catch Moulene. There came a scratching roar of sound that might have been a derisive laugh if it were slower, and the blur streaked across the room to whip the tube from his hand with absurd ease. In an instant, the situation was reversed! The gaping muzzle pointed directly at Gale's breast! Sonya clapped her hand to her mouth in stunned horror—and screamed!

If that scream, which pierced with nerve-searing sharpness to every corner of the ship, had been a signal for Fate to intervene, it could not have been better timed. The kaleidoscope of events turned a fraction and a new pattern clicked into place!

Moulene's thumb, already touching the clip, lost its godlike speed. The inexplicable phenomenon of *poinaud* became manifest in unutterable slowness!

It would take seconds to depress that clip now!

With that awful scream still ringing in his ears, Gale swung his fist in a long arc to Moulene's jaw. All the weight of his hard, compact body and a seething, mounting hatred for this man were behind that blow, and Moulene fell like a pole-axed steer.

At the same time that Gale's fist cracked home, the door behind him thudded closed in its gasketed frame.

"Escaping air!" he thought, thanking the designers of the *Spacebird II* for the smooth functioning of the pressure equalizers.

Sonya looked "What happened?" at him, and he gurgled what he intended as "The Invader!" as he leaped to the controls.

Grim, haggard lines cragged his smeared face as he stared through the observation ports. His fingers flying with deft sureness over the control keyboard, under this stress, caused the great ship to revolve with dizzy speed as he sought to bring the stranger into view before him.

SUDDENLY it was there, swimming in the framed picture of star-studded space presented by the center port; a stranger, indeed! Like a great spoked wheel with a nubbed circumference shimmering in a halo of some strange radiation, if revolved through space around a huge spherical hub fully as large as the *Spacebird II*.

Sonya knelt for a moment at Stacie's side. He had got one knee under him in an interminable effort to rise. Almost frantically she slapped his face and pleaded, crying for him to snap out of it and do something. It was useless. She moved to Gale who was throwing the ship around even more violently than Moulene had done. There was despair in his eyes, hopeless despair.

"That light," she breathed. "That pale, blue light—there, stabbing at us from the hub. Is . . . is that—"

Gale nodded.

"It touched us once," Sonya said. "It must have disintegrated part of the hull—the door closed—kept in the air—"

The ray flicked nearer. His fingers jabbed frantically over the keyboard. The *Spacebird II* leaped wildly to one side, taxing the gravitators to their utmost. Then down in a wild plunging dive ending in a spinning, turning leap upward; up a thousand miles, like a Gargantuan bounce of a gigantic ball.

Always the Invader stabbing with the blue forefinger of death; always the nerve-racking jitter of fingers finding the correct combination of keys; always the ray—just missing!

Then the Invader tired of the game. The blue beam winked out!

"Now what?" Sonya murmured.

Gale, intent on the keyboard, did not answer. With that light out, they had a chance. Swiftly taking the advantage, he slammed past the alien Invader at maximum acceleration which drew a grinding whine of protest from the gravitators. But the advantage was short lived. Gale may have proved more capable of evading the disintegrating ray than most pilots, but the Invader was not through by far.

Pale-green radiance suddenly glowed around the nubs in the circumference of the strange wheellike craft. Brighter and brighter they grew until they seemed like eight malevolent green suns radiating an alien hatred against a background of gem-studded black velvet. As the weird coruscations lanced out, the plunging *Spacebird II* shuddered as if undecided whether to go on or stop. Slowly the speedometer hesitated, then retreated with reluctant, halting jerks.

Gale pointed to the needle.

"Tractor beam?" asked Sonya.

Gale nodded wearily. Savagely he stabbed the keys. Like an untamed thing the ship twisted and turned and spun. Without avail! Threshing, leaping, tossing—a tethered tarpon of space, fighting viciously for freedom—a darting, prancing demon denying each bitter inch of the way.

Slowly, inexorably, it was drawn closer. There was no respite from that awful drag.

GALE SET the controls at maximum power against the drag of the tractor beam and turned away. There was a noticeable slump to his shoulders. Infinite despair cried out from the harassed spirit behind lowered eyes.

"Weapons no good against them?"

asked Sonya. But she did not need the shake of Gale's head to remind her of the newsflash which had told of even better weapons as impotent as toys. "Oh, well," she shrugged. "The end can't come too quickly for me. My life's a mess anyway."

A sudden movement, out of the corner of her eye, made her whirl around.

"Stan!" she gasped.

Lying prone, resting on his elbows, Moulene held the Zeeray tube steady on the pair at the control keyboard. Behind him, Stacie stood motionless, his features leering vacantly, as an expression of surprise changed to another not yet indicated.

"Nice sentiment," nodded Moulene. "I'm kinda fed up, too. But before they get us, I'm going to have my little joke. We came aboard this thing together and we'll go out together! But first, I'm going to blast a couple of guys I don't like." The tube moved a trifle and covered Gale. "You first!"

Gale did not wait. He dove headlong at Moulene and screamed in midair as a proton blast paralyzed his shoulder in glancing contact.

Then he landed heavily—*where Moulene should have been!*

And would have been, too, but, even as he screamed, another cry merged with his. "Moule—e-ene-e—!" it started, but ended in a high babble of unintelligible gibberish, as Stacie metamorphosed into the high gear of unpredictable *poinaud*. Almost simultaneously with the cry, Moulene seemed to disappeared with unbelievable velocity as Stacie heaved him from the floor and slammed him head on into the unyielding metal wall of the room.

Sonya should have felt sick at the sight. For a man splashes at that speed when he hits a stationary object. But there wasn't time! Her eyes had not completed a blink when she felt herself whirled off her feet and, in one dizzy instant, eased into a spacesuit from a locker which seemed to leap open of itself. Then she fainted.

Gale, bounding to his feet almost as soon as he hit the floor, saw the emergency airlock, with which every outside room on the ship was equipped, open, and two blurred forms clothed in spacesuits enter. The door closed. Almost at once, it opened and a nebulous Stacie flicked back into the room. The inert form of Leeds was next to be clothed in a spacesuit.

Gale ran to the observation port. They were facing the Invader and picking up velocity every second. Then it dawned on him what Stacie was doing. But the air lock was facing directly into that tractor beam. If Stacie ejected them from this position they would still be drawn to the giant wheel. Instantly he moved his hands toward the controls. But they had barely started when he felt himself brushed violently aside.

FOR ONLY a fraction of a second was Stacie visible as he touched the keys. Gale got one glimpse of stars streaking across the observation ports, and then in the rear-vision screen the Invader sprang into view and stayed there. Almost in the same clock-tick his senses reeled with the rush of breath from his lungs as Stacie whipped him from his feet, over to the locker, into a spacesuit, and into the air lock with the others.

Stacie, visible only because he remained in one place long enough to be seen, manpulated the outer lock. At once, their suits bloated, he shoved them outward with all his strength, motioning them away under full acceleration from the tiny gravi-units each suit carried, and in line with the neutral-drag area on this side of the *Spacebird II* away from the Invader.

Gale grabbed the still unconscious Leeds and led the way. But Sonya did not follow. She slipped back through the closing lock to stay with Stacie. Gale

did not try to stop her. From now on, he would be a spectator, and with the agonizing pounding in his crushed face and the crackling pain-darts in his shoulders he cared little what anyone did. Stacie had taken over.

As the distance between him and the doomed *Spacebird II* widened, he saw the great gaping hole in the metal hide where the blue ray had first touched, and from its size he wondered if there would be any other survivors.

In a moment, he knew. Slowly the *Spacebird II* revolved, and emergency locks opened as they came opposite to the Invader. Twenty bloated spacesuits darted toward him before the ship stopped its revolution. Gale flicked on his communicator. Almost at once he learned that the Crasston-Reene triangle was intact and that several of Honorable Gregory's party survived. But from that worthy there was no response. He and two of the engineers were somewhere, bloated without spacesuits. Gale switched off the excited babble and turned his attention to the ship which again faced as it had when he left. Apparently, Stacie was waiting for the last of the twenty to clear before he left, himself.

Then the lock opened, and for a moment Gale could see two figures, alternatively gesticulating and struggling, framed in the opening. It appeared that Stacie wanted Sonya to leave and that she was insisting upon remaining. Finally Stacie gave her a tremendous heave, and, before she could re-enter, slammed the lock closed. An instant later, the *Spacebird II* leaped ahead like a stag at the sound of a shot.

There was more than full acceleration to that lunge. Under the combined forces of acceleration and tractor drag, the gallant ship became little more than a silver streak.

Gale's crushed lips pressed apprehensively together tighter and tighter while tears furrowed the dried blood on his cheeks, as he thought of Stacie savagely slamming the controls full forward; probably insanely cursing the Invader, and shaking a futile fist in the rear vision screen. If the *poinaud* ever failed him now— And even if it didn't fail—

Grimly he watched as panic invaded the Invader. Almost frantically the green, tractor emanations winked out, and the wheel commenced a jerky revolution as its pilot tried to dodge the awesome projectile hurtling out of the blackness.

GALE thrilled! Thrilled to the tickling chill of an appreciation of glory—the glory that was Stacie's, riding a bullet to hell!

Then, abruptly, the port opened and a tiny figure leaped prodigiously into the void. From Gale's vantage point it appeared to remain too close to the open lock. For an interminable split second he hung emotionally and mentally over the pit of black apprehension. Then the tiny figure veered off to the side in a long, wide arc. And another figure, far behind, turned and made off after the first. Sonya would be there at the finish, regardless of what it might be.

Slowly the gap between the ship and Stacie widened until Gale knew he would make it. Then Gale really thrilled! Pounding blood beat a pæan of triumph that made his ears ring! He couldn't speak, but he could yell!

So he yelled!

Again and again he yelled. And the words that screamed in his brain had been seared there peramanently!

"Ram him!" they screamed. *"Ram him! Damn him! Ram him!"* Over and over, louder and louder, while the distance between the two ships grew less and less until it ceased to exist. And—

c-r-a-s-h-h-h!

Soundless in the void of space, the impact could not be heard, but Gale saw it; saw the proud *Spacebird II,* great splits in its crushed hide, ricochet away

into the vastness of space after smashing through the circumference of the giant wheel.

The blinding, pluming explosion which obliterated the Invader occurred bare seconds after the impact.

First, jagged sparks of unbelievable voltage leaped the gap in the circumference, Thermite bombs, fused under the tremendous heat of that arc, spewed white-hot incandescence from the redly glowing hub. At the same time, the nubs, all awry, bloomed brightly green and unfocused tractor beams pulled and twisted, collapsed the wheel around the hub, like a spidery, green shroud.

Then it burst, soundlessly in the void, a mushroom of white and green fire. And even as it burst, a blue haze generated in its center, spread outward over the wreckage. And everywhere it touched there was—*nothing!*

Three hours later, a shocked, silent group sat in the dingy salon on *Pluto's* lines, listening after a fashion to a *Bride,* a frowzy ancient of the freight colorful, profane account of the rescue, and the newscasts. The other Invader, too, had been rammed. Captain MacCullough did not seem to realize that three times he had repeated the story of receiving the S O S from "Sparks" and arriving just as the heating units in the spacesuits started to give out. Nor did he realize that each time he made himself just a little more heroic than the last. He was aware of only one listener—and Renee Reene's adoring eyes.

In another part of the ship, Gale smiled through voluminous swaths of bandage at Stacie, lashed in his bunk, trying to smile at Sonya who sat at his side. For ten minutes his expression had been changing, but as yet it had not arrived.

"THERE AIN'T NO SUCH!"

In which old Dame Nature makes science-fictioneers look like a bunch of suckers! An article of absolute fact about animals so completely haywire not even an author of fiction would try to make them believable.

By L. Sprague de Camp

Illustrated by Hatcher

If I were going to have a concession at a world's fair, I couldn't think of a better money-maker than a zoo peopled by some of the odder animals that have appeared in science-fiction. That would ***be*** something. I can imagine myself:

"This way, ladies and gentlemen. This menacing monster, captured on Venus at great risk, snares his prey by shooting out his tongue to a distance of forty feet. This thing that looks like a winged cucumber is really quite intelligent. Bosco, extract some square roots to show the people how intelligent you are. No, no, that's long division you're doing. *This* creature subsists entirely on a diet of phosphorus; this one, on borax. Over here, my friends, is a man-eating plant. We feed it fifty pounds of hamburger a day, mixed with chopped hard-boiled egg. And this blue fellow, with all the legs, secretes the deadliest poison in—" No, poor Mr. Buck wouldn't have a look-in.

But before we regret that the Earth hasn't anything to offer so bizarre as these creatures of our writers' imaginations, it might pay to look at our own terrestrial animal kingdom. We may find to our surprise that actually our authors aren't as imaginative as we might think. Right here on Earth are plenty of living creatures which in form and habits are quite as remarkable as the fictional inhabitants of other planets and solar systems. Nor, when we stop to think about it for a minute, should this state of affairs surprise us. After all, the average man has direct conscious contact with only a few—well, maybe a few hundred, if he's given to zoos and museums—of the hundreds of thousands of different species that live here. He naturally judges the rest of the animal kingdom by these. But, with so many species in existence, it is not surprising that many of them differ most radically from the limited, average man's eye-view of what is normal.

Furthermore, the things that we consider freaks are freaks only because we aren't used to them. A vertebrate with three functional eyes would be a freak. But if all vertebrates had three eyes—as some Permian reptiles did—there wouldn't be anything odd about it. And, if nobody had ever seen an elephant, a live elephant would be strange enough to satisfy any right-thinking connoiseur of the bizarre.

Then why doesn't somebody set up a zoo of these terrestrial freaks? Well, some are small—often too small to be seen with the naked eye. Some live in environments difficult to reproduce, such as the deep sea. And with some, their oddity lies in their method of growth, or their food, or in some other

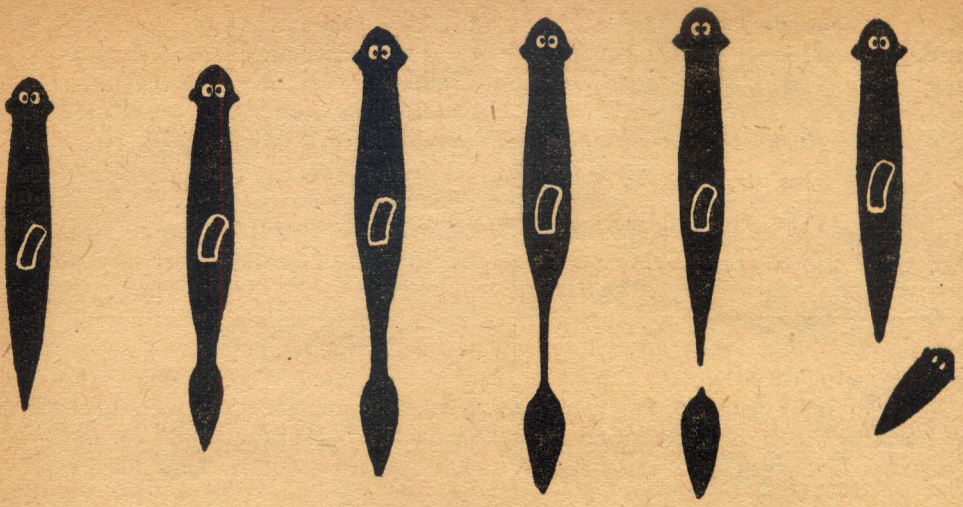


Fig. 1. One form of reproduction in a planarian worm (they always look cross-eyed): The hinder portion of the body grips the bottom while the rest of the worm continues trying to crawl forward; after several hours the body narrows and breaks in two. The right-hand picture shows the hind end developing into a new Planaria; this process of course takes much more time than is implied by its position in the picture.

factor that would not make them a good exhibit. Sometimes their peculiarities require a certain degree of sophistication in biological matters to be appreciated.

For instance, the average man, if told that a mussel from the Great Lakes makes its shell of the salts of the rare metal strontium, instead of the calcium that any self-respecting mollusk uses, is apt to respond with a deflating "So what?" But one who really knows a little about biology and chemistry will sit up with a "No kidding?" or "I say, not really?" or *"Doch? Merkwürdig!"*

But let's quit philosophizing and get down to the actual members of our freaks' club. I think the most practical way of discussing them is to classify them according to their life-activities; in other words, to consider first how they are born, how they grow, and so on.

WE'RE familiar enough with live birth and egg-laying, and practically all of us know about the fission practiced by the ameba and other protozoans. Some of us may be inclined to think of vaviparity —the first method named—as a prerogative of the mammals only. But it is widely distributed throughout the animal kingdom. It occurs in a number of snakes, notably the pit-vipers, the family that includes the rattlesnakes and the bushmaster. It is found in a number of fish, such as the blue shark, and even occurs in insects: the tsetse fly. Outside of the mammals, however, it is really an extra-early hatching of a more or less normal egg, as the cold-blooded vertebrates and the invertebrates are not equipped with the elaborate mammalian apparatus to enable the embryo to derive nourishment directly from its mother right up to the time of its birth.

Among the animals that practice fission, some introduce novel wrinkles into an otherwise straightforward method. With some planarian worms, the hind end periodically grips the bottom while the front end keeps on trying to crawl forward. After several hours of this tug-of-war, the body narrows in the mid-

dle and eventually breaks apart. Both parts of the worm regenerate the missing organs and become whole new worms. (Fig. 1.)

Planarias, while unimpressive little things, are favorites with biologists. They are the most primitive organisms with definite head, front and rear end, right and left sides, and top and bottom. They also have extraordinary powers of regeneration; a planaria cut into several pieces will grow into as many new planaria as there are pieces. Most of us have probably never seen a planaria in the flesh, but they are easy enough to find if you know where to look for them; on dead leaves and pieces of water-logged wood at the bottoms of streams and lakes; sluggish flat brown fellows half an inch long. They actually have the cross-eyed look shown in the illustration.

Among some sea-anemones, the process of fission has an almost accidental aspect: As they crawl over the rocks, pieces catch on the sharp corners and are torn off. The pieces then grow up to be adult sea-anemones.

There is a huge variation in the ratio of the size of a new-born animal and its parent, even in such a restricted group as the mammals. The new-born cub of a 1,500-pound grizzly bear is about the size of a bullfrog—which it somewhat resembles; a new-born kangaroo is no bigger than your finger. On the other hand a new whale calf may be half the length of its mother. In the case of the kangaroo, since these marsupials lack the plancenta of the "higher" mammals, the infant is not really complete, and the earlier part of its stay in the female's pouch is a kind of halfway stage between gestation and indepedent existence.

We are familiar with the process of growth in men and grasshoppers, in which the offspring is much like its parent. We also know about the radical change from tadpole to frog and from caterpillar to butterfly. At least, we think of these latter as radical changes.

But wait a minute: for screwy growth-processes, how about the nemerteans or proboscis-worms? These are smallish aquatic worms, mostly living along seashores. A nemertean starts life as a thing called a helmet-larva, so called because it looks something like a sixteenth-century tilting-helm, or perhaps like a miniature fire hydrant. This larva, which is fixed to one spot, has an intestine, like most animals of its degree of complexity. Well, in due time, the intestine grows itself a set of organs, breaks out of the larva, and swims away. This runaway gut is the adult worm! The larva continues to live for a little while after its intestine has fled. If helmet-larva could sing, they would no doubt sing something meaning: "Bring back, bring back, oh bring back my digestive mechanism to me!"

But for really spectacular life-cycles, we have to go to the flukes, which are harmful parasitic relatives of the harmless planarias. Take the sheep liver-fluke, *Fasciola hepatica*. An adult Fasciola is a hermaphroditic flatworm an inch or more in length. It lays enormous numbers of microscopic eggs, which pass down the sheep's bile-duct and out its intestine. The eggs hatch out as active little things less than 1/200 of an inch long, just about visible, with two eyes but no mouth or intestine.

One of these is called a *miracidium*. It swims about in puddles and dew-films by means of cilia until it finds a pond-snail. If it doesn't find a snail in eight hours, it dies. If it does, it bores into the snail's body and changes into another form, a sausage-shaped bag called a *sporocyst*. It remains in this condition, feeding on the snail's blood, for some weeks; then it gives birth to a number of embryos and dies. The embryos develop into tiny worms 1/25 of an inch long, called *rediae*. These reproduce their own kind for a while, giving rise

to several generations over a period of months.

Eventually, the rediae give rise to a generation of another kind of animal, a still smaller tadpolelike creature called a *cercaria*. The cercariae break out of the snail's body and crawl up on grass stems, where they wall themselves up in hard capsules. When a sheep eats the grass, it obligingly digests away the capsules, freeing the cercariae, which crawl up the sheep's bile-duct into its liver and grow up into adult flukes. After about six weeks from the time of their arrival the flukes are ready to start laying eggs, and the whole cycle begins over again, the organism having passed through six distinct forms, if you count the eggs laid by the adult.

I have been unable to find a more striking simile to describe this process than that of Wells: "It is as if the offspring of men were mice, and the offspring of mice were men." He might, however, have suggested that the mice give birth to guppies, which in turn give birth to green parrots, which finally give birth to men.

One would think that any respectable parasite would find the change of scene involved in living on two different hosts alternately—as many parasites besides the liver-flukes do—enough for all practical purposes. But the Chinese liver-fluke *Clonorchis sinensis* goes Fasciola one better. It skips the miracidium stage, the eggs being eaten by snails and developing directly into sporocysts. When the cercaria stage appear, the organism attach themselves to fish, bore into their muscles, and encyst themselves. In this condition they wait for some unfortunate human being to eat the fish raw so that they can invade his liver. Thus they have three hosts: man, snail, and fish, in the order named. The disease, if you want to call it that, could probably be wiped out in short order if the millions of Asiatics who suffer from it were both willing and financially able to cook all their fish before eating it.

PEOPLE are usually classed as bilaterally symmetrical animals; meaning that a man has a right and left side, one of which is a mirror image of the other. Of course, this isn't exactly true; many of the internal organs, such as the heart and spleen, are set on one side or the other. And even in its external features the two sides differ; the right arm is usually a little longer and heavier than the left. But compare the development of a human being with that of a gastropod such as a pond-snail!

Here some of the organs on one side or the other, such as the gill or kidney, either fail to develop at all, or if they develop they degenerate and disappear. As a result, the gastropod's whole anatomy becomes twisted into the spiral or helical—actually it's a little of both—shape that is the trade-mark of the order. Some gastropods, such as garden slugs, have reverted to external bilateral symmetry. But, as organs once lost are seldom or never regained in the normal course of evolution, the organs that have disappeared have not been regained, so that these gastropods have only one gill and one kidney. That is one way that we know their symmetry to be a secondary development, like the fishlike form of whales.

But for a case of really unbalanced development we should go to the echinoderms: the starfish, sea-urchins, and sea-cucumbers. These animals share with the cœlenterates—hydras, jellyfish, coral-animals, and sea-anemones—the feature of radial symmetry; instead of having similar right and left sides, they have five or more similar sectors radiating out from the center. Naturally the earlier taxonomists put the echinoderms together with the cœlenterates—pronounced se*len*terits—in one subkingdom Radiata. But it is known that the two groups are far apart

in their ancestry; the echinoderms are, in fact, believed to be descended from bilaterally symmetrical animals more closely related to the ancestors of the vertebrates than to any of the other major groups.

A starfish begins life as a bilaterally symmetrical larva that swims by means of cilia. At one stage in its development it has four internal pockets called cœlomic—pronounced *selommik*—sacs. The left front one of these expands enormously and grows around in a circle from which five radial outgrows bud off. The larva's other organs either disappear or become completely reorganized along this pentagonal plan. To get a more drastic change in fundamental organization, it would be necessary to have a human baby grow up into an adult octopus.

The curious manner in which some animals grow is matched by the curious forms they grow into. However, here the fictioneer has an advantage over nature, for real animals have to obey the laws of physics, mechanics, and chemistry, which impose certain restrictions of form, proportion, and size. Still, old Earth can show some pretty weird organisms. For instance, there are a number of organisms, such as flies of the genera *Pelmatops, Achias,* and *Laglasia,* and shrimps of the genus *Eretmocaris,* whose eyes are on stalks as long as or longer than all the rest of the arthropod. The purpose of these stalks is not known. In the hammerhead shark we at least think we know the function of the lateral projections of his head, on whose ends his eyes are mounted: they serve as a pair of vertical bow rudders, to help him make quick turns.

For the queerest-looking animal derby, I'll enter just one contestant: the deep sea crustacean *Munnopsis* shown in Fig. 2. It has six long legs forward and six short ones aft. The six long ones are used to walk forward over the oozy bottom of the abyss, their length presumably being to spread the creature's weight on the treacherous surface. The six short ones are used to row the crustacean backward when it feels like swimming.

In imagining life on other planets, our authors have had to make allowances for the unearthly environments in which such life-forms would have to live. (At least, the more conscientious authors do. Others simply ignore the effect of environment, to the annoyance of their more literal-minded readers.) But the surface of the Earth presents quite a wide variety of environments, and there are few, indeed, except the insides of glaciers and volcanoes, in which life of some sort has not taken hold. Some of the homes that our earthly animals pick are difficult, at least from our point of view; some are downright hostile to life; and some are simply whimsical.

For instance, there is the little eel-shaped fish *Fierasfer,* which lives in sea-cucumbers; and *Apogonichthys,* the cardinal-fish of Florida, which lives in the mantle-cavity of a conch-shell. A crawfishlike crustacean makes its home in water-logged pieces of bamboo tubing that are carried down the rivers of southern Asia and settle on the floors of the Indian Ocean. Its chelae or pincers have been modified so that they can be used as a door to close the entrance to its little castle. But the quaintest of all is a nematode—roundworm—that is found in and *only* in felt beer-mug coasters.

For difficult environments, two extremes are represented by the algæ that live in hot springs—often coloring them beautifully, as in Yellowstone Park—at temperatures up to 175° F, and the Emperor Penguin, which lives on Antarctic ice-floes when it is not in the water. Since an ice-floe is about as unpromising a place as you can pick to look for nest-building material, the emperor incubates its single egg by holding it between its

feet and its belly. This seems at best like a precarious existence, but it is matched by the life of the insect *Halobates*, which runs around on the surface of the Atlantic Ocean, like our familiar fresh-water water-skaters. Only, Halobates does its skating in the Sargasso Sea, hundreds of miles from shore—and if it once gets wet, it dies.

There are even more egregious cases of adaptation to inhospitable environments: Parasites live on the skin of electric eels, apparently unaffected by the powerful discharges. A small shrimp-like crustacean, *Artemia*, lives in the briny waters of Great Salt Lake. A fly-maggot lives in the petroleum waste from California oil-well overflows. A mold lives in concentrated sulphuric acid. What it did before there *was* any concentrated sulphuric acid is not known.

Now let's look at the means that animals use to get around. We're all familiar with ordinary legs, wings, and fins, and also with the pseudopodal crawling of the ameboid protoza. Most of us have heard of the cilia, minute hair-like structures, with which non-ameboid protozoa jerk themselves through the water.

But some appendages are not quite what they seem. For instance, among birds, the puffins, their cousins the razor-bills, and the dippers use their wings both for flying and for swimming—or, one might say, they fly both in air and water. We see here the beginning of the evolution of the penguin's flippers, which have lost their ancestral feathers and become swimming organs pure and simple. The extinct great auk, a relative of the puffins, represented a halfway stage. The wings, with which it swam, were still feathered, but were much too small to fly with.

Some curious wings are exhibited by certain very small ichneumon flies—not true flies, but relatives of the ants, bees, and wasps—of the genera *Mymar* and *Alaptus*. These wings are used to fly, all right—but instead of being solid sheets of chitin, like normal insect wings, they are reduced to mere bristle-fringed

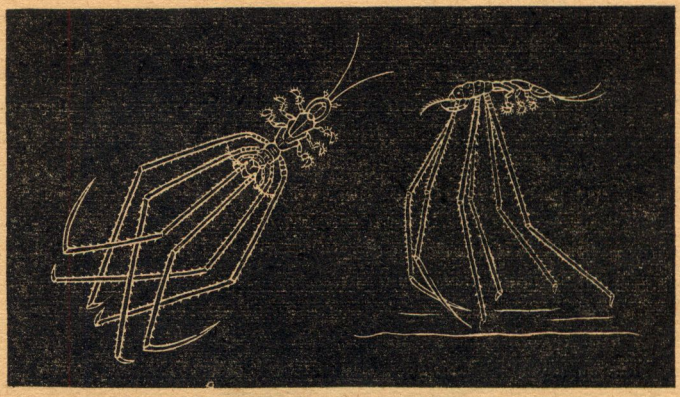
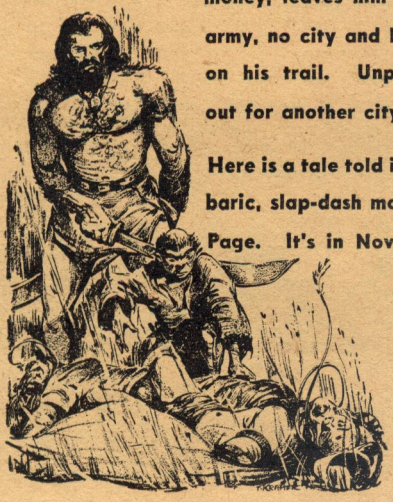


Fig. 2. The queerest-looking animal? If the deep-sea prawn Munnopsis isn't it, it's a strong contender for the honor. At right, Munnopsis is shown walking forward on the oozy bottom of the abyss, using its six long walking-legs. At left, Munnopsis swims backward with its six short swimming-legs, trailing its walking-legs behind it. The great length of walking limbs is required to spread the crustacean's weight on the soft surface.

SONS OF THE BEAR-GOD

Prester John, super he-man, the man who fears no one, conquers a city ruled by magicians who worship a giant bear as a god. He rides rough-shod over them, kills one of their divine bears, makes their slaves revolt and wins the city.

On the verge of complete success, a woman snags the works, takes his money, leaves him with no friends, no army, no city and half the country hot on his trail. Unperturbed, he starts out for another city to conquer.



Here is a tale told in a delightfully barbaric, slap-dash manner by Norvell W. Page. It's in November UNKNOWN.

UNKNOWN

20c A COPY

rods. Moreover, the bristles are a good deal more than their own diameters apart. The ability of these insects to fly at all with these little combs is explained by their size: they are only about half a millimeter, or 1/50 of an inch long, though they have all the complex organs of a normal insect. (They compare with the rest of the hexapods the way a ring watch compares with an alarm clock.) With such small mass to be lifted, almost any kind of appendage will do for a wing.

As size increases, the mass increases as the one-and-a-half power of the surface available—assuming the shape stays the same—so relatively larger, more efficient wings in the form of impermeable membranes become necessary. The same principle applies to swimming-organs; as size increases, cilia become hopelessly inefficient and are replaced by assorted fins and paddles.

For unusual fins, there is *Pterophryne,* the fringed sargassum fish, which looks as if it were dressed up to play François Villon in one of his more impecunious moments. The paired—pectoral and ventral—fins of the sargassum fish are prehensile, and with them it climbs slowly around the floating masses of weed in the Sargasso Sea, quite like the sluggish potto—a tailless lemur from West Africa—on land.

ALL of us, probably, have seen snakes and earthworms at one time or another, but I doubt whether we all have a clear idea of how they move. The motion of an earthworm is simple enough: The worm narrows and extends its front end; then expands it to fill its burrow. The end is anchored in place by a quadruple row of small backwardly-projecting bristles along the worm's under-surface. The hind end is now drawn up, and expanded in its turn, setting its bristles; the whole cycle is then repeated.

The motion of snakes is more complicated. When a snake is in no hurry, he can move along slowly with his body almost perfectly straight. He does this by moving his ribs back and forth in waves. The rear edges of the broad belly-scales, which are connected with the ribs, catch in the ground and propel him on his way. When he really wants to go somewhere, he sends a series of wide lateral sine-waves down his body. These outflung curves of the body are braced against irregularities in the ground. A little consideration of applied mechanics will show that, as the wave moves back on the snake, there is a backward component of the pressure of each section of the body against its irregularity, and an equal and opposite forward pressure of the ground—or grass, rocks, or what have you—on the snake, which sends him scooting forward.

An amusing illustration of this principle is furnished by placing a snake on a polished surface such as a glass table top. The snake makes frantic efforts to crawl by his sine-wave method; he goes through all the motions, but they get him nowhere. He just stays where he is and flutters like a flag in the breeze.

The hoop-snake, which has chased so many people's great-grandfathers, is a myth if there ever was one. The *Smithsonian* once put up a thousand-dollar reward for anybody who would produce one that actually hooped; that was thirty or more years ago, and the reward hasn't been claimed yet. But to compensate there are a couple of snakes whose mode of progression is almost as singular. The rubber boa *Charina bottae,* a small harmless blunt-tailed fellow from the Pacific coast, may when frightened, try to escape by tying himself into a tight ball and letting gravity roll him downhill. (Fig. 3.)

The really accomplished snake is the sidewinder or horned rattlesnake *Crotalus cerastes,* a small pale rattler, with

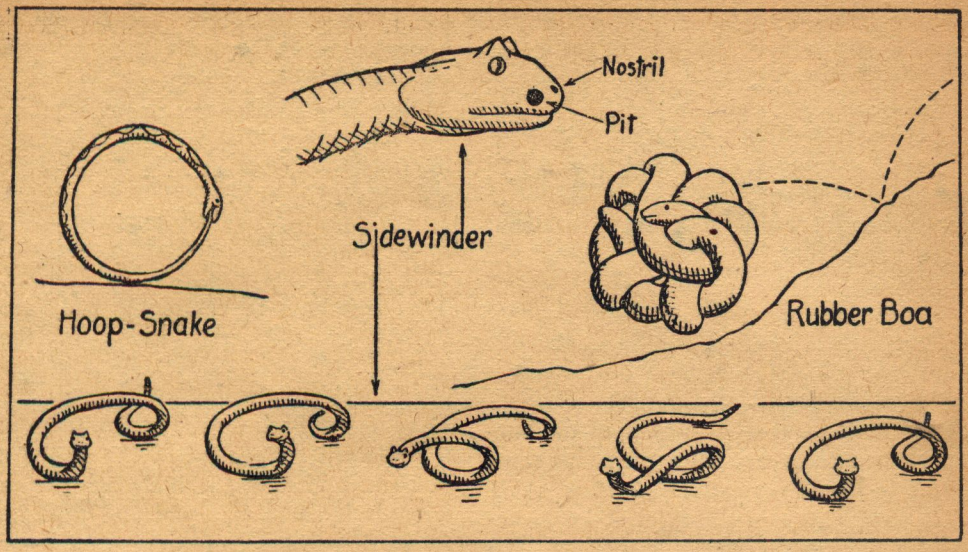


Fig. 3. Snakes: One legendary and two real. The hoop-snake is a myth, but the rubber boa and the sidewinder have means of progression almost as singular. The rubber boa, when threatened, may tie himself in a knot and let gravity roll him downhill. The sidewinder travels with an extraordinary looping motion, like that of a helical spring rolling on its side. Five steps in the sidewinder's motion are shown at the bottom, reading from left to right. The snake is traveling toward the reader and to the reader's left. At the top is a close-up portrait of the sidwinder, showing the pit with which it and other rattlesnakes detect heat-radiations from warm-blooded prey at night.

a large hornlike scale over each eye, who inhabits our southwestern deserts. He can crawl like any other snake. But when *he* is in a hurry he throws alternate loops of his body forward and to one side, so that he travels at a strange flopping gait diagonally forward. He has to be seen in action to be appreciated, and even when you've seen him you aren't sure how he does it. The process is almost impossible to describe intelligently, but I'll try:

Imagine that you have a helix consisting of several turns of light wire, the whole coil resting on its side so that it will roll. Now press down on it with your hand, so that the helix is flattened, and looks like a narrow ellipse when seen axially. Then move your hand horizontally, so that the helix rolls. Now imagine that the helix is your sidewinder, except that *he* keeps his back up and his belly down, instead of turning over and over the way the wire does. It's neither rolling nor walking, but a little of both, and it enables him to get across soft sand more readily than he could by the conventional gaits. Some African vipers that also live in sandy country use a similar mode of progression. The sidewinder naturally leaves a peculiar track when he sidewinds; something like this: ∫ ∫ ∫ ∫ ∫ ∫.

One marine crawler, the acorn-worm *Balanoglossus*—which is more closely related to us than to the earthworm—varies the extend-expand-draw up method of crawling through a burrow: it has a hollow proboscis at its front end, and a hydraulic apparatus for pumping this full of sea water to expand it

against the walls of its tunnel.

Starfishes also have a hydraulic walking system, but a much more elaborate one. Water is taken into a circular tube in the central part of the animal through a strainer, and from this tube, which has about the proportions of a bicycle tire, it is pumped out into five radial tubes extending down the five arms. Each radial tube has pairs of short lateral branches, at the end of which are the hollow cylindrical tube-feet, which at their upper ends—above the lateral connecting tubes—swell into bulbs called *ampullae*. When each ampulla contracts, the water in it is forced down into the tube-foot, which is thus extended. In most starfish the tube-feet end in suction-cups, which can be seen in action when one of the animals crawls over the glass of an aquarium tank.

Among the other marine crawlers, the gastropod mollusks mostly creep forward on their single belly-foot; I haven't been able to find out just how, but it *looks* as though they did it by sending a series of vertical waves along the foot forward, which is essentially what a caterpillar does. But one of them, a small whelk-like animal called *Strombus*, has the foot so developed that it can travel along the sea-bottom in a series of zigzag leaps.

Many of the pelecypods—bivalves—don't move at all—the oyster being an example. Those that do, usually extend a narrow bladelike foot out between the shells, thicken the tip, and haul it back and themselves forward through the sand. This is hardly a method of locomation to be recommended for speed, but some razor-clams can ooze along at quite a respectable rate. The fresh water mussels have a strange slow method of crawling, with no obvious advantages. They shoot out threads of mucus which adhere to the bottom and harden; then they reel these threads in, pulling themselves forward.

Planaria has a ventral foot superficially much like that of the gastropods, but it has its own way of using it. The foot secretes mucus, and is also covered with cilia; the planaria rows itself along through its own mucus with these cilia. Hydras can move by turning repeated somersaults.

Among the swimmers, besides the assorted scullers, rowers, and wigglers that we all know, there are a number of forms that use other methods. We might mention the rocketship propulsion of the cephalopods—squid and octopus—who suck water into their mantle-cavity, a kind of pocket encircling most of the animal's body; close the pocket with a hook-and-eye apparatus; and squirt the water out through a nozzle called the siphon, shooting themselves backward. At least, it *looks* as though they were going backward. But which *is* their front end? Some marine worms habitually swim "backward," and have eyes on their "tails" to guide them.

When we compare the anatomy of a squid with that of his cousin the snail, we see the following: the snail has his foot at the bottom, his head in front, and his viscera on top, piled up on the foot. If we put the foot of a squid at the bottom and his viscera on top, we find that (a) his head has gotten mixed up with his foot, which has become a set of tentacles with his mouth in the middle, and (b) his other extremity—his visceral end, corresponding to the top of the snail—is his leading end when he is going all out, though he can travel slowly the other way—toward the head-and-foot end—by undulating the fins that stick out from the sides of his body. I leave this little problem in biological relativity to the reader, and may it drive him nuts. (Fig. 4.)

THE SMALL free-swimming marine gastropod *Atlanta* habitually swims upside down. So does the American water-boatman *Corixa*. Hence the

name, the insect's back is shaped much like the bottom of a rowboat, and its swimming-legs, sticking out laterally, look something like a pair of oars. This bug—using the term in its strict sense to mean a member of the order Hemiptera, which includes the bedbugs and stink-bugs—is one of the few organisms that is at home in the water and the air, but not on land. When they fly, they fly from pond to pond—except when one of them disastrously mistakes a piece of smooth pavement for a water-surface.

We might mention a few other mollusks with curious means of getting from *A* to *B*. As stated, most of the pelecypods move slowly or not at all. But the scallops not only move, they *swim,* which no pelecypod is expected to do. They flap their shells open and shut. When they open them, water is sucked in the jamb side; when they close them, it is squirted out the hinge. Some of the clam family are given to burrowing through clay, wood, or even rock; they have to move a little to enlarge their burrows so they can grow. The date-mussel *Lithophagus* goes to what some might consider extreme measures to accomplish this. It dissolves its way through calcareous rock by means of acid secreted by a gland in its foot. To avoid dissolving its own shell, which is calcareous, too, it covers the shell with a horny coating.

The maximum speeds of animals are highly controversial, mainly because of the difficulties of getting a wild animal to run, fly, or swim in a straight line at maximum speed over a measured mile. The fastest land-animals are probably the cheetah and the Mongolian gazelle, which can do sixty-seventy miles per hour. The fastest fish, the tuna, tarpon, mako sharp, and swordfish, can all probably exceed forty; the swordfish may be able to touch sixty. Porpoises of the more active species can possibly do better yet; somebody timed one with an airplane recently and claimed that it did seventy. At least, they have no special difficulty in swimming rings around forty-knot destroyers. The maximum speeds of birds are even more uncertain. They are probably of the same order of magnitude as those of land and water animals, though some species, such as the duck hawk, may be able to do better.

At least, the alleged eight hundred-mile-per-hour speed of the deer-botfly seems to have been pretty well exploded. Somebody figured out the aerodynamics of such furious flight, and concluded that at that speed the air resistance would be more than enough to squash the fly flat.

Nobody has given much attention to the question of what animals move the most *slowly*. To even things up, we ought to state their speeds in terms of their own dimensions; otherwise the protozoans would have an unfair advantage. A good example of a slow poke is the sea anemone *Meritridium,* an eight-inch specimen of which was observed to crawl an inch and a half in twenty-four hours. But this is race-horse speed compared with that of some of the burrowing clams, which may move a few inches over a period of years.

Having considered how animals move, we might take a look at how they eat. In order to eat you first have to find your food. This is no particular problem to an internal parasite, which lives in its food. But animals whose food manifests a strong desire not to be eaten require various sense-organs for locating it and appendages for seizing it.

The sense-organs are mostly of the same kinds as our own, though they may be more highly developed. For instance, the chemical sense of a fish corresponds closely to our own senses to taste and smell. The sensitive hairs by which a blind animal, such as a cave-crawfish, locates its prey work very much the

same way as our own hairs. Move a finger of one hand over the back of the other hand so as just barely to disturb the hairs; you get a sensation distinct from that of contact between a solid object and bare skin. This arises from the sensory nerves whose ends are wrapped around the hair-roots.

Our eyes are not as good as those of a vulture, nor our ears as keen as those of a bat—bats seem to hunt insects mainly by hearing—nor our sense of smell anything like as good as a bloodhound's. But they work on the same principles. A cat's eyes do have a special feature for night-vision: a reflecting surface in back of the retina to bounce back any light that gets through, so that the retinal cells pick up faint light coming and going.

As far as special senses, to detect stimuli to which we are "blind" go: The extraordinarily developed ears of bats almost certainly have some purpose, though what it is has not yet been established. It may be that they enable bats to sense air-vibrations far below the frequencies audible to men, and thereby to avoid obstacles by "hearing" the echoes of their own wing-beats.

We know what an electric shock feels like, but we don't ordinarily class our

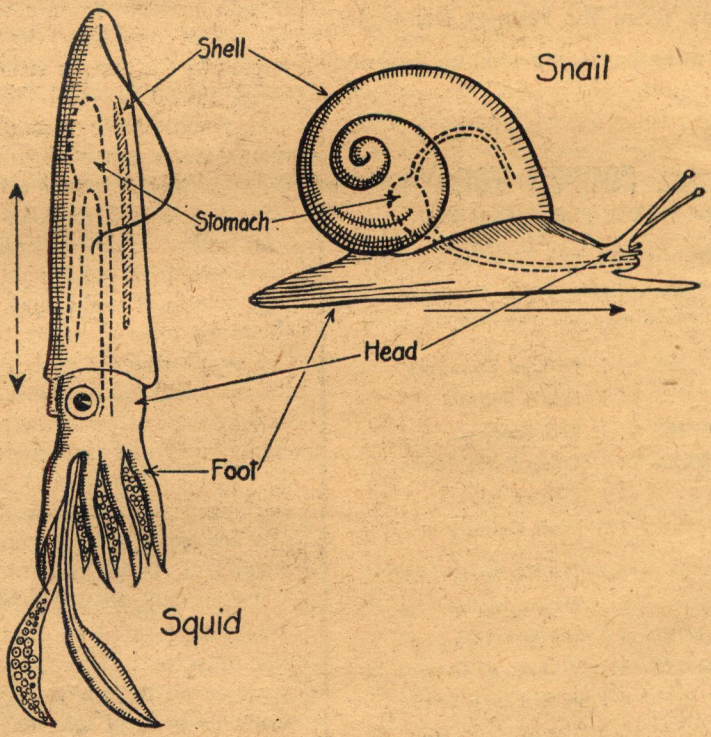


Fig. 4. Problem in anatomical relativity: Which side is up? Two dissimilar but related animals, a snail and a squid, with their corresponding parts shown by the arrows. The squid's shell is rudimentary and entirely internal. The arrows with the solid black heads show the direction in which these mollusks normally travel. The squid moves slowly in the direction shown by the broken arrow, and swiftly in that shown by the solid arrow.

reactivity to shocks as a sense, because we don't use this kind of sensitivity in our business. The electric eel does. When an eel has stunned some of the small fishes on which it preys, other eels, apparently aroused by the sensation of electric currents in their neighborhood, swarm around to share the meal. It has been found that, when a current is run through an electric eel's tank, the eel will immediately go to the positive electrode. Explanation? Simple: his own head is positive. He's looking for the head of another eel, in the hope that lunch will be there. He's not interested in the *tails* of other eels.

IN A PREVIOUS article I made some skeptical remarks about senses for detecting electromagnetic radiations very far above or below the range encompassed by the human vision. It now appears that I was too hasty. The pit-vipers—subfamily *Crotalinae*—that are named for a pair of deep depressions on their faces between the eyes and nostrils. (See Fig. 3.) The purpose of these pits has only recently been established. They are infra-red receptors. Most pit-vipers hunt at night, and the pits enable them not only to detect the presence of the small rodents and birds that form the principal food of most species, by the heat-radiations from their bodies, but to strike accurately at their prey in the dark. (Take a good look at the next rattlesnake or copperhead you see; the pits are quite conspicuous.) I can still plead that the pit is hardly an eye; and it works only on warm-blooded prey.

Having located its prey, the organism has to seize it somehow, and for this purpose we have a variety of arms and tentacles bearing assorted hands, claws, and suckers. The squid has eight short tentacles arranged in a circle around his mouth, like his relative the octopus. But the squid also has a pair of extra-long tentacles, with suckers on their flattened tips only, which are normally curled up in pouches and are shot out to capture any small fish or shrimp who gets too

close. The frogs, toads, anteaters, and chameleon use their tongues in this manner.

The dragon fly larva has a sort of jointed arm with a pair of pincers or tongs on the end, growing out of its head. This apparatus is normally kept folded up under the nymph's body. The clasp knife operation of the front legs of the praying-mantis are familiar; a crustacean, *Squilla,* resembling a large shrimp, has a similar arrangement, except that the last joint of its grasping-legs points up instead of down. A squilla is said to be able to snatch a table knife out of a man's hand without difficulty.

Some of the more eccentric means of getting hold of unwilling food are: The archer-fish *Toxotes* spits a drop of water out of its tube-shaped mouth at insects resting on stems and leaves above the surface, knocking them into the water. The nemertean worms—the ones with the helmet-larvae—have a proboscis that is extended by turning it inside out, and which is shot out to capture prey; some species have a harpoon arrangement, with a sting at the end of the snozzle.

The luminous lures of the deep sea angler-fishes are familiar to most of us, but one of these fishes, which has been brought up not far from New York harbor, has an interesting variant. The stalk on which the lure is mounted is jointed, and the lure itself is shaped like a hand. The fish is thought to swim up to smaller fishes, reach around behind them with its hand, and then turn its lights on, scaring the victims right into its jaws.

Animals that feed on pelecypod mollusks adopt various safe-cracking expedients to get into their victims' shells. A starfish attacks an oyster by pulling on its upper shell with its tube-feet in relays; thus it wears down the oyster's resistance. When the oyster has been opened, the starfish everts its stomach —turns it inside out—and digests the oyster in its own shell.

Seagulls fly up with clams and drop them on rocks, thereby breaking them open. They just love a concrete roadway for this purpose, and the fact that they may brain a passing motorist doesn't worry them. (Along New Jersey coast, cars have, in fact, been damaged this way.)

An octopus in the Naples aquarium was observed to watch a closed clam intently, meanwhile holding a small stone in its tentacles. When the clam opened, the octopus popped the pebble between the shells, preventing the clam from closing. The skates and rays simply crush their molluscan food between their teeth, which are broad bands running athwart the upper and lower jaws, making the whole mouth a simple and effective press.

Most of the marine gastropods are carnivorous, and their favorite food is their pelecypod cousins, presumably because they are the only things that move slowly enough for the gastropods to catch. The gastropods bore right through the shells of their victims with their lingual ribbon—their only internal hard part, a kind of tongue set with minute teeth. The number of these teeth may be enormous: the Chinese umbrella-shell has seven hundred and fifty thousand. (Don't ask me who counted them.) On the islands off the coast of Florida—a conchologist's paradise—one finds great numbers of pelecypod shells pierced by circular holes, as neat as if they had been drilled by machinery. The small yellow clam locally called a butterfly-shell seems to be a favorite victim.

Speaking of these islands, which are practically built of mollusk-shells in various stages of breakage and decomposition, another interesting seashore inhabitant is the little half-inch clam called the coquina, *Donax variabilis.* Every

receding breaker leaves hundreds of coquinas strewn along the beach. They lie glistening on their sides for a few seconds; then, as if worked by strings, they all up-end and vanish into the finely ground shell of the water-level. But the remarkable thing about this otherwise ordinary little pelecypod is that no two, apparently, have the same coloring: they are streaked with rays and bands of white, yellow, red, brown, and lavender in every imaginable combination and pattern.

Another shell that is considered something of a find on the beaches is the burrowing clam called the angle-wing, which has a pair of fragile white shells that look amazingly like their namesake. But angel-wings are common enough if you know where to look for them: in mud-flats in the lee of the islands that are a few inches below water at low tide. All you see of the clams is their burrows and the upper ends of the tubes through which they draw in and squirt out water containing the micro-organisms on which they live. My taste for angel-wing hunting got an early jolt when I stepped with bare feet on an active and resentful blue crab.

On one of these islands I saw my first and only manta—devil-fish or giant ray. It leaped at least a quarter of a mile from shore, but I could hear the smack as it landed. Despite the fact that this twenty-foot monster looks like the marine equivalent of Dracula, it is a more or less inoffensive creature that lives on small fish and invertebrates, which it scoops up with the two short tentacles growing out of the sides of its mouth.

The normal food of swordfish consists of small fish, which they slash up with their swords—an adult swordfish is toothless—and gulp. The thresher-shark's habits are similar, except that he uses his tail in lieu of a sword. As for the sawfish, this is a sluggish near-shark that prowls around muddy, shallow bottoms and uses his formidable snout, on the sides of which his teeth are mounted, to dig up the marine worms and things on which he feeds. There is, by the way, no reliable evidence that any of these three fish attack whales, popular yarns to the contrary notwithstanding. But a sawfish will slash half-heartedly at a man who molests him. And a hooked swordfish recently not only charged the fisherman's boat, but drove his sword and himself in one side and halfway out the other, killing himself in the process. He must have been a very angry fish.

TO BE CONCLUDED.

THIS SHIP KILLS

By FREDERICK ENGELHARDT

THIS SHIP KILLS

A devil-ship of the skyways, the haunted ship of space! From its beams and rockets, voices spoke—and lured men to death!

By Frederick Engelhardt

Illustrated by Wesso

THE intense blackness of a northern California winter's night hung like a pall over the busy spaceport atop lofty Mount Shasta, but even it paled before the black fury that masked the rough-hewn features of Captain Guy Helmuth.

Helmuth's blue-gray eyes, cold as the space lanes he traveled, were riveted to his latest command, the dowdy tramp ship *Heloise*. The raffish old tub, sprawled on the cleared, frozen ground and complacently absorbing the last of her cargo of concentrated foodstuffs for Mars, returned the captain's gaze owlishly through her round bow observation ports.

Men walked lightly and silently when circumstances brought them near the motionless, fur-swathed figure. Hell-ship Helmuth was as hard as the granite mountain beneath his feet, and as sudden and explosive as a rocket exhaust, and he had let the whole Universe know it.

But nothing of the busy scene before him was registering now on Helmuth's brain. The picture he saw—the only thing he *could* see—was the magnificent, gleaming passenger liner *Space Queen*, now being maneuvered into the launching pit at the other end of the field, behind him.

As though he had eyes in the back of his head, Helmuth could visualize every detail of the scene—the powerful electric "bugs" seizing and lifting the huge, shining hull and crawling along their tracks to slide her, stern foremost, into the chrome-steel-lined pit; the bands playing, drowning out bawled commands; the hundreds of passengers, white faces pressed against the fused-quartz windows of the observation deck, disappearing one by one over the lips of the pit; the thousands of visitors being herded back by port police.

And inside the liner—Helmuth could visualize that, too—officers hurrying to their posts, obsequious stewards scurrying around, strapping passengers into elastic slings; smart crewmen making last-minute check-ups of their stations; everyone, grim or excited, preparing for the rocket blasts that would hurl the great ship through the atmosphere and beyond Earth's gravitational pull.

It was quite easy for Helmuth to picture this. From the time the *Space Queen* was built, three years before, until he had found it expedient to break a mutinous cadet engineer's jaw on her last trip, he had commanded the luxury liner. The youngest, toughest, most experienced shipmaster of them all, with more space hours to his credit than any other two men, he was the natural choice of the line's directors.

BUT Helmuth forgot to move with the times. Those three years had brought changes and competition. No longer was each voyage an exploration; the *Space Queen* now followed a fixed route, and a timetable.

A captain's ability to bring his ship home through countless unknown dangers, to meet any and every emergency as it arose, weighed less and less with the various lines. His ability to entertain passengers, to give his ship a reputation for comfort and pleasure, weighed more and more.

And that cadet engineer was the son of the chairman of the line's board of directors.

A week ago thin-lipped, lanky Walter Capet, of Capet & Lance, found Helmuth unconscious in a cheap cabaret in Berryvale, at the foot of Mount Shasta. He took the spaceman to his home and spent a full day sobering him up. When Helmuth was able to see without propping open his eyelids, Capet talked to him.

"I know all about your record, and your trouble with Space Lines," he had said. "I don't care about the latter, but the first interests me. You know our company?"

"Sure. You've got four old tramps that just about hold together and you're damn near broke."

"Five," Capet went on, imperturbably. "We just bought the *Heloise.*"

Helmuth whistled. "That ship's a killer. She's had accidents every trip since she was built. And spacemen claim she's haunted."

"That's why we were able to buy her so cheap," Capet said. "But it is vital to us that she makes a profitable trip. That's why Lance and I want *you* to command her."

"I haven't much choice now." Helmuth's voice was cold and bitter.

"Succeed, and *we* won't forget you. We're fighting for trade, and we need tough captains. As this line prospers, so will you. We're willing to give you an interest in the company, but we want your wholehearted support."

"It's a deal," Helmuth had said.

A roar and a blinding flash of orange light told him the *Space Queen* had taken off. He turned slightly and looked up. A bright but rapidly diminishing speck in the dark void marked the liner's course. Helmuth's attention returned to his own command.

"Men are all aboard, sir." The ugly face of his first mate, Garrick, fringed in furs, loomed beside him.

"Enough of them sober to take off?"

The mate nodded. "Just about. I had to lay out a couple. They didn't want to come with us."

Helmuth's teeth gleamed in a brief smile. "Bashful, eh? Well, if *we* can stand a trip on that dilapidated old tub, they can. I don't doubt they'd prefer the dole, but I need a crew.

"All right," he added. "We'll start at once. We don't have to wait for any band."

The mate, following custom, preceded the captain into the ship. Helmuth paused for a brief last look along the scarred sides of the *Heloise,* then he, too, disappeared into her hull. The double-doored port clanged shut behind him and a dozen "bugs" seized the vessel, as though impatient to get her out of the way.

FROM his post on the control bridge in the bow of the ship, Helmuth followed the outside activity through television screens. He did not bother with the interior routine. His officers, all hard spacemen like himself, were hand-picked.

Cold phosphorescent lights illuminated the bridge as the bow sank below the rim of the launching pit. Helmuth adjusted his shock harness. In the mirrorlike reflection of the quartz observation ports he could see the other members of the bridge crew flattening themselves against the now-horizontal after bulkhead.

"All set outside," rasped a voice in the televisor.

Helmuth leaned forward and jabbed a thick finger at a button on the engine-

room communication panel. As he did so he saw the reflection of a young bridge boy climbing hand over hand along the girders toward him.

"Get back, you damn fool!" he shouted.

Then the ship leaped out of the pit and the elastic harness twanged in protest under the strain. Snapped back into position, and gaining his feet as the artificial gravity plates along the keel took hold, Helmuth concentrated on swinging the hurtling ship onto her predetermined course for Mars.

When he turned around again, he saw the whole bridge crew huddled at the after end of the cabin. "Take the controls," he snapped at a helmsman. As the man jumped to obey, Helmuth moved aft and joined the group.

"Good God!" he breathed. "The poor kid! He never had a chance. He must have hit that bulkhead at a thousand kilometers an hour."

"You called him, sir," a petty officer ventured.

"Are you cazy?" Helmuth snapped.

"But we all heard you, sir," the man persisted. "You called: 'Willy, come here.' Willy started forward before we could stop him."

Helmuth fixed the man with his cold stare. The other wilted.

"Get this," he said slowly. "I did not call that boy. God only knows what put that idea in your heads, but get it out. And quickly."

There was silence for a minute, then a grizzled old spaceman muttered something under his breath. But Helmuth's keen ears caught it.

"Haunts, is it?" he roared. "So this ship is haunted, eh? Well, understand this and pass the word around. From now on you take orders from me and the officers, and not from any haunts."

The men fell silent and began to disperse. Helmuth beckoned to the old man.

"Get that off the bulkhead. Wrap it in cloth and shove it through a spaceport."

Later, in his own cabin, he received Garrick. The ugly mate looked troubled.

"Afraid we're going to have trouble, captain," he said. "The men are all talking about young Willy."

"So they still think *I* called the little fool?"

"No, it ain't that. The older hands have more sense than to think that. But this ship has a terrible rep for being haunted. The men say they hear voices twenty-four hours a day. There's a couple who've made trips on her before."

"Send them to me," Helmuth ordered.

When the two men, both veteran space sailors, arrived, Helmuth demanded their stories.

"Well, it's like this, sir," the younger of the two said hesitantly. "This business that happened to young Willy ain't the first thing of the kind aboard here. John, here, and me made a trip to Jupiter last month, before Capet & Lance took over the ship. And we lost five men. Accidents, just like what happened to Willy."

"Accidents are always happening," Helmuth snapped.

"Sure, captain. We know that. But in every one of these accidents, someone called to the man and he jumped or turned his head or something. One engineer fell into an open tank of liquid air. Another guy just opened a spaceport. It sucked him and two others right out into space."

"There aren't any 'haunts,' as you call them," Helmuth said coldly. "No doubt every one of those accidents could be explained. I know this ship's reputation, and I know the way she's been run. But it's going to be different from now on.

"If I catch any man listening to 'voices,' he's going to be listening to

the birdies sing for an hour afterward. That's all. Get out."

THE NEXT two days were routine —for any ship Helmuth commanded. There was a certain amount of hazing, necessary to put the shanghaied members of the crew in a proper frame of mind for work. Helmuth and Garrick knocked out three mutinous souls, then kicked them into consciousness again.

"You'd 'a' gone out a spaceport, only we need all hands," Garrick informed them.

Chief Engineer Rumhler, the fat czar of the *Heloise's* pitlike engine room, greeted the captain and Garrick with his customary hiccuped, "All's well," on the fourth morning's inspection tour.

"Been having trouble?" Helmuth asked, frowning at two limp figures on the floor plates and the spanner in Rumhler's pudgy fist.

"Oh, no. Nothing like that," the engineer wheezed. "The boys are behaving nicely. They just want to be coaxed now and then."

"That guy knows how to handle 'em," Garrick commented as they climbed the winding stairs.

"He keeps discipline, all right," Helmuth admitted. "I guess that's the only way to handle these pressed crews. But sometimes, just once, I'd like to finish a trip without having all the officers' knuckles skinned."

A shrill, piercing scream, echoing and re-echoing through the passages, froze both men on the stairs.

"Good God! What now?" Helmuth took the rest of the steps three at a time, Garrick pounding along at his heels.

"Down there!" Garrick exclaimed, as they crossed the 'midships vertical passage. Helmuth glanced down and saw a white face, surrounded by a cluster of spacemen. They ran down the spiral stairs in time to hear the injured man's last words.

"Mother," he whispered, "I heard you."

"He was polishing brass up there,"

an eyewitness explained, pointing to the top landing, "when, all of a sudden, he steps straight back and falls. Gawd, he musta dropped a hundred feet."

"Anyone up there with him?" Helmuth snapped.

"No one," the sailor said. "He was all alone."

Suddenly Helmuth felt himself jerked off his feet. At the same instant, a heavy wrench hurtled past his head and clanged against the dural bulkhead. Helmuth flipped himself into a sitting position, flame pistol in hand, and found Garrick straddling him, menacing the scowling crew men with his own weapon. Helmuth regained his feet.

"What the hell is this all about?"

"That young punk yonder in the yellow shirt," Garrick explained. "I saw him sling that wrench at your head and had to yank you."

The boy in the yellow shirt found his voice.

"Yes, I did it," he yelled. "I'll do it again, and again, until I get you, you murdering beast."

Garrick's huge paw swept out and knocked the boy kicking into a corner.

"You *kidnaped* us," the boy continued to shriek. "We were just on a trip from college, and *you* had to dope us and shanghai us on this hellship. And now George is dead."

Helmuth looked inquiringly at the other men.

"They were brothers," a sailor volunteered.

"Well, don't stand there," Garrick snarled. "Strap up this punk and prepare a spaceport. You know the penalty for mutiny in space."

"No," Helmuth said quietly. "Let him go, this time. He's just hysterical. Give him a shot in the arm and toss him into his bunk to sleep it off."

He turned and walked toward his own quarters, leaving his mate and the crew men, mouths agape, staring at his back.

"You're lucky, kid, your body ain't out there driftin' around with the asteroids," a sailor told the youngster as he gently led him aft to the crew's quarters. "I'm tellin' yuh, that ain't like Helmuth. He must be gettin' soft."

WHEN Garrick reported to the captain's cabin an hour later, he found the latter mulling over a scrawled radio transcript. He recognized the lean Capet's handwriting.

"Buck," Helmuth said after a while, "what are your chances of getting a mate's berth on another ship?"

"Damn slim," Garrick admitted with his characteristic bluntness. "I'd be lucky to ship as an able spaceman. I ain't appreciated."

"No more I," Helmuth said slowly. "This berth is my last chance. I've got to make good, or I'm through."

"Well, captain," Garrick said, scratching his head, "we've been together a long time, and we've been through a helluva lot. If this job's washed up, too, what say we swipe a ship and go in for a little pirating? I know a swell hangout up north on Ganymede."

"It's not washed up yet, Buck. But we've got to lay the ghost on this ship. I made a deal with Capet & Lance. If we make a profitable voyage, and keep clear of the space lawyers, Capet & Lance are going to expand. It means a better ship for me, and maybe a command for you."

"Sounds reasonable, captain," Garrick said. "I'm with you. After all, I ain't as young as I was, and I've got a wife back at Shasta. Couple of kids, too."

"I've been communicating with Capet," Helmuth continued. "I told him what has happened. He says he and Lance hocked their teeth to buy this ship. If I don't come through for them, we're all in the soup. Capet & Lance with the department of finance, and us for brutality in space. There won't be

enough petty cash left in the company to buy us a square meal a day on the way to the Japetus prison colony, let alone hire a good lawyer."

"Well, I'll do my damnedest to find this ghost for you, captain, but I don't know what I'll do with it when I do find it."

"Ghost!" Helmuth was bitter. "Other things aren't bad enough. They have to ring ghosts in on me. My God, Buck, you'd think we were living in the eighteenth century, instead of the twenty-third."

Followed by Garrick, Helmuth sauntered forward to the control bridge and gloomily peered through an observation port. Mars, orange and green, and about the size of a small chestnut, twinkled off the starboard bow.

"In six days," Helmuth said, "our course and Mars' orbit will intersect. Then we land—and start making explanations to the space-directorate investigators. And I can't think of anything to say. I can't tell them ghost stories."

"It seems to me we had trouble with those guys last year," Garrick hazarded.

"I'll say we did. We nearly went to jail. Because you forgot to read the mutiny act to a sailor before blasting him. And the Kiosk investigators haven't forgotten the way we made fools of them. If they can lift our licenses, they'll do it in a minute.

"But if we can only lay the curse that's plaguing this ship, Buck, and give them some logical explanation. She's not a bad tub—just neglected. And then there's that kid—the one whose brother was killed."

"Aw," Garrick said, "we can forget about that, captain. The directorate has to wink at shanghaiing. I heard at Shasta that they were certifying every old hulk that could pass an air-tight test to move cargoes. And how do they think we're going to work ships without crews?"

"I know. I know. But I still feel sorry for that boy. You shouldn't have grabbed college kids, Buck. No telling who or what their parents are. But maybe I can square him with a cadet ship."

"It shouldn't be hard," Garrick said. "I've got a hunch space is getting into his bones. But there's something else I wanted to tell you. The men are getting ugly. They're talking of seizing the ship and turning the officers over to the Space Patrol."

"See that all officers go armed," Helmuth ordered. "And make sure the barriers between our quarters and the bridge and the crew's quarters are working properly."

Garrick left to carry out these orders, leaving Helmuth feeling more like his old self. This was something the hard-bitten captain could understand. He had handled mutineers before. And this time the law would be on his side.

But nothing happened that day, or the next, or the one after. Helmuth's tensed vigilance relaxed. Then, twenty-four hours away from Mars, all hell broke loose.

THIS TIME it was in the engine room, or, rather, in the inspection tunnel that ran between the two huge rocket tubes.

The place was in a turmoil when Helmuth, summoned by the frantic Rumhler, arrived on the run, followed closely by Garrick.

"This is it!" the latter exclaimed, buckling on a pistol belt.

The entire engine gang were milling around the converters at the bottom of the pit, shouting execrations at Rumhler, who, with two of his assistants, held the high-perched engine-control platform. All three had their pistols out.

"Hell's been popping, all right," Helmuth grunted, indicating several sprawled forms on the floor plates be-

low as they crossed a flying bridge to the control platform.

"They're out of hand entirely," Rumhler wailed, his alcoholic breath souring the air. "They're mad. They've already killed the second engineer and a tube tender."

"To hell with that," Helmuth barked. "What about the ship? What went wrong? That's more important."

"Gawd, Rumhler," Garrick gasped, as the portly engineer turned a red face to him, "those concentrated brandy pills you live on smell worse than the real thing. I betcha your breath has rotted the tube walls."

"It happened in the tunnel, sir," one of the assistants told Helmuth. "There were three men working in there, checking strains. All of a sudden, for no reason at all, one of them yanks open a manhole in the side of the port tube.

"I saw the whole thing from the lower platform. It was awful. The exhaust fumes blew into the tunnel and cremated them in an instant. They didn't even fall down. They just turned black, then cherry-red, then dissolved. Then the stern plate at the end of the tunnel blew out. That set off the mutiny. It's been brewing some time."

"What then?" Helmuth demanded.

"I threw an emergency switch and sealed the tunnel door. And shut off the exhausts."

"You mean this engine room was open to space?" Garrick demanded. "How come there's any air left?"

"The exhaust gas in the tunnel insulated us for the few seconds the door remained open. But it was a close call."

For the first time Helmuth took cognizance of the howling mob below.

"All doors down there sealed?" he barked.

"Yes, sir, first thing we did," the third engineer replied.

"Well, you two stay here and keep them cooped up. You're armed. They're not. Garrick, lock this blubbering, drunken lout in his cabin, before a spark reaches his breath and he explodes. I'm going back to the control bridge."

Halfway along the passage Helmuth found his progress barred by three brawny spacemen, all sailors.

"So you're in on this, too, eh?" the captain growled.

"Jump him!" yelled the biggest of the three. "We'll give him what for!"

Helmuth had no time to draw his pistol, but then he didn't feel he needed it. He was in a mood to work off some of his stored-up nervous energy. He side-stepped as the first of the trio rushed him and drove an iron fist into the man's short ribs. The sailor folded up with a *whoosh* and his forehead rang against the metal floor plate.

The second man, close behind him, felt himself seized in a viselike grip and lifted bodily off his feet. The third was stricken with a fatal hesitation, which gave Helmuth time to break the fellow's ankle with a backlashing blow of his heel. As he folded up, the second man came crashing down on top of him.

"Well, so much for that," Helmuth grunted. He jerked out his pistol and continued toward the bridge, from which came grunts, cries and the dull crack of fists against bone.

He found the third mate and the radio operator standing shoulder to shoulder, their backs to the operating panel, fending desperately against a veritable wall of screaming mutineers. Helmuth leveled his pistol—then changed his mind. Reversing the weapon, he brought the heavy butt around in a long side sweep. It thudded off the three nearest heads and the men collapsed without a groan.

Boring into the mob, Helmuth swung the butt again and again. By the time the crazed sailors realized they were being attacked from behind, half their number were sprawled on the deck. The fight oozed out of them at the sight of the flame pistol, once more leveled at them.

"You two all right?" Helmuth barked at the officers.

"Yeah. I guess so, captain," the operator mumbled, exploring his jaw with tender fingers.

"Then herd these men into the port-side strong room and lock them in. It's empty. Where are your guns?"

"Mine's empty, and I ain't had time to recharge it, sir," the mate said.

Helmuth's eyes flecked around the bridge. Huddled around the entrance to the port transverse passage were half a dozen charred forms. The whole corner of the bridge was scarred and seared.

"Damn it all, mister," Helmuth growled. "I wish you'd use some discretion and learn to handle your fists better. What do you think God gave them to you for? You've done a thousand gold dollars' worth of damage to this bridge."

The operator crawled out from under his instrument bench, a pistol dangling in his hand.

"It was knocked out of my hand," he explained.

WHEN THE BRIDGE was again cleared, Helmuth checked his course and ran an experienced eye over the navigation instruments. The *Heloise,* drifting with her exhausts cut off, was being drawn into an orbit around the orange planet. A dull *boom* over his head reminded Helmuth of the danger of whirling asteroids and speeding meteorites. The *Heloise's* owners hadn't bothered to equip her with the new deflection screens, and an expert hand at the helm was vital to her existence.

Helmuth tested the steering exhausts. There was no response.

"That damn fool engineer," he snarled. "He threw the master switch."

His finger stabbed savagely at the engine-room panel and the third engineer's worried face appeared on the local television screen.

"Give me some gas in the steering exhausts, you idiot," Helmuth rasped.

The four red lights on the steering-lever standard glowed almost immediately—but not a minute too soon. Out of the corner of his eye Helmuth saw a huge asteroid bearing down on the ship. He wrenched at the controls, and the *Heloise,* her bare thousand-kilometer-per-hour drift just about giving her steering way, moved sluggishly out of the path of the hurtling mass.

Helmuth heard a profound sigh of relief behind him. It was Garrick, mopping a streaming face.

"*Whew!* That was close!" the mate grunted.

"Where have you been? Taking a nap, or chewing some of Rumhler's brandy pills?"

"About Rumhler, captain. I—"

"To hell with Rumhler. Take over the helm. I'm going aft."

"But Rumhler said—"

"You heard me. You want to be a prima donna, too?"

Garrick seized the controls, but still sought to hold Helmuth's ear.

"Listen, captain. This'll interest you. It's about the ghost."

But Helmuth was already halfway back to the engine room. The two engineers still held the control platform, but the gang below was quieter.

"Can you get those tubes back into commission?" Helmuth demanded.

"I can open up the starboard tube," the senior said. "But I'd hate to take a chance with the port. With that manhole still open, the flames would shoot right down the inspection tunnel, and there's no telling how many plates were strained. We'd have to check them from outside."

"Maybe Chief Rumhler could figure out a way," the other put in.

"He'll have to," Helmuth snapped. "We're caught in Mars' gravitational field, but not far enough in to be drawn to the planet. We're spinning around her like a damned satellite, and we'll

need the power from both tubes to break out of this orbit."

"What about them, sir?" the third engineer asked, indicating the still-grumbling gang below.

"Pick out the men you can trust the most and order them up on the second platform. You hold them there with your pistol. The fourth and I will lock up the rest."

Helmuth sent the third mate forward to relieved Garrick and with the latter began a tour of inspection. They found the second mate dead in his cabin, his head crushed.

"That's tough," Garrick commented. "He was a good guy."

That brought the total casualties among the officers to four, the boatswain, leading the mutineers to the bridge, having been shot down by the third mate. The fourth mate had sustained only a split scalp, received when the mutineers tossed him down a vertical passage. Of the mutineers, nine were dead and another dozen were so battered as to be *hors de combat.*

"We'll have to work two watches after we get under way again," Helmuth decided. "Keep the crew locked up in the strong rooms, except for those actually on duty."

"I was trying to tell you, captain, Rumhler says—"

"Hell, yes. Rumhler. Come on. I need that drunk's brains. Damn it, if I could find another engineer half as good as he is, I'd shove him through a spaceport. He hasn't drawn a sober breath in twenty years."

THEY FOUND Rumhler on his hands and knees in his cabin, painstakingly gathering up an assortment of colored pills. Helmuth stepped on his hand, then jerked the man to his feet. The engineer blinked at him with his piggish little eyes.

"You're on duty, Rumhler," Helmuth snapped. "I'll give you just one hour to get that port exhaust tube back into commission."

"Port tube. Port tube." Rumhler blinked again, then a smile of recognition dawned on his round, red face. "Oh, yes, the port tube."

Helmuth choked back an exclamation.

"I've already got that figured out," the engineer went on, surreptitiously slipping a pill into his mouth. "That'll be nothing. Nothing at all, captain. But let me tell you about the ghost. It—"

"Write it out and mail it to me when we reach Mars," Helmuth howled. "I'm not interested in ghosts. Any kind of ghosts. All I want is that port tube back in commission. Get moving before I get mad."

Rumhler hurried along the passage to the engine room, with Helmuth stepping on his heels every half meter of the way. The captain paused at the central platform, surrounding the butts of the huge tubes, while Rumhler puttered around his valves and needle gauges.

Grunting to himself, the fat engineer hauled a sheaf of plans from a locker and slowly traced out the hieroglyphics with a stubby forefinger. Then he called the third and the pair went into a mumbled conference for several minutes.

"Sure, it'll be easy," Rumhler beamed.

"Maybe so, but *I* ain't going to do it," the third stated flatly.

"What's this?" Helmuth demanded.

"He wants to turn on the exhaust, fill the tunnel with flaming gas to insulate it against space, then send *me* out there in an asbestos suit to close the tube manhole. *Nuts!*"

"I'll go myself," Rumhler declared, hiccuping slightly.

"You didn't see those three men cremated," the third protested. "They went like *that.*" He snapped his fingers.

"Rumhler, you'll never make it," Garrick put in. "You're a fire hazard just standing in here."

"*Mr.* Garrick," the engineer declaimed, throwing out his wabbly fat chest, "you stick to punching people in the jaw. Leave matters calling for brains to me."

"I don't give a damn what you do, or how you do it," Helmuth interrupted. "But do something, and do it quick. I want to get out of this orbit. We're probably already listed on the space charts as Ginsberg's Comet, or something."

"First," Rumhler went on, blithely ignoring this comment, "I'll work up a mixture that isn't quite so hot, but has velocity enough to overcome the suction of space. If my new spacesuit which I am inventing only worked, it would be simpler."

"Go on," the captain urged.

"Then I'll rig a line to the top of the manhole cover, which is hinged on the bottom and opens into the tube, pass it through an eye in the top of the tunnel —there's one there already—and lead it through the tunnel door."

"There ain't any hole in that door, and I'm not going to hold it open on sheer space," the third objected.

"Kindly shut up," Rumhler said. "You will drill a hole through it. And leave the drill in the hole until I thread the line through it."

"And then?" Garrick asked.

"Then I come back into the engine room, close the tunnel door and yank on the line. The manhole cover will snap shut and the dogs will fall into place, locking it. Simple, isn't it?"

"No," said the third.

But he and the two surviving tube men fell to work under Rumhler's direction while the fat engineer eased his huge frame into an asbestos suit.

"You all understand what to do, now?" he demanded.

The others nodded and Garrick clamped a helmet over the engineer's head. All held their breaths as the third gingerly opened the tunnel door —and immediately fell back as angry tongues of flame licked out at them. Unhesitantly, Rumhler, grotesque in his bulky armor, waddled into the inferno, trailing a beryl-steel wire. Another wire, looped around him as a lifeline, prevented him from being sucked out into space by any sudden vacuum.

Three minutes—which seemed like three days to the watchers—passed.

THEN THE drill jumped out of the partly closed door and the snakelike end of the first wire emerged in its place. The door opened again and Rumhler staggered into the room. He motioned to the third, who quickly closed and sealed the door. Garrick and a tube-man leaped forward to relieve Rumhler of his cumbersome armor.

Rumhler's red face was glowing, and he was soaked with perspiration, but he

wore a triumphant smile.

"Now," he said, "all hands. Haul on this wire."

Garrick seized the wire—then dropped it with a howl.

"I forgot to tell you," Rumhler said. "Use gloves. It's hot."

A muffled *clang* came to their ears as the wire grew taut under their combined efforts. Rumhler waddled to his bank of indicators and nodded in satisfaction.

"It's all right now," he said. "You can switch on the regular gases in both tubes."

Helmuth heaved a sigh of relief. He handed the confiscated container of alcoholic pills to the engineer.

"Here's your tonic, Rumhler," he said. "Remind me to buy you a carton of these in Kiosk."

He started up the winding stair to return to the bridge, but Rumhler's wheezing voice stopped him.

"About that ghost, captain—"

"What about the ghost!" Helmuth's blood pressure shot up again.

"I've found it."

"You *what!*"

"Yes. It was so simple that our overeducated minds couldn't conceive of it. Now, any twelve-year-old boy in the twentieth century would have guessed it right off. But it wasn't until I heard my favorite radio program—"

"Just repeat that." Helmuth came back down the stairs and stood, arms akimbo, before the perspiring engineer.

"Why, yes. You know the program. 'The Perils of Paulette.' Last week, you remember, she fell into the clutches of the fourth-dimensional men of the outer Universe and they locked her in a tank full of ten-armed man-eating aborigines. It's sponsored by Kemp's Koncentrated Kalories."

Helmuth sat down. "I know it was hot in that tunnel, Rumhler," he said gently. "Just take it easy."

"But I'm telling you. Last week Paulette was locked in this tank. The episode closed with her beating frantically on the manhole cover while slimy arms wrapped around her legs. It came over good on my telecast receiver. How they think up these things I don't know."

Understanding dawned on Helmuth's hard face.

"So when I heard the opening line of this week's episode—I think it was: 'Open that manhole, you fiends, and let me out'—I caught on right away."

"It's too thick for me," Garrick grunted.

"Why," Rumhler explained. "It's simple. That tunnel is lined with copper to prevent accidental sparks exploding any stray gas fumes. The copper tarnished, and there you have a very good, working crystal radio set.

"It picked up 'The Perils of Paulette' broadcast, one of the men heard it and, without thinking, opened the nearest manhole."

"By God, Rumhler, you've got it!" Helmuth exclaimed. "I remember now hearing that, when this ship was built, the builders saved by using pure copper plates instead of berylium copper. There was a lawsuit over it, I recall."

"And every time we passed through a radio-broadcast beam, music or voices would come out of corners and lockers," Rumhler went on. "That boy who fell down the vertical passage last week was working near a copper-lined locker. I bet if you check up on all the accidents, you'll find every one occurred somewhere near a hunk of copper."

"Well," Helmuth said, "we can soon check that. You all know what this means. With no hoodoo, and a few repairs, the *Heloise* will be the finest, fastest freighter in space. Capet & Lance will remain in business and we will still have our jobs. Garrick, we've got another honest future."

And Hellship Helmuth came as near as he ever did to smiling happily.

HABIT

By LESTER DEL REY

HABIT

The straight line is the shortest distance between two points, and habit adds, the quickest line between two points— But it may not be—

By Lester Del Rey

Illustrated by Isip

HABIT is a wonderful thing. Back in the days of apelike men, one of them invented a piece of flint that made life a little easier; then another found something else. Labor-saving ideas were nice, and it got to be a habit, figuring them out, until the result was what we call civilization, as exemplified by rocket racing.

Only, sometimes, habits backfire in the darnedest way. Look at what happened to the eight-day rocket race out of Kor on Mars.

I was down there, entered in the open-class main event, with a little five-ton soup can of rare vintage, equipped with quartz tube linings and an inch of rust all over. How I'd ever sneaked it past the examiners was a miracle in four dimensions, to begin with.

Anyway, I was down in the engine well, welding a new brace between the rocket stanchion and the main thrust girder when I heard steps on the tilly ladder outside. I tumbled out of the dog port to find a little, shriveled fellow with streaked hair and sharp gray eyes giving the *Umatila* the once-over.

"Hi, Len," he said casually, around his cigarette. "Been making repairs, eh? Well, not meaning any offense, son, she looks to me like she needs it. Darned if I'd risk my neck in her, not in the opens. Kind of a habit with me, being fond of my neck."

I mopped the sweat and grease off the available parts of my anatomy. "Would if you had to. Since you seem to know me, how about furnishing your handle?"

"Sure. Name's Jimmy Shark—used to be thick as thieves with your father, Brad Masters. I saw by the bulletin you'd sneaked in just before they closed the entries, so I came down to look you over."

Dad had told me plenty about Jimmy Shark. As a matter of fact, my father had been staked to the *Umatila* by this man, when racing was still new. "Glad to meet you." I stuck out my hand and dug up my best grin.

"Call me Jimmy when you get around to it—it's a habit." His smile was as easy and casual as an old acquaintance. "I'd 'a' known you anywhere; look just like your father. Never thought I'd see you in this game, though. Brad told me he was fixing you up in style."

"He was, only—" I shrugged. "Well, he figured one more race would sweeten the pot, so he blew the bank roll on himself in the *Runabout*. You heard what happened."

"Um-hm-m-m. Blew up rounding Ceres. I was sorry to hear it. Didn't leave you anything but the old *Umatila*, eh?"

"Engineering ticket that won't draw a job, and some debts. Since I couldn't get scrap-iron prices for the old soup can, I made a dicker for the soup on credit. Back at the beginning, starting all over—and going to win this race."

Jimmy nodded. "Um-hm-m-m. Racing kind of gets to be a habit. Still quartz tubes on her, eh? Well, they're faster, when they hold up. Since you aren't using duratherm, I suppose your soup is straight Dynatomic IV?"

I had to admit he knew his tubes and fuels. They haven't used quartz tube linings for ten years, so only a few people know that Dynatomic can be used in them straight to give a forty-percent-efficient drive, if the refractory holds up. In the new models, duratherm lining is used, and the danger of blowing a tube is nil. But the metal in duratherm acts as an anticatalyst on the soup, and cuts the power way down. To get around that, they add a little powdered platinum and acid, which brings the efficiency up to about thirty-five percent, but still isn't the perfect fuel it should be.

Jimmy ran his hand up a tube, tapped it and listened to the coyote howl it gave off. "A nice job, son. You put that lining in yourself, I take it. Well, Brad won a lot of races in the old shell using home-lined quartz tubes. Must have learned the technique from him."

"I did," I agreed, "with a couple of little tricks of my own thrown in for good measure."

"How about looking at the cockpit, Len?"

I hoisted him up and helped him through the port. There wasn't room for two in there, so I stood on the tilly ladder while he looked her over.

"Um-hm-m-m. Nice and cozy, some ways. Still using Brad's old baby autopilot, I see, and the old calculator. Only that brace there—it's too low. The springs of your shock hammock might give enough to throw you against it when you reverse, and you'd be minus backbone. By the way, you can't win races by sleeping in your shock mattress—you ought to know that." He held up my duffel and a half can of beans. "And that isn't grub for a meteor dodger, either."

"Heck, Jimmy, I'm tough." I knew he was right, of course, but I also knew how far a ten-spot went on Mars.

"Um-hm-m-m. Be like old times with a Masters in the running. Got to be a habit, seeing that name on the list." He crawled out of the port and succeeded in lighting a cigarette that stung acridly in the dry air. "You know, Len, I just happened to think; I was supposed to have a partner this trip, but he backed down. There's room and board paid for two over at Mom Doughan's place, and only me to use it. We'd better go over there before her other boarders clean the table and leave us without supper. Eating's sort of a habit with me."

He had me by the arm and was dragging me across the rocket pit before I could open my mouth. "Now, Jimmy, I'm used—"

"Shut up. You're used to decent living, same as anyone else, so you might as well take it and like it. I told you I'd paid for them already, didn't I? All right. Anyhow, I'm not used to staying alone; sort of a habit, having somebody to talk to."

I was beginning to gather that he had a few habits scattered around at odd places.

JIMMY was right; shock cushions and beans don't make winners. With a decent meal inside me, and an air-conditioned room around me, my chances looked a lot rosier. Some of the old cocksureness came back.

"Jimmy," I said, lying back and letting the bed ease my back lazily, "I'm going to win that race. That hundred-thousand first looks mighty good."

"Um-hm-m-m." Jimmy was opening a can of cigarettes, and he finished before answering. "Better stick to the second, kid. This race is fixed."

"I'll change that, then. Who told you it was fixed?"

He grinned sourly. "Nobody. I

fixed it myself." He watched my mouth run around and end up in an open circle. "Maybe Brad forgot to tell you, and it's not common news, but I'm a professional better."

It was news to me. "But I thought dad— Did he know?"

"Sure, he knew. Oh, he wasn't connected with it, if that's what you're wondering. When he switched from jockeying to dodging, I left the ponies to handicap the soup cans. Learned the gambling end from my father, the best handicapper in the business. It's a habit in the family."

There was pride in his voice. Maybe I was screwy; after all, some people have a pretty low opinion of rocket dodgers. I decided to let Jimmy spill his side without foolish questions.

"Um-hm-m-m. Natural-born handicapper, I am. I won twice every time I lost. Never cheated a man, welshed on a bet, or bribed a dodger to throw a race. Anything wrong with that?"

I had to admit there wasn't. After all, dad used to do some betting himself, as I should know. "How about the race being crooked?"

Jimmy snorted. "Not crooked—fixed. Don't go twisting my words, Len." He stretched out on the bed and took the cigarette out of his mouth. "Always wanted to be famous, son. You know, big philanthropist, endow libraries and schools. Got to be a habit, planning on that; and you can't make that kind of money just handicapping. Your dad ever tell you about that fuel he was working on?"

I began to see light. "We knew he'd been doing something of that sort, though the formula couldn't be found. Matter of fact, he was using it in the *Runabout* when it went out."

"That's it." Jimmy nodded. "A little bit of the compound in the fuel boosts the speed way up. There were a couple of kinks in the original formula, but I got them straightened out. I pick the winner—the fellow who needs to win most, if that's any comfort to you—

and sell him on the new fuel. Only the thing won't work in quartz tubes—burns 'em out."

"I won't need it. I'll win this race fair and square." All the same, that did mess things up; I knew dad had thought a lot of that fuel.

"No rules against better fuels. A man can pick the fuel he wants, the same as he can travel any course he wants to, no matter how long, if he goes past the markers." He grunted. "Brad didn't want you racing, so he sent me the formula. Had a hunch about going out, I guess; dodgers get a habit of hunches."

"And we Masters have a habit of winning. Better change your bets, Jimmy."

"It's all fixed, too late to change, and the odds are big. After this race, I'm going back and get the habit of being a big philanthropist. Look, kid, you're not sore about my using Brad's formula?"

"If he gave it to you, that was his business." I pulled the sheet up and reached for the light switch. "Only don't blame me when you lose your bet."

BUT THE morning of the start, I had to confess I wasn't feeling so cocky, in spite of living high on Jimmy for a week. I'd seen the favorite—*Bouncing Betty*—and Jimmy's fix, the *Tar Baby*, and the both looked mighty good to me.

"What's the *Tar Baby* pulling?" I asked Jimmy. "Or do you know?"

"Olsen says he's driving her at better than two G's all the way. The *Bouncing Betty's* pulling straight two, which is tough enough, but Olsen thinks he can stand the strain at two and a quarter."

I looked them over again. An extra quarter gravity of acceleration, even if it is only an extra four feet per second per second, uses a lot of additional fuel, even for a sixteen-ton soup can. "How about that mixture, Jimmy? Does it pep up the efficiency, or just the speed—combustion rate and exhaust velocity?"

"She'll throw out a fifty-percent mixture I gave Olsen; optimum is good for eighty." Something began to click in my head then, but his next words sidetracked it. "You'd better draw out, kid. An eight-day race is bad, even if you can hold two G's. How's your supplies?"

I was worried a little myself, but I wouldn't admit it. "They'll last. I've stocked enough soup to carry me to Jupiter and back at two G's, if I had to, and the marker station is forty million miles this side of the big fellow, on a direct line from here. I've got plenty of oxygen, water, and concentrates."

They'd given out the course that morning. We were to head out from Kor, point straight at Jupiter with a climb out of the plane of the ecliptic, dive down and hit a beacon rocket they were holding on a direct line with the big planet, forty million miles this side of him; that made about an even three-hundred-trillion-mile course from Mars, out and back, figured for eight days at a constant acceleration and deceleration of two gravities. It had been advertised as the longest and toughest race in rocket history, and they were certainly living up to the publicity.

"That's a tough haul on a youngster, Len," Jimmy grumbled. "And with quartz lining, it's worse."

"I've had plenty of practice at high acceleration, and the tubes are practically safe for six days' firing. I think they'll last the other two."

"Then you're matching the *Bouncing Betty's* speed?"

I nodded glumly. "I'll have to. The *Tar Baby'll* probably run into trouble at the speed she's meaning to make, but the *Betty's* built to stand two."

The starter was singing out his orders, and the field was being cleared. Jimmy grabbed my hand. "Good luck,

Len. Don't ride her harder'n she'll carry. You Masters make too much of a habit of being crazy."

Then they forced him off the field, and I was climbing into the cockpit, tightening the anchor straps of the shock hammock about the straitjacket I wore.

And I expected to need them. Two gravities mean double weight, during eight days, fighting your lungs and heart. If you take it lengthwise, it can't be done, but by lying streched out on the hammock at right angles to the flight line, it's just possible.

The *Betty* roared up first, foaming out without a falter. Olsen took the *Tar Baby* up a little uncertainly, but straightened sharply and headed up. Finally, I got the signal and gave her the gun, leaving Mars dangling in space while I tried to keep my stomach off my backbone. The first ten minutes are always the toughest.

When that passed, I began feeding the tape into the baby autopilot that would take over when I had to sleep, which was about three quarters of the time, under the gravity drag. There wasn't anything exciting to the take-off, and I was out in space before I knew it, with the automatic guiding her. I might have to make a correction or two, but she'd hold at the two-G mark on course for days at a stretch.

I'd been fool enough to dream about excitement, but I knew already I wasn't going to get it. By the time I was half an hour out, I was bored stiff, or felt that way. The automat ran the ship, space looked all alike, and the only sensation was weight pressing against me. I looked around for the *Betty*, and spotted her blast some fifty miles away, holding evenly abreast of me. The others were strung out behind in a little cluster, except for Olsen. His blast was way up ahead, forging along at a good quarter gravity more than I could use. At the end of an hour, he was a full ten thousand miles away from me; there was no mistaking the harsh white glare of his jets. Olsen had decided to duck over the ecliptic, as I was doing, but the *Bouncing Betty* had headed below it, so it was drawing out of sight. That left me out of touch with what I hoped was my leading competitor.

Of course, the radio signals came through on the ultra-wave every so often, but the pep-talk description of the thrilling contest for endurance racing didn't mean much when I put it up against the facts. A racing ship in space on a long haul is the loneliest, most God-forsaken spot under the stars. For excitement, I'll take marbles.

Having nothing better to do, I turned over and went to sleep on my stomach. You can kill a lot of time sleeping, and I meant to do it.

THE HOWLER was banging in my ear when I woke up. I reached over and cut on, noting that the chronometer said sixteen hours out of Kor.

"Special bulletin to all pilots," said the ultra-wave set. "The *Bouncing Betty*, piloted by James MacIntyre, is now out of the race. MacIntyre reports that, in cutting too close to the ecliptic, he was struck by a small meteor, and has suffered the loss of three main tubes. While out of the running, he feels confident of reaching Kor safely on his own power.

"This leaves Olsen of the *Tar Baby* and Masters of the *Umatila* in the lead by a long margin. Come in, Olsen."

Olsen's voice held a note of unholy glee that the obvious fatigue he was feeling couldn't hide. "Still holding two and a quarter, heart good, breathing only slightly labored; no head pains. Position at approximately twenty-two and a half million miles from Kor; speed, two million eight hundred thousand per hour. Confident of winning."

"Report acknowledged, Olsen. Come in, Masters."

I tried to sound careless, but I guess I failed. "Acceleration at two, holding course beautifully on autopilot, rising over ecliptic. Body and ship standing up O. K. Pyrometer indications of tube lining very satisfactory. Position, twenty million miles out; speed, two and a half million. No signs of meteors up here. Can you give next highest acceleration below me?"

Already it took time for the messages to reach Kor and return, and I tried to locate Olsen with his two-and-a-half-million-mile lead. Even if he cut down to two now, the race seemed a certainty for him—unless something happened. Finally the report came back.

"Burkes, on the *Salvador,* reports one and three quarters, refuses to try higher. No others above that except yourself and Olsen. Are you going to match the *Tar Baby?*"

Match the *Tar Baby,* indeed, and run short of fuel or blow-up! "No chance. Still expect to win, though."

Well, at least it would sound nice back home, and it might worry Olsen a little. He was too conceited about his speed. But I couldn't see myself making good. Even if I cut closer to the ecliptic, it wouldn't save enough time to count, and the risk wasn't worth while. I dug into my store of concentrates and satisfied a raving hunger—double weight takes double energy, just as it does sleep. The only thing I could think of was to wish I could maintain acceleration all the way, instead of just half.

That's the trouble with racing. You accelerate with all you've got half the way, then turn around and decelerate just as hard until you reach your goal; then you repeat the whole thing in getting back. The result is that as soon as you reach top speed, you have to check it, and you average only a part of what you can do. If there were just something a man could get a grip on in space to slew around, instead of stopping dead, every record made would go to pieces the next day.

I checked over the automat, found it ticking cheerfully, and fiddled around

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Statement of the Ownership, Management, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of Astounding Science-Fiction, published monthly, at New York, N. Y., for October 1, 1939.

State of New York, County of New York (ss.)

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared H. W. Ralston, who, having been duly sworn according to law, deposes and says that he is Vice President of Street & Smith Publications, Inc., publishers of Astounding Science-Fiction, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

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Sworn to and subscribed before me this 30th day of September, 1939. De Witt C. Van Valkenburgh, Notary Public No. 24, New York County. (My commission expires March 30, 1940.)

with the calculator. But the results were the same as they'd been back in Kor. It still said I'd have to decelerate after about forty-four hours. Then I messed around with imaginary courses to kill time, listened to the thrilling reports of the race—it must have been nice to listen to—and gave up. Setting the alarm, I went back to sleep, with the announcer's voice concluding some laudatory remark about the "fearless young man out there giving his ship everything he's got in a frantic effort to win."

But I was awake when the next bulletin came in from Kor at the end of the forty-hour mark. "Special bulletin! We've just received word from Dynatomic Fuels that there's a prize of fifty thousand additional to any and every man who makes the course in less than eight full days! Olsen and Masters are now way ahead in the field, and about to do their reversing. Come on, Masters, we're pulling for you; make it a close race! All right, Olsen, come in."

"Tell Dynatomic the prize is due me already, and give 'em my thanks. Holding up fine here, fuel running better than I expected. Hundred and forty million out; speed, seven million. Reversing in two hours."

"O. K., Olsen. Come in, Masters—and don't forget that special; you're still in line for it."

By a tight margin, I might make it, since it applied to as many as came in within the time period. "I'll be in the special field, Kor. Everything like clockwork here, standing it fine. Pyrometer still says tubes O. K. Position, one twenty-five millions; speed, six and a quarter. Reversing in four hours."

"O. K., Masters; hope you make it. Watch out for Jupiter, both of you; even at forty million miles, he'll play tricks with your steering when you hit the beacon. Signing off at Kor."

JUPITER! Right then a thought I'd been trying to nurse into consciousness came up and knocked on my dome. I dug my fingers into the calculator; the more the tape said, the better things looked.

Finally I hit the halfway. Olsen had reversed a couple of hours before with no bad effects from the change. But I was busy dialing Mars. They came in, after a good long wait. "Acknowledging Masters. Trouble?"

"Clear sailing, here and ahead, Kor." It's nice to feel confident after staring second prize in the face all the trip. "Is there any rule about the course, provided a man passes the beacon inside of a hundred thousand miles? Otherwise, do I have free course?"

"Absolutely free course, Masters. Anything you do after the beacon is O. K., if you get back. Advise you don't cut into asteroids, however."

"No danger of that. Thanks, Kor."

I'd already passed the reversing point, but that wasn't worrying me. I snapped off the power, leaving only the automat cut into the steering tubes, and gazed straight ahead. Sure enough, there was Jupiter, with his markings and all; the fellow that was going to let me maintain full speed over halfway, and make the long course the faster one. I was remembering Jimmy's remark that put the idea into my head: "A man can pick the fuel he wants, the same as he can travel any course he wants, no matter how long."

With power cut off, I was still ticking off about seven million miles an hour, but I couldn't feel it. Instead, I felt plenty sick, without any feeling of weight at all. But I couldn't bother about that. Kor was calling again, but I shut them up with a few words. If I was crazy, that was my business, and the ship was doing O. K.

I set the buzzer to wake me when I figured I'd be near Olsen. Looking out, when the thing went off, I could

see his jets shooting out away off side, and a little ahead. But he was cutting his speed sharply, while I was riding free, and I began sliding past him.

I was all set to gloat when his voice barked in over the ultra-set: "Masters! Calling Masters!"

"O. K., Olsen."

"Man, decelerate! You'll crack up on Jupiter at that rate. If something's wrong, say so. We're way out ahead, and there's plenty of time. Give me the word and I'll try to cut in on you. The *Tar Baby's* strong enough to hold back your soup can. How about it, Masters?"

That was the guy I'd been hating for a glory hound, figuring him as out for himself only. "No need, Olsen, but a load of thanks. I'm trying out a hunch to steal first place away from you."

The relief in his voice was as unquestionable as his bewilderment. "It's O. K. if you can do it, mister. I'll still make the special. Why not let me in on the hunch? I won't crib your idea."

"O. K., but I don't know how it'll work, for sure. I'm going around Jupiter at full speed instead of cutting to the beacon."

"You're crazy, Masters." The idea didn't appeal to him at all. "Hope your tubes hold up under the extra eighty million miles. So long!"

Sixty-seven hours out of Kor I passed the beacon at the required hundred thousand miles—which isn't as wide a margin at full speed as it sounds—and headed out. Olsen must have called ahead to tell them what I was doing, because they acknowledged my call, verified my distance, and signed off without questions.

I CAUGHT an hour's sleep again, and then Jupiter was growing uncomfortably close. I'd already been over my calculations twenty times, but so darned much depended on them that I wasn't taking chances. I ran them through again. The big fellow was coming up alongside like a mountain rolling toward an ant, and I was already closer than anyone I'd ever heard of.

But it worked out all right, at first. I grazed around the side, was caught in his gravity, and began to swing in an orbit. That's what I'd been looking for, something to catch hold of out in space to swing me around without loss of momentum, and that's what I'd found; Jupiter's gravity pulled me around like a lead weight on a swung rope.

Which was fine—if I had enough speed to make him let go again, as close as I was to his surface. Fortunately, he hasn't any atmosphere to speak of in proportion to his diameter, or I'd have been warmed up entirely too much for pleasant living. In no time I was coming around and facing back in the general direction of Mars; and then two things happened at once.

Jupiter wasn't letting me go on schedule; he seemed to think he needed a little more time for observation of this queer satellite he'd just caught. And Io swung up right where it shouldn't have been. I'd forgotten the moons!

That's when I began counting heartbeats. Either Jupiter pulled me too far, or he threw me square into Io, and I didn't like either prospect. The steering tubes were worthless in the short space I had at that speed. I waited, and Jupiter began to let go—with Io coming up!

Whishh! I could hear the outer edges of the moon's atmosphere whistle briefly past the sides of my soup can, and then silence. When I opened my eyes, Io lay behind, with Jupiter, and I was heading straight for the beacon. Dear old Io! Light as its gravity was, it had still been enough to correct the slight error in my calculations and set me back on my course, even if I did come too close for my peace of mind.

I was asleep when I passed the bea-

con again, so I don't know what they had to say. It was Olsen's call that woke me up.

"Congratulations, Masters! When you reach Mars, tell them to hold the special and second prizes for me. And I'll remember the trick. Clear dodging!" He was still heading in toward the beacon on deceleration, and less than eighty hours had passed.

Well, there wasn't much more to it, except for the sleeping and the ravings of that fool announcer back on Kor. I reversed without any trouble at about the point where I'd stopped accelerating, and began braking down for Mars. Then the monotony of the trip began again, with the automat doing all the work. The tubes, safe for six days, would be used only about three and a half, and I had soup to spare.

Miraculously, they had the landing pit cleared when I settled down over Kor, and the sweetest-looking white ambulance was waiting. I set her down without a jolt, slipped out, and was inside the car before the crowds could get to me. They've finally learned to protect the winning dodger that way.

JIMMY was inside, chewing on an unlit cigarette. "O. K.," he told the ambulance driver, "take us to Mom Doughan's. Hi, kid. Made it in a hundred and forty-five hours. That gives you first and special, so you're out of the red. Nice work!"

I couldn't help rubbing it in a little. "Next time, Jimmy, bet on a Masters if you want to go through with those endowments of yours."

Jimmy's face was glum, and the cigarette bobbed up and down in his mouth in a dull rhythm, but his eyes crinkled up and he showed no rancor at the crack. "There won't be any endowments, kid. Should have stuck to the old handicapping, instead of trying to start something new. I'm cleaned, lock, stock, and barrel. Anyway, those endowments dreams were just sort of a habit."

"You've still got your formula."

"Um-hm-m-m. *Your* fuel formula; I'm sticking to the old habits and letting the newfangled ideas go hang."

I stopped playing with him then. "That's where you're wrong, Jimmy. I did a lot of thinking out there, and I've decided some habits are things to get rid of."

"Maybe." He didn't sound very convinced. "How'd you mean?"

"Well, take the old idea that the shortest time is made on the shortest possible course; that's a habit with pilots, and one I had a hard time breaking. But look what happened. And dad had one habit, you another, and you'd both have been better off without those fixations."

"Um-hm-m-m. Go on."

"Dad thought a fuel was good only in racing, because he was used to thinking in terms of the perambulating soup cans," I explained. I'd done plenty of thinking on the way in, when I was awake, so I knew what I was talking about. "You had a habit of thinking of everything in terms of betting. Take that fuel. You say it gives eighty-percent efficiency. Did you ever stop to think there'd be a fortune in it for sale to the commercials? The less load they carry in fuel, the more pay cargo."

"Well, I'll be—" He mulled it over slowly, letting the idea seep in. Then he noticed the cigarette dangling in his mouth and started to light it.

I amplified my scheme. "We'll market it fifty-fifty. You put up the fuel and salesmanship; I'll put up the prize money and technical knowledge. And if you're looking for fame, there ought to be some of that mixed in there, too."

"Um-hm-m-m." Jimmy stuck out his hand. "Shake on the partnership, Len. But, if you don't mind, I'll use the money like I said. These endowment ideas sort of got to be a habit with me."

POWER PLANT

By HARL VINCENT

POWER PLANT

If making the first commercial atomic power plant work wasn't grief enough, Les Vance had sabotage on his hands, too!

By Harl Vincent

Illustrated by Wesso

I.

LOOKING down the hundred and twenty foot height from the ancient coal bunkers to the engine room floor, Lester Vance experienced a breath-stopping recurrence of his old acrophobia when he saw what was happening down in those softly lighted depths. This fear of heights he would never conquer, no matter how many greasy iron steps he climbed, no matter how many equally greasy siderails he grasped, no matter how hard he tried to keep his gaze from below and stare vacantly at what was or was not above him. He once—long years ago—had slipped and hung by a hand for ghastly moments. He had dreamed about that and still continued to dream at times. Height! Not in one of the stratoplanes; there it bothered him not at all. But on the ragged edge of nothing; that was something else again.

And something he had seen below now had almost caused him to lose his grip on the handrail, almost caused him to go slithering down over that slippery tread edge into screaming oblivion. Joyce Kirk was swinging down from the engine room floor to the condenser pit on a crane hook, clinging to a load of International equipment which had only that day arrived from the factory for a circulating pump repair. And Kirk had no business with that stuff. Kirk was up to something, no doubt of it; Vance had suspected him for a long while. Now, it seemed, if he could get down there soon enough, he might learn a few things. It even might be he would be able to circumvent what was going on in the Atlas organization that was playing havoc with International.

Vance slid dizzily along the rail to the long gallery paralleling the tiled wall where the dim top lights glowed redly in the murk. He'd never get down those long, slippery flights; he'd have to wait for the elevator. He prayed it might be near the uppermost floor. It was.

Slow, though, that freight elevator. Vance thought he'd never reach the basement level. Eventually he did. He ran past the long rows of pumps on the north lane, past the air ejector banks toward condenser number nine, where he knew the repair material was to be delivered and used. The shaft and rotor parts were just being eased down to the concrete, several tons of them—and Kirk riding the load!

Atlas was up to some of its old tricks, he was sure, and from what he had seen and known of Kirk, he figured him to be just the sort of a representative to handle their dirty work.

The rigger was signaling the crane operator; the load was handled perfectly. And Kirk, tall, dark, immaculate, debonair, even in his dungarees, waved airily as he stepped from the chains.

"Hiya, Vance?" he greeted nonchalantly.

"Hi!" grunted the chunky grease-

smeared, blond International man gruffly. "What you doing on my stuff?"

"Just taking a ride, that's all. What's it to you?"

"Huh! Going to take a shower? You need one."

The shower bath stalls were on the basement level of the plant and Vance thought he saw a queer gleam in Kirk's eye as he took the ribbing.

"Sure; how'd you guess it?" the Atlas man retorted. "Take a bath with me. You need it worse than I do."

He disappeared past number eight condensate pump and ducked into the alleyway that led to the shower stalls. Vance scratched his head. A phony, if there ever was one! There was something in the air—and not in the air of the basement level. With a sudden inspiration, Vance made a dive for the iron stair running to the engine-room floor, forty feet overhead. As he padded swiftly up its greasy grilled treads, he heard the scream of the vapor alarm. At the same time there was the crackling thunder of a high-tension arc high above, its vivid flash lighting all blindingly, then snapping out. And a shrill squeal which, to his trained ears meant a heavy turbine rub.

Mercury vapor was loose! There had been a high voltage short. One of the turbines was ripping out its blades by the bucketful. Someone had gone haywire on the AC switchboard. And, by whatever gods there were, this sleek Kirk was responsible.

Vance's thoughts raced crazily. He heard the vapor alarm scream once more, saw a twisted body come hurtling down from the heights of number seven mercury boiler. Then the plant went dead. Completely dead. Even the lights went out; the emergency power supply was cut off, an inconceivable eventuality.

In the sudden gloom a man was screeching horribly, like an animal in intense agony. The blood-curdling sound shut off mercifully in a moment; then came only the confused yelling and babbling of the men in the condenser pit, the amazed cries of the watch engineers on the turbine floor, the howling of the siren from the high board, the abrupt cessation of the booming of the atomic blast which had been starting one of the boilers from cold. Number seven, probably; Vance did not know the schedule.

He was halfway up the stair. His fingers held insecurely to the oily rail. Dimly below he could see figures. The dying whine of pumps came from there. The turbines above whined down in unison. The boilers thrummed to the quenching of atomic fires with liquid cadmium. Through the gratings, Vance could see running dark forms up there. There came the heterodyne throb which tells of differing speeds of units that have kicked off the bus and tripped out.

It was a mess, all right. And Kirk was in the showers. A perfect alibi.

THE emergency lights flashed on soon and activity in the plant rose to fever pitch. The loud-speakers began to bellow instructions from the chief operator on the AC switchboard. Higher up the north wall, through the glass-inclosed bay of the DC board, furious commotion could be seen. The load dispatcher was jumping up and down as if bouncing on rubber legs. Men were running in all directions above and below. Vance reached the turbine floor.

"Number one atomic blast!" the chief operator called for.

There was great activity at the far end of the floor. The quenched fire of number one boiler was dumped and the cores refueled. There was the sing of the motivating switch. Three hundred and fifty thousand volt DC had been switched in directly off the high line. The boom of the atomic blast followed. Then this shut off as atomic disintegration in the fuel rods was started. Number one mercury boiler was in operation; the rising whirr of the overhung turbine

atop her was the next thing to be heard. In a moment the mercury condenser would be producing steam for number one steam unit. So far, all was going well.

Vance sprinted toward number one steam unit. That was his baby. The mercury equipment on number one was of Atlas manufacture, the first of its kind and the only one in the plant not matching the steam end of the combined unit; that was their look-out, not International's. But Vance wanted to see that nothing happened to his own apparatus now. Too much had gone on in this plant lately to suit him.

Steam rushed down from the superheaters; you could hear the thud as pressure filled the throttle valve. Vance cracked the throttle slightly and heard the steam screen through into the valve chest and first stage nozzle blocks. He cracked it a little further and the unit began slowly turning over. Though the turbine was still hot, he watched the rotor truth indicator and listened carefully for any sign of blade or packing rubs. There was none; it was safe to bring the unit up to speed.

This was a condensing unit, starting non-condensing. He yelled into the condenser pit microphone for the operator down there to start the pumps. The shift engineer was alongside him, objecting.

"This is my job," he told Vance. "Number one's been turned over to us years ago. You got nothin' to do with it now."

"I'm making it *my* job till she's on the line this time. Too much funny business around here. And I've been the goat too long."

Circulating and condensate pumps were now up to speed below and the air ejectors were bringing up the vacuum on number one. With the handle of a screwdriver to his ear and its long shank pressed against the turbine casing, Vance listened for rubs. He clung to old-fashioned methods, not trusting the instruments. Still all was in the clear, and the vacuum was over twenty inches of mercury. He straightened up and looked keenly at the shift engineer. The man squirmed visibly.

"Oh, it's O. K., Mr. Vance," he said uneasily. "I only . . . only was thinkin' I ought to be doin' it myself. You know."

"I don't know. Charlie, what do *you* know about this mess?"

"Nothin' at all. Honest, Mr. Vance. But I got an idea."

"Yeah? Want to spill it?"

The thick-spectacled operating man looked up and down the aisle, then said in a hoarse whisper just audible above number one's hum: "Know who that was got killed fallin' off number seven mercury?"

Vance started guiltily. In his anxiety for his beloved machines he had entirely forgotten that there had been a fatality. "No," he admitted. "Who?" He looked down the aisle himself, saw a knot of men gathered at the base of number seven boiler.

Charlie put tobacco-stained lips vaporously near Vance's ear. "Jerry Curran," he said. "Your own man. Looks like he's been double-crossin' you."

Suddenly Vance's eyes were unseeing, his ears unhearing. He did not even notice the flashback from the highboard telling the turbine floor that number one was safely on the line, did not even observe that they were starting up number two—Kirk's unit. Number one was the oldest steam unit in the plant; Vance had nursed it on and off for twenty-three years, having been present at its regular inspection every two years since it was installed, and it was still the smoothest running job in the plant. And was not far below the efficiency of number ten, the latest and most up-to-date Atlas machine. These things meant nothing to him at the moment. Jerry was gone, lying up there on the floor-

plates a crumpled heap. But to think of the laughing-eyed Celt as having two-timed him—

"I don't believe it!" he spat out at the watch engineer, and walked toward the knot of men at number seven.

THE investigating committee that came out from Washington next day, was doing its blundering best to arrive at a conclusion as to the cause of the shut-down and the manner of Jerry Curran's death. So-called experts, electrical and mechanical engineers and physicians had, after an entire day of going over the ground, so far been mystified. The two physicians did not agree —and the coroner's opinion had been at variance with both—as to what had killed Jerry. One doctor stated that mercuric poisoning was responsible; the second argued hotly that he had been electrocuted by the high tension arc; the coroner pronounced with the voice of authority that there was not sufficient mercury in the system to have caused death, that there were no burns such as would have been left by the arc, but that the man had merely been frightened by the miniature lightning flash atop the boiler and had jumped over the rail or had staggered into it and fallen to his death below. This, despite the fact that there was no evidence of concussion and only two simple fractures. The argument was unending, it seemed. Which was not unusual with investigations, Vance reflected.

And so it was with the cause for the shut-down, although here the evidence was of more certain nature in many respects. It was mainly the sequence of events that was in doubt. And as to the blame, it seemed it could not be pinned definitely to any one man.

At the long conference table in the main office, Vance sat directly across from the chairman of the committee, listening boredly to the conversations that drifted this way and that. In his own mind he was conducting his own private investigation. Kirk had already been questioned and, as Vance had foreseen, his alibi was perfect. Besides, no Atlas apparatus had been involved.

It was Vance's turn to be questioned. "You are the representative here of International Electric, Mr. Vance?" he was asked. "In charge of all service work?"

"I am."

"Have you reached any conclusion regarding the . . . er . . . incident of yesterday?"

"Not yet."

"It was exclusively International equipment which was involved, was it not?"

Vance bridled. "It was no fault of the apparatus. Besides we do not build the mercury boiler."

"Of course"—sarcastically—"we understand that Atomic Power builds that part of the combined unit. But International purchases it from them and erects it with their mercury turbine, steam turbine and condenser as a complete unit, does it not?"

"Atomic Power services its part of the combined unit, Mr. Jordan."

"We'll come to that later. But you admit that number seven mercury turbine had a blade wreck which resulted in the breaking of the mercury vapor inlet pipe?"

Vance saw that Kirk was regarding him through lids half covering his greenish eyes, that a sneering smile twisted his lips. He turned to Jordan with assurance. "I admit the blade wreck, but not that it caused the pipe breakage. The accident to the blading is a common one and occurs with mercury turbines of all makes. It is one of the things in connection with atomic power which we have to combat and will eventually master, all of us. With the extreme penetration of neutron bombardment, a certain portion of the vaporized mercury is broken down into

platinum, barium and other elements. This, mainly the platinum, deposits on the blades or buckets and sometimes the encrustation is so rapid that unsuspectedly close clearances result. Rubs ensue and, if heavy, cause a blade accident like the one you have seen."

"Vibration would be heavy at the time, would it not?"

"Quite possibly, but in this case such vibration did not break the pipe."

"How do you know, Mr. Vance?"

"By examination of the fracture. Crystallization of the material, as examined microscopically, has taken place over a period of time; the pipe was on the point of failure just before the accident. The shock of the blade failure was sufficient to complete the damage, that's all." Vance's smile broadened.

Jordan said: "Still it is International responsibility. It was your pipe, your turbine; if crystallization has been progressive, the turbine must have vibrated ever since it was installed."

"It never vibrated in operation. The charts of the recording vibrometer will prove that conclusively."

"Very well. That is all, Mr. Vance." Jordan turned from him to question Tomlinson, the Atomic Power representative.

So this was an investigation! Vance hardly listened further. Two things were certain. Something—and he was sure it had been no accident—had started a three hundred and fifty thousand volt arc across the terminals of the tall insulating bushings atop number seven boiler. Something—and this was no accident, either—had caused the mercury vapor line to the turbine up there to snap off at a point three feet from the inlet to the machine. The shut-down had resulted.

The occurrence of the arc had tripped the outdoor high voltage circuit breakers and cut the plant off the transmission line. With the consequent dropping of the entire plant load, someone on the AC board had pulled the master trip control which shut down every unit on the floor. Why the emergency power was out, no one could learn, but Vance would be willing to bet Kirk knew something about that, too. That made four separate items to look into: Jerry's death, what started the arc, what had caused the pipe fracture, and the mystery of the emergency power failure. Well, he had wired the factory and tomorrow two experts would arrive, a metallurgist and one of the highvoltage research engineers. Between them all they should be able to dope out something. You couldn't do this to International!

Rousing from his thoughts, he saw that the conference table was clearing. The investigation was over. And in the morning the papers would have plenty to say about the cause of the shut-down. Plenty of untruths there would be, plenty to blacken the name of International Electric. Without looking again at Kirk, Vance ambled out and into the yard. His own shanty looked pretty good right now.

II.

IT WAS after five; all of his men had left. It was a good place to think, alone. Vance lighted his pipe and comfortably located his heels on the desk top, slouching in his chair and abandoning himself to aimless reflection.

This Potomac River Plant of Seaboard Superpower was the first atomic power plant in the world to be successful commercially. Other plants there were, to be sure—purely experimental. But Potomac was supposed to be the final word. It was working, or had been until yesterday. Rebuilt from the old station constructed in 1942, when the 1,350 pound, 1,000 degree Fahrenheit steam boiler was still in vogue. When back-pressure turbines took this red-hot steam and expanded it to a pressure of 400 pounds for use in the larger turbines

where it was again expanded to twenty-nine inches of vacuum and the maximum possible of its available heat extracted. In those older days the binary fluid system was still in the experimental stage. Atomic power had only been dreamed of. Now atomic power was here and with it the binary fluid system was inevitable.

Electrically, the old plant had turned out juice at 13,800 volts, 3 phase, 60 cycles. This had been stepped up in the huge oil-cooled transformers to 220,000 volts AC for transmission over the Seaboard lines. All this, too, was now changed. Transmission was direct current, not alternating, the line voltage 350,000. The old alternators still operated at the original voltage and frequency, as did the new ones on the mercury units, conversion to the high tension DC being in the phanotron rectifiers that had replaced the old transformer banks. It was a new era.

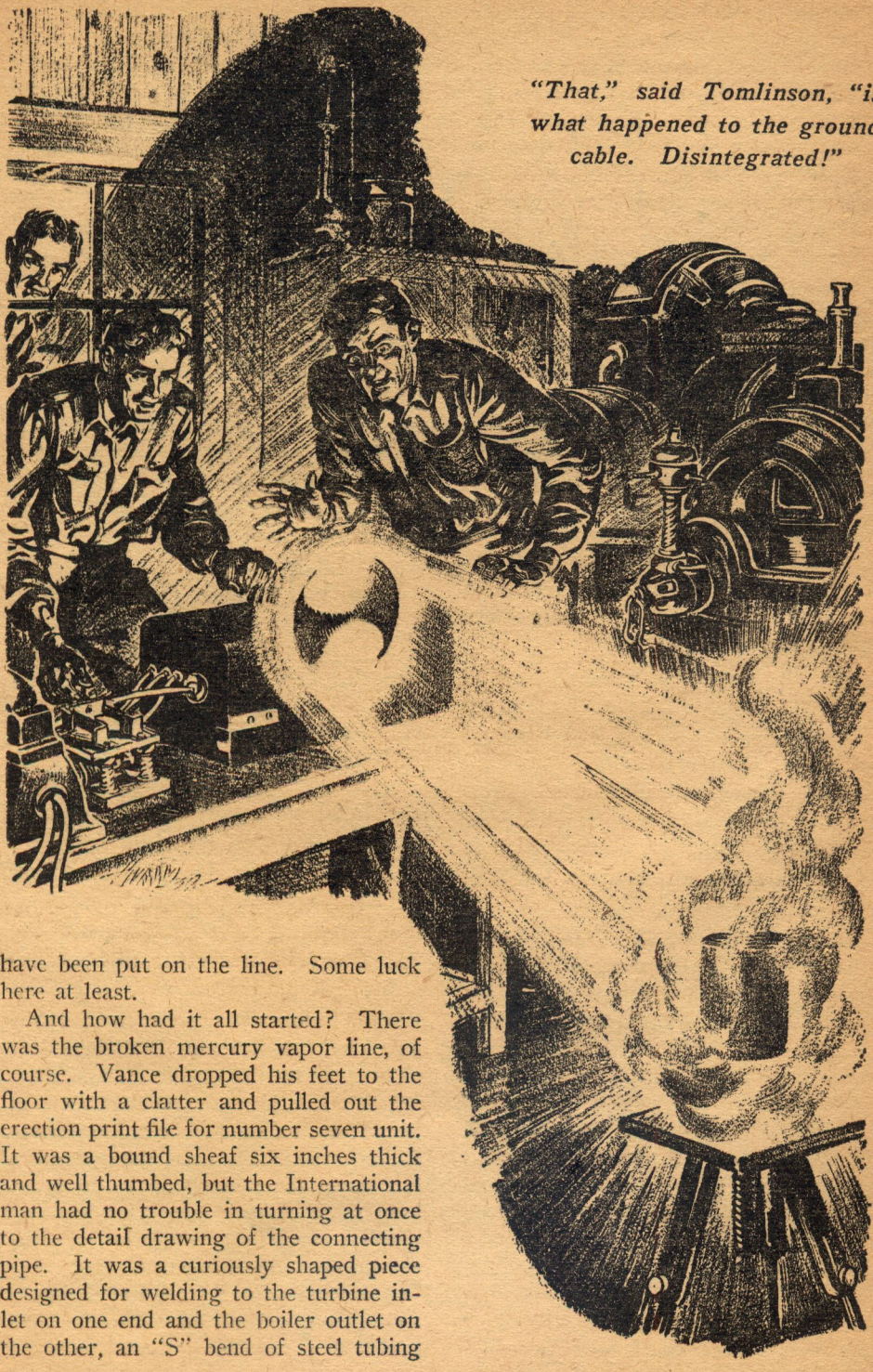
And the direct current transmission had been the key to the atomic powering that now made the old coal bunkers, pulverizing equipment, boilers, and high pressure steam units obsolete. Atomic power! Dreamed of, written about, and experimented with for years. Not as difficult of accomplishment as had been feared.

Three hundred and fifty thousand volts DC fed into the blast tubes whose neutron bombardment served as the igniting energy for the progressive disintegration of fuel having a uranium base. Such an inferno of heat was developed as had never been approached with the old pulverized fuel burners. And at less than one percent of the cost for fuel, with the additional advantage that no forced or induced draft fans were necessary, no stacks, and a minimum of residue removal. Atomic power was here, had been for some time and was successful. True, there were still minor difficulties to be ironed out. It would be a number of years until all of the experimental work was finished. Therefore, the clutter of manufacturers' shacks in the yard between the plant and the river. Condenser builders, turbine and generator manufacturers, the switchboard experts, atomic blasts, pumps, motors, phanotrons—all were represented. Each had a small office and toolshed combined. And each its own little hotbed of intrigue.

Of these, the sheds of Atlas and International Electric were the largest and the best equipped. And the feeling between employees of these two organizations was most bitter. Why, no one could say. Of course, commercially, they were strong competitors; the loyalty of the employees of each was great. And their personal animosities were engendered thereby.

Vance had been on this job for International now for a period of more than a year; Kirk had only recently arrived, and it seemed that his advent had marked a series of plant troubles which had not been the rule when his predecessor was here. And always the difficulties seemed to originate with International apparatus. Vance knew in his own mind that the sleek Atlas engineer was responsible, but had never been able to put the finger on him. Now, with this latest and most serious of the shut-downs, he was going to break his neck to get the evidence.

With Potomac down for so long, the other plants of Seaboard had been hard put to stay on the line at all and were forced by the huge overload thrown on them to cut off the power in large areas of distribution. Factories and mills were shut down for periods up to an hour. Raw stock ruined, processes needing complete restarting, vilification of Seaboard everywhere, it seemed. Had there been any burnouts in the switch house or the phanotron rectifiers, it would have been half a day before Potomac could



"That," said Tomlinson, "is what happened to the ground cable. Disintegrated!"

have been put on the line. Some luck here at least.

And how had it all started? There was the broken mercury vapor line, of course. Vance dropped his feet to the floor with a clatter and pulled out the erection print file for number seven unit. It was a bound sheaf six inches thick and well thumbed, but the International man had no trouble in turning at once to the detail drawing of the connecting pipe. It was a curiously shaped piece designed for welding to the turbine inlet on one end and the boiler outlet on the other, an "S" bend of steel tubing

with a ten-inch offset in the plane of the bends. He reached for his slide rule and made some rapid calculations, then sat back and scratched his head, puffiing furiously at his black brier.

The point of maximum stress when acted upon by a force horizontally, was precisely at the point of welding to the turbine inlet. But if acted upon by a force vertically, the maximum stress was exactly where the break had occurred! If turbine vibration had crystallized the material, the pipe would have broken at the weld, for turbine vibration is in the horizontal plane. Therefore, there must have been a powerful oscillating force acting in the vertical plane. How could that be? The answer was, it couldn't, yet here were the figures.

"Damnedest thing I ever heard of!" Vance swore aloud.

"THERE'S lots of funny ones, Les," a cool voice came from the doorway.

"Oh, hello, Tom." Vance looked up at the gaunt figure which faced him. Tomlinson, lean-jawed, bald, and with those serious gray eyes now twinkling, stood there.

"May I come in?"

"Sure thing. What's on your mind?"

"Same thing that's on yours, I guess." Tomlinson took the seat Vance indicated by a wave of his pipe stem. "Only I'm between two fires. Atomic sells their stuff both to Atlas and International. I'm in the middle."

"Oh, then you have the same suspicions I do."

"I wouldn't say that, Vance. Wouldn't dare. But something is mighty queer."

"You're telling me. What do you think of the broken pipe?"

Tomlinson shrugged wearily. "It's beyond me. I know the boiler couldn't have anything to do with *that.*"

"How about the arc?" asked Vance.

"That's something else again. You send for your electrical man? There are your bushings on the boiler, you know."

"Yeah, I sent for him. Be here tomorrow. Say, tell me something more about the atomic power business, Tom. I'm an old time turbine and condenser man, you know, and I'm not so hot on this new end of the boiler game. Just how does the thing work?"

Tomlinson cocked a quizzical eye. "Got a hunch, have you? Anyway, I can give you the lowdown in words even you can understand. You've seen the inside of the boilers; you've seen the tubular tungsten alloy fuel cores; you've seen the big vacuum tubes that use the 350 kv. juice—some cluck called them blast tubes and the name has stuck. The cores really should be called that instead, for that is where the blast of regenerative distintegration is produced. Well, the fuel comprising the rods that are fed slowly into the cores is a special mixture of uranium oxide and dilutants to bring up the bulk and bring down the temperature of disintegration. The blast tube is merely to ignite the uranium, which then continues its own production of flying neutrons and keeps up the disintegration indefinitely by the resultant bombardment. The actual heat of disintegration of pure uranium oxide is unheard-of and unusable, some two hundred million million degrees Centigrade, therefore the need of diluting."

"Can't you stick to Fahrenheit?" grumbled Vance. "A thousand F. is about the limit of my comprehension. What's the temperature of the fuel cores?"

"Something like 5,000 degrees on your Fahrenheit scale. Therefore, the use of cores containing a high percentage of tungsten, which melts at 3,370 Centigrade . . . I beg your pardon . . . 6,100 Fahrenheit. This intense heat radiates upward into the series of corrugated mercury drums overhead and the steam superheaters above those; it produces steam and mercury tempera-

tures just at your thousand degrees. There are no gases, no flues, no stacks —the heat is trapped; it can only leave the boiler by way of transfer to the mercury and steam and the inconsequential radiation. Efficiency is thus almost one hundred percent."

"Doesn't require much fuel, does it? In bulk, I mean."

"Very little. And, as you know, there is such a small amount of residue that the cores only need cleaning about once in six months. Not like the old ash and slag handling in the steam boiler room back there.

"No-o." Vance sighed reminiscently. "Not at all like the old days. And say, why the grounding of the fuel cores?"

"Because, in distintegrating, uranium breaks down into atoms of barium and masurium, with a small proportion of tellurium, iodine and such. These atoms later explode also from the continued bombardment. But, in the regenerative process, whole atoms are shot off with an energy equivalent of 200 million electron volts, actual potential of four million volts. And this potential must be grounded off."

"Holy smoke! Lot of power in that stuff."

Tomlinson laughed. "Listen Vance . . . I think you know all of this, you faker . . . when we released for use the energy of the atom we got something. One cubic foot of uranium oxide, disintegrating, releases energy equivalent to that contained in three and one half million tons of coal or fourteen million tons of TNT. One pound of the pure oxide an hour could produce more power than all of the plants in the country combined. How do you like that?"

Vance whistled. He had not heard some of these figures before; very little was being published by Atomic Power about their product. "What is the stuff you use to dilute the uranium oxide?" he asked guilelessly.

Tomlinson grinned. "A lot of people would like to find out. But say, confound you, all of this has nothing to do with your trouble or mine."

"Yours? You don't know anything about trouble."

"What about the arc?"

"They'll blame it on the International bushings—you know that. It has never once happened on an Atlas job."

"Hm-m-m. But, Vance—"

Both men sat up suddenly as if propelled by springs. A faintly shrill scream rose on the air above the sixty cycles hum of the big plant across the yard. The vapor alarm. Again! As with one accord, they were out through the doorway of the shack, sprinting toward the powerhouse.

INDESCRIBABLE confusion once more reigned in the place, this time reaching almost the proportion of a panic. Number nine unit was off the line, slowing down, molten cadmium pouring into the fuel cores to quench the fires. The rest of the plant remained in operation; there was to be no shut-down. This was only an escape of vapor. But possibly a serious one.

Vance was up the iron stair alongside number nine two steps at a time, Tomlinson crowding at his heels. By the time they reached the top the air would be clear; the leakage was stopped, since the vapor pressure had been blown down —with considerable loss of mercury— and there would have been complete condensation of what vapor had already been loosed up there.

When they reached it, the mercury turbine had almost come to rest. There was no indication of a blade rub, this unit having been inspected and cleaned recently. But the heavy insulating covering had been blown partly away from the inlet pipe; it was sizzling; dripping metallic mercury.

"Better use a mask," Tomlinson warned, taking two from the locker.

Vance donned one hastily and ex-

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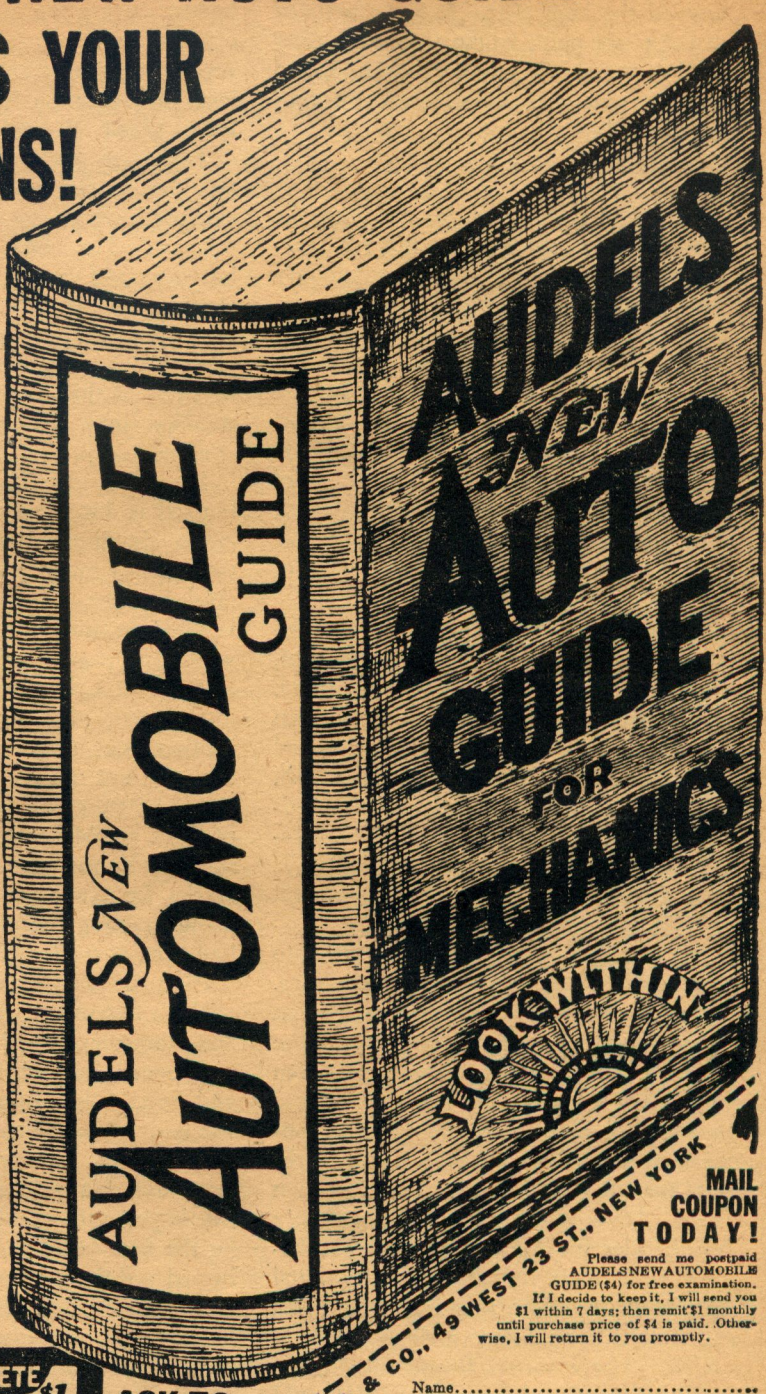

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amined the inlet pipe. It had fractured at the exact point where the same thing had occurred on number seven. And number nine was likewise an International job!

III.

LATER that evening, Vance used the long-distance telephone, talking earnestly and at length to International's vice president in charge of engineering. He had to get his man at his home and some of what he had to say would not have been safe in the mails. When he had finished, he had Bannerman's promise that Joyce Kirk's record with Atlas would be investigated. Carefully, of course, ever so carefully—but thoroughly. You couldn't make trouble with Atlas, but there were ways of learning things.

At Potomac there was a million kilowatts of capacity under the one roof. One million in ten combined units. Now, with two International units down for repair, this was cut to eight hundred thousand. And Potomac was base load, supposed always to be operated at maximum capacity, the pilot plant of the system and by far the most efficient. It was a serious situation for International and bound to react unfavorably.

In his hotel room, Vance sat far into the night considering the possibilities. Number one mercury unit was safe; that was Atlas. But three and five were entirely International, along with seven and nine. He would put men—there ought to be regular watch engineers continuously up there, anyway—atop three and five, and keep them there. His own men. He would keep others constantly on the alert to observe any possible disturbances with the three International steam units still operating. And he, personally, would keep a close watch on Kirk. There would be no more grief with International equipment if he could help it. He supposed they would start up some of the old high pressure steam boilers during the night and two of the old back pressure turbines so as to get seven and nine condensing steam units back on the line. And how they would holler about the cost of fuel!

Trying to puzzle out reasons for the troubles of the past two days, Vance smoked a whole can of his foul-smelling tobacco. The bowl of his pipe was so hot he could hardly hold it. And his tongue was raw. Still he could not put his finger on any one thing that seemed plausible as an explanation. Eventually he tired of this unpleasant pastime and tumbled into bed, where he fell into troubled sleep.

He awoke unrefreshed, nearly scalded himself in his shower, and cut his chin while shaving. Breakfast left a bad taste in his mouth; his pipe was worse. And his car, when he started it, developed an annoying body rattle. So it was in no particularly good humor that he arrived at the plant.

He went at once to the shack and snapped out orders at his men. But they did not notice; they were, most of them, as upset as he. And every one of them would do anything in the world for Les Vance. Looking up at the old stacks, he saw at once that his surmise about starting the old steam equipment had been correct. He would hear about it from the plant superintendent later.

With two men each on numbers seven and nine mercury, burning off the old pipe bends, and with one each on three and five, he had only two left to watch the five International condensing units. He wired the factory for more men and reiterated his previous message as to the importance of emergency shipment on the new bends. As an afterthought, he ordered three spares to follow.

Tomlinson came from his own shack to meet him when he started across the yard to the powerhouse. "Got any new ideas, Vance?" he asked.

"Not a damn one. You?"

"Even less than that. But"—Tom-

linson lowered his voice—"I saw Kirk way up on the top gallery a while ago, looking down at number five."

"Yeah? What the hell can he be doing up there?"

"Search me. It's a mystery, all right. You could drop a wire across terminals from up there but you couldn't break a pipe."

"Well, he better keep out of my way today. And away from my machines," growled the International man. "I'm getting fed up with this."

"Don't blame you, Vance. Of course, I can't say a word or do anything, but you know I'm with you in spirit."

"Thanks." They were in the plant now and Vance stopped to watch the crew that was working on the circulating pump repair on number nine. This shut-down had given them a chance at this earlier than expected.

Something about the new bronze runner caught his eye and he stooped to examine it more closely. Two of the broad vanes had been neatly cut away on one side with a thin-bladed saw. If this runner had been installed and the 30,000 GPM pump started up, there would have been another wreck. And this casting had been part of the load Kirk had ridden down from above two days ago. This was the first time the Atlas man had really left his tracks.

Vance said nothing to the men of the Potomac repair gang, but walked through the basement to the elevator. If Kirk was still on the top gallery, he'd have it out with him up there now.

COMING FROM the elevator on the boiler room side of the wall, Vance saw that two of the old 1,350 pound boilers were in operation as well as two of the 25,000 KW, 1,200 pound back-pressure machines. These now were feeding 400 pound steam to numbers seven and nine condensing units. There had been good reason, it seemed, for keeping the old equipment for stand-by service.

Going through to the gallery on the engine room side, he saw that Kirk was still there, a motionless, shadowy figure in the dimness. There was something in his hands, something that he alternately raised and lowered, first fussing with it at waist level, then raising it and holding it close to his face. Vance moved nearer. The thing was a candid camera and the Atlas man was taking pictures of the various units in the plant. He stood directly above number five.

The International man grinned in spite of himself. So Kirk was one of those—a minicam enthusiast. Well, there could be no great harm in taking pictures, even if some of them were of International machines. The pump runner and the other incidents were something else again. Vance moved to where the amateur photographer stood.

"Getting anything in this light?" he asked innocently.

Kirk jumped as if shot, tried awkwardly to hide the camera behind him. Vance observed that from its compact body there projected the tube of a long-focus lens, a telephoto. The Atlas man was taking close-ups. "What's it to you?' he demanded of Vance belligerently.

"Nothing. Only I'm a fan myself. Mind if I look at your box? Seems like a good one."

Kirk's sneering smile somehow had faded. He hesitated, half handed over the candid, then, midway of his motion, clumsily let it fall. It bounced off the edge of the gallery floorplates, arced out and, a few seconds later, crashed sickeningly on the iron gratings behind number five mercury.

The Atlas man was white and shaking. "Damn you!" he grated. "That's a three-hundred-dollar camera."

"Was," Vance corrected him. "And I didn't drop it."

With a grunt that might have meant anything, Kirk ducked through the door to the elevator and was gone. Vance

leaned his elbows on the rail and looked down at the top of number five mercury. His man, he saw, was seated there keeping a close eye on the indicating and recording instruments. Over at seven and nine, his men were burning away the fractured vapor lines. Far down on the turbine floor, two of them were going methodically from one to the other of the International 60,000 KW condensing machines, checking up on their operation. There was no indication whatever of trouble, either actual or impending.

Vance thought of the changes since he had gone in for power plant work twenty-five years ago. Then it had all seemed fairly simple and understandable; troubles had precedent—you knew how to handle them. Now everything was different. The atomic powering, as such, gave very little cause for anxiety excepting as to maintenance of efficiency. Most of the difficulties were in the mercury drums of the new type boilers and in the mercury turbines themselves. This, of course, was due to the penetrating neutrons which continuously brought foreign elements into being in the vapor. Vance had often thought the mercury turbines were poorly placed on top of the boilers. Yet he knew it had to be so on account of the feeding of the condensed mercury back to the drums of the boiler by gravity, thus eliminating a feed pump. The mercury condenser directly beneath the turbine likewise gave little trouble; it really was a steam boiler providing the steam for the condensing unit on the floor below. Yet it operated, excepting for the temperature, almost exactly like those 55,000 square foot condensers in the basement. Vance recalled vaguely some figures.

Mercury vapor expanded from 180 pounds absolute pressure at 1,000 degrees Fahrenheit to one and one half pounds absolute, about twenty-seven inches vacuum in the turbine. The exhaust steam at 485 degrees F. contained sufficient heat to evaporate the condensing water and produce steam at sufficient pressure to maintain 400 pounds at the throttles of the condensing machines below and take care of the piping loss between. So the maximum possible work was obtained both from the vapor and the steam. It was really something, this binary fluid cycle. If only there weren't so many aggravating details to look after, platinum and such junk to be scaled from the blading, vapor leakage, God knows what. But, some day, they would have it all under control.

Vance, just turned forty-six, remembered when platinum was considered a costly metal and was highly regarded in the jewelry trade. Now, since the advent of atomic power, it was a drug on the market. Times sure had changed.

Far below, he now saw Kirk retrieving the remains of his camera. A mounting grin slowly changed to an expression of solemnity which would have been obvious to any observer, even in the dim light up here. At this moment, Vance would have given a great deal to examine that smashed-up picture-taking contrivance. Perhaps he was much too suspicious of the Atlas man, but certainly the guy had a lot of tricks up his sleeve. Might not this camera be another subterfuge?

Two men in street clothes were mounting the long flights of steps to the top of number seven. These would be the factory experts Vance had sent for. He made haste to get down there.

Dick Norman, the metallurgist, Vance knew. But he had never met the high tension research man, Backus. Number seven mercury turbine, of course, was open for scaling. Seated on the flange of the cylinder base, Vance told the story of the difficulties in as few words as possible. And Backus and Norman went immediately to work.

Vance returned to the turbine floor and went looking for Kirk. That was

his job now, to keep tabs on the man he was sure had been at the bottom of all the trouble. A search of the plant convinced him that Kirk was not around. He went out on the old fuel unloading dock and into the yard. The door to the Atlas shack, he saw, was now closed. Earlier, it had been open.

He skirted the edge of the yard, keeping well behind the row of shanties, until he came to the back of the large one put up by Atlas. There was a smudged window here, through which he peered. Kirk was inside, at one of the workbenches, with a smashed mechanism in his hands. It was the candid camera, a sorry sight now. But a duplicate box, great blinking eye and long tube of the telephoto lens and all, was before the Atlas man on the bench. He was removing something from the twisted box of the ruined instrument, something that looked like a series of disks of white metal with black separators between them. Vance could not see well through the dirty pane, but certainly this was no film Kirk was handling. What then? The International man let his eyes rove. This was a back room of the shack, probably Kirk's private sanctuary. There were a number of portable instruments on a shelf—the like of which Vance had never seen. Certainly nothing like these was included in the test equipment furnished by International.

A quick movement of Kirk's head toward the window caused Vance to duck out of sight. He would have to find a way into this shack tonight and see what he could learn.

ONCE MORE on the turbine floor, he found Dick Norman arguing with Tomlinson. "But I tell you," he was saying, "there has been a slowly oscillating force acting on the bend in a vertical direction. It must have been from the boiler."

"Impossible," Tomlinson smiled. "There is no characteristic of the boiler condenser, or of the connecting piping beneath, which could account for it. Besides, the expansion loop leading to the outlet is anchored solidly just beneath

the welded connection to your inlet pipe. That *can't* move."

Vance butted in, addressing Norman: "I found the same thing, that only a vertical force could snap the pipe at the point of fracture."

Tomlinson walked thoughtfuly away, toward one of the mercury boilers. Vance could see that he was more than ever puzzled.

Norman said, "I can't understand it. The fracture shows unmistakable evidence of material fatigue. For some time that tubing has been flexed slowly up and down, the localized stress at the point of fracture having been raised again and again, beyond the elastic limit of the material."

"Why do you say slowly?"

"Because if there had been oscillation at any considerable rate of speed it must necessarily have been audible, must have been felt in the form of vibration."

"And it wasn't." Vance stared at the metallurgist.

"Well"—Norman was suddenly a little wiry bundle of energy—"I'm going to take the portable X ray up on number five and see if the same thing is happening on that connecting piece. Don't want another—" His voice trailed off as he vanished down the aisle.

Vance climbed the stair to where George Abt sat watching the instruments. If anything happened atop number five it would be just too bad.

"Everything all right, George?" he asked.

"Far as I can see, boss. Look at the instruments."

Instead, Vance walked over and stood regarding the sweeping bends of the inlet pipe. A hand laid on the heavy insulating covering conveyed to his brain no sense whatever of movement, either vertical or horizontal. The 40,000 KW mercury turbine itself was as vibrationless as ever a unit had been built. It was operating at full speed of 900 RPM and, at no point, either on the turbine or its hydrogen-cooled generator was there more than the faintest tremor.

The recording vibrometer showed uniformly for the past twelve hours of its chart vibratory movement not exceeding one half a thousandth of an inch on any of the bearings.

Norman arrived with the portable X ray, which he set up at the connecting pipe, plugging in back of the instrument board. He wrapped film envelopes around the pipe at the point where the others had fractured, making two exposures. Then he was off down the stairs to his developing tanks.

Vance followed slowly floorward. It would be ten minutes until Norman had his answer. You couldn't help admire the little guy for his efficiency. He wasn't taking any chances on repetitions of the previous failures. But suppose he did find that number five connecting pipe was about to fail? What would Potomac say if they had to ask for an outage of the unit? The thing was becoming more and more complicated. And what *could* produce a slowly oscillating force, anyway?

He was halfway down to the turbine floor when it happened. There was a terrific roar from within number five boiler beside him. Its sides seemed to bulge and its bulk almost to leap from the foundation. The stair shook crazily; on his knees, Vance clung for dear life to its greasy treads. Then the scream of the vapor alarm, a pandemonium of men yelling, George Abt clattering down from above, enormous heat radiating through the thick insulation of the boiler walls.

"Nothing wrong on top," Apt was yelling. "What in hell happened?"

Together they crept down to the engine room. A glare illuminated number five steam unit; the sputter of molten cadmium and the roar of the quenching atomic fires was deafening. Men were running in all directions from the heat and escaping vapor. Vance and Abt, shielding their eyes against the glare with their arms, skin seared, lips clamped tight and noses pinched shut, ran with them as soon as they had set foot on floorplates.

The entire front of number five boiler had blown out. Red-hot drums were bent, twisted and broken. The fuel cores had been ripped apart and were sagging, sputtering masses in the quenching. Fortunately, no steam line had broken.

At a safe distance, donning a mask suddenly thrust into his hand by Tomlinson, who appeared providentially from nowhere, Vance looked back disbelievingly at the wreckage.

Poor old Tomlinson would have a headache now.

IV.

NUMBER FIVE had been tripped off the bus without disturbing any of the other units. Again a complete plant shutdown had been avoided. They were getting wise up there on the AC board, getting used to this sort of thing and calmly handling it. But within two hours the plant was full of men, old and young, running hither and yon, gesticulating—and gathering for frequent, red-faced arguments. Investigating.

Two Seaboard men had been instantly killed by the blast. A long period of outrage and costly repairs were necessary. Number five had dumped her two hundred tons of mercury. Much of this could be reclaimed from the sump, of course. Still there was a great loss. And a new mystery to solve.

Tomlinson was like a man bereft. Executives of Atomic Power were already here, jumping him unmercifully. But what could he do? Somehow, incredibly, the entire forty foot length of the ground cable below the floor had disappeared. Just vanished, that was all. There was the terminal lug up above at the boiler, and the terminal lug at the bottom of the duct in the foundation. Examination of both ends showed that the cable, in some unexplainable way, had been fused entirely away. Yet there

were no signs of burning nor was any molten material found in the duct. The four million volt potential above had crashed across to the nearest mass of metal when the ground was interrupted. And the nearest mass of metal had been the staggered bank of mercury drums overhead, now so sadly wrecked.

For all that, this was Atomic equipment, Vance knew that International held the bag with Seaboard. It was still his funeral and he looked as if ready for an actual one. Kirk was nowhere to be seen. Undoubtedly he would again have a perfect alibi.

"Nice mess again, isn't it?" he remarked to Tomlinson. They stood for the moment alone near where the men were clearing away the débris from in front of the boiler.

"Swell. And am I taking it on the chin!"

"But I'm the real goat, as usual."

"Sure, you have to account to Seaboard. But maybe you don't think my people'll have to account to yours. And International can be tough, too."

A messenger, running up the aisle, stopped and tapped Vance on the shoulder. "Telegram for you, sir," he said.

Vance grunted as he ripped open the envelope: "This'll be good, Tom."

The wire, from Bannerman, read: "Man you mentioned clever research worker for years on death ray, long range magnetization nad demagnetization forces, and radio transmission of power. Demoted to service engineering on account of anti-social activities in New York state. Watch Davis, his assistant. Am flying down. Will arrive Potomac Plant this afternoon."

"How do you like that?' asked Vance, handing the wire to Tomlinson. "Death ray man, is he? Now we know what happened to Curran, but try and prove it."

"Why, the man's a homicidal as well as a destructive maniac," said Tomlinson, handing back the yellow slip. "He ought to be locked up."

"He will be"—grimly. Vance turned and saw that Kirk, suave as always, but with his usual sneering smile forced out of sight, was approaching them from the direction of the main entrance.

"Hard luck," he said hypocritically, when he reached them. "Seems something is always happening when I'm not here."

"Yeah. Where the devil were you this time?" growled Vance.

"Had to go up to the city for a couple hours. Ask Davis here." A beetling, square-built man had walked over from number six to join them.

"He your yes-man?" Vance sneered.

"Hey, you louse, I resent that," the newcomer snarled, doubling hamlike fists.

"Go ahead and resent, cockroach. And if you want to make anything of it, come out in the yard. You're a pair of crooks, the two of you." Vance walked away with Tomlinson, leaving the two Atlas men with heads together, muttering.

"YELLOW as hell, both of them," Vance told the Atomic man. "That's the Davis Bannerman said to watch. And I just thought of something; he's been working on a big Atlas motor down below, circulating pump drive on number six condenser. Let's take a look down there."

They found the big, slow-speed Atlas motor partly dismantled, but no man of Kirk's crew was in sight. A large, black case stood beside the motor and to this case there had been run three temporary cables from the three phase 2,220 volt line which normally fed the motor, but was now disconnected.

"Ever see any test apparatus or instrument like that?" Vance asked Tomlinson.

"Never did. What is it?"

"You're asking me. Well, I can

guess. Notice the circular disk on this side of the box; notice it faces directly toward that ground cable duct under number five?"

"Cripes! So it does. You think—"

"I think Kirk had Davis turn this thing on and that one of his damned long range energies did away with the ground cable. Let's pull the switch and see what happens. The cable's gone; it can do no further harm. But maybe we can—" Vance was at the switch which ordinarily started the motor when Davis hove into view.

"Get to hell out of there," the man roared, his face purple. "You got no right fooling with our stuff. I'll break your lousy neck, you—"

"That's what you think," Vance shot back. "What's this thing, Davis?" He indicated the black case.

"None of your business. And get out of here before I throw you out."

"What's in this case?"

Bellowing like an angry bull, the man rushed in. Taken by surprise, Vance went down under a sledgehammer blow to the jaw that took him off balance. But he was up again like a bouncing rubber ball. Shaking his head to clear it, he weakly parried a storm of flying fists until he was sure of his ground. Then, dancing away, he squared off and took the aggressive. For all his forty-six years, Vance had kept in excellent trim.

He bored into the square-set Atlas man with the fury and vigor of a youngster, enthusiastically egged on by Tomlinson. Swift jabs to the midsection had the Atlas man doubled over and in sharp pain. An uppercut set him back on his heels. But Davis was no mean antagonist. He recovered and once more came in slugging. A blow that glanced off Vance's temple had him reeling; one over the heart sent shooting pains through his chest that were almost intolerable. Specks floated before his eyes; he could barely see the leering face before him. He backed off. Davis, too, quick following his advantage, left himself wide open for just the necessary instant. Vance, recovering miraculously, brought a haymaker up from the concrete floor that landed on the point of Davis' chin with a crack like a snapping board. The square form of his antagonist straightened up as the head snapped back; then it sagged slowly to the floor. Davis was down and very much out.

"Attaboy!" whooped Tomlinson. "Why buy fight tickets with you around?"

"Yeah," observed the International man gloomily. "That's all right, but now he'll tip off Kirk when he comes to, that we know something."

"What of it? Let's swipe the black case; then he'll be sure we know something. I'm in on this now as deeply as you. I'll keep the apparatus, whatever it is, in my shack until the fireworks are over."

"You wouldn't."

"I would—and will." Already Tomlinson was disconnecting the cables. In a minute he had hoisted the case to his shoulder and was on his way to the yard.

Davis had not yet stirred when they left the scene.

SOMETIME LATER, Vance and Tomlinson were watching the work at number five. An emergency repair gang had been called in and the débris inside the boiler was rapidly being removed. Below, another crew was replacing the ground cable. Tomlinson had plenty of his own men on the job and plenty of replacement stock.

Kirk and Davis were nowhere to be seen, had not been for several hours. There was something ominous about this; ordinarily, at least Kirk would have been hanging around with his knowing leer. But now he was among the missing.

Number five steam unit was again operating; they had started up another of the old high pressure steam boilers and the third one of the back pressure machines. Soon there should be violent protest from the front office.

There was. A boy pranced up with the information that Mr. Bannerman was in with the plant superintendent and requested the presence of Mr. Vance. Tomlinson dropped a suggestive eyelid as Vance turned to follow the boy.

"Good luck, old timer," he flung after him.

But the luck was not so good. In the super's office, flanking the conference table were several pompous gentlemen, all of whom wore expressions that could be classified only between frowns and scowls.

Bannerman arose and indicated an elderly, aristocratic man at his side. "Vance," he said, "This is Mr. Van Doren, president of Atlas Electric. Sit down."

Vance sat, facing the two.

Bannerman cleared his throat. "I am afraid, Vance, that I have a painful duty to perform. But first I must tell you the reasons, tell you what I have learned. Mr. Van Doren is here at my request, and I am glad he found it advisable and possible to come. There has been a serious situation here at Potomac, a situation with which you are acquainted and in great part responsible for."

"Mr. Bannerman . . . your wire—"

"Just a moment, please. It is now plain to me that you misrepresented the facts in your telephone conversation last evening. It is likewise plain that neglect on your part accounts for most of the troubles with International apparatus. In the first place, there never would have been the blade wreck of number seven mercury turbine if you had seen to the regular inspection for blading deposits."

"That is not true, sir. These platinum deposits come suddenly . . . they—"

"You will please keep your counsel, Vance. I have the floor. Norman tells me, too, that a vibratory force broke the pipes on seven and nine. Those turbines were not in balance."

"Did Norman tell you all of it?" Vance could not remain quiet.

Bannerman purpled and forgot his dignity. "Shut up!" he snapped. "Further, Backus reports that there is no explanation possible for the arc across number seven excepting that someone must have tossed a wire across the terminals. The wire, of course, would have completely burned up. And that someone, could only have been your man Curran, who was up there alone. Your supervision was lax, Vance."

"And Jerry Curran's dead," Vance said bitterly. Even Bannerman's scowl could not keep him quiet.

"Not only your laxity is blameworthy, but you have not conducted yourself as a gentleman with the Atlas men. You have continuously persecuted Mr. Kirk, and today you laid violent hands on his assistant, Davis, who is in a deplorable condition from your manhandling."

Vance was forced to grin. And the grin brought the chill of ice into Bannerman's tones.

"I shall not discharge you," he said, "on account of your long service with the company. But I must remove you from this work here and return you to the shop."

"Mr. Bannerman!" Vance was on his feet, rage eating into his vitals. "This job went along fine until Kirk came on it. He, not I, has been the—"

"Stop it!" Bannerman shouted. "I must remind you that you are my employee. I must remind you that Mr. Van Doren is president of Atlas. I must likewise remind you that, while he and I are competitors, we are both interested most of all, in the good of the industry as a whole. And for the good of the industry there must be no

friction between the two companies. Vance, you will remain on the job only until your successor arrives, which will be tomorrow. Then you will report at the factory, to Mansinger."

Mansinger! In the blade shop. They expected him to go back to a job like that. Vance was on his feet again; nothing could stop his tongue now.

"Mansinger, hell!" he spat out. "I don't accept your demotion, Bannerman—I resign, here and now. Letter follows. And now I'm going to tell you something, you and your precious co-worker for the good of the industry. You can both take it and like it. Atlas or no Atlas, International or no International, a crooked game is on foot here. And Kirk is responsible for it. I can, and will prove it, on my own.

"I know certain things and surmise others I know I can prove. Murder has been committed here on this job—Jerry Curran's deliberately, the two Seaboard men indirectly. Sabotage of the worst sort has been perpetrated. And the Atlas Company, through the dirty work of their representatives, is responsible. I tell you and Van Doren both, that it will all come out—through me. And don't forget that there are such things as the County Police and the F. B. I. You, Bannerman, have taken the words of Kirk and Davis without listening to my story. I warn you, you'll regret it. You, Van Doren, have put one over on International—temporarily. The two of you, separately or together as you choose, can go to hell. Good-by, gentlemen."

Vance stalked out and slammed the door vigorously against the dead silence that followed his speech.

V.

As HE wandered aimlessly down the main aisle of the plant, Vance's mood sank from one of intense rage down through bitterness to Stygian gloom. Twenty-five years with International, practically brought up in the company,

always loyal and conscientious, and now to join the great army of the unemployed. It wasn't fair. In fact, it was entirely screwy. He couldn't understand the sudden change in front Bannerman had exhibited. That wasn't like the man; Vance had always known him to be sensible and just in his decisions. Something screwy here, too. Did Kirk have them all hypnotized as he had some of the fool women? Or what was it?

Well, doggone it, job or no job, Vance was still an International man. And he was not going to stand by and see the company's property destroyed and its reputation blackened. This now was a personal feud between the Atlas man and himself.

Tomlinson, he found, was no longer at number five; one of the men said he had gone out to the Atomic shack. Vance wandered out into the yard. He found the door to the shack closed and bolted on the inside.

"Hi, Tom," he called, banging on the rough wood.

After a moment of silence: "Who's there?" Tom's voice husked cautiously.

"Vance. Got something to tell you."

"Oh." The bolt was withdrawn. Tomlinson rebolted the door as soon as Vance was inside. "You've got something to tell me? Wait till you hear what I'm going to tell you."

"All I had was I'm through with International."

"Bannerman? I suspected something of the sort when I saw him with Van Doren. Didn't want to tell you. Don't worry; we've the goods on one thing at least."

"The black case?"

"Sure thing. Look here." Tomlinson led him to an inner room where were set up the electrical testing apparatuses used in Atomic's experimental work on the job.

Davis' black case was connected to the 2,200 volt side of the step-down transformer. Its disk, gleaming copper-red, faced an insulated tripod which sup-

ported a large copper terminal lug, such as those used on two million circular mil cable. Tomlinson pulled the switch and there was a sharp sixty cycle hum from within the case. Nothing happened.

"Now watch," said the Atomic man, attaching a length of number six weather-proof wire to the lug and grounding its other end on the water pipe.

Again he pulled the switch. This time, with the sixty cycle hum, there came a blinding flash from the tripod top. The copper lug vanished in a quick puff of green smoke. It was almost like the explosion of old-fashioned flashlight powder.

"That's what happened to our ground cable," croaked Tomlinson. "That crook of a Kirk must have swiped this apparatus from the main Atlas research laboratory. I don't believe they know he has it."

"W-what is it? Atomic disintegration?" snapped Vance.

"No; something different. I haven't been able to dope it out. Only works if the object's grounded and only with copper. No effect on other metals. Seems to be just a terrific heat which vaporizes copper. The gas from the cable escaped out the duct vent. I saw copper-plated bolt heads all around under the boiler."

"Lot of cute tricks our friend has, I'd say," said Vance.

There was a window at the back of this room; Vance was staring at it. "Yes," he gritted. "Such as spying on his neighbors. Taking a page out of my book."

Tomlinson's eyes followed the ex-International man's gaze. He saw, as did Vance, Kirk's face pressed against the pane. The man's eyes were those of a maniac; fixed and glaring with unutterable hatred. Then the face was gone and so was Tomlinson.

Vance tore out after him as the Atomic man sprinted after Kirk. He was sure that Tomlinson was thoroughly aroused. Kirk ran for the plant like a scurrying rabbit and was inside the great double doors when Tom was still a hundred feet behind. Vance caught up with his friend just inside the railroad siding entrance and found him looking in all directions for his quarry.

"You search the basement and I'll go up to the turbine floor," Tomlinson said. "I didn't see which way he went, the slippery snake."

With Tomlinson's clattering up the stair came one of Vance's sudden inspirations. They would not find Kirk in the basement nor upstairs, either. Sure as God made little apples, he'd head for the top gallery. Why this inspiration seemed logical, Vance did not know. It did not seem possible that the crazy Atlas engineer would attempt any more monkey business with Van Doren here, especially after having cleared himself with the president of his company and so successfully shifting the blame. But you could not account logically for Kirk's actions, anyway. Vance headed for the elevator.

Its dial indicator showed it halfway to the top of the shaft. Vance would have bet good money right then, that Kirk was riding it. He waited patiently for its down trip, then pressed the button again and again. It seemed it would never hit bottom.

On his way up at last, Vance was so lost in thought that he did not call his destination. The result was he soon found the car stopped in the penthouse whose door led to the flat roof of the plant. Another inspiration!

"Want off here?" asked the operator.

"Yes." And Vance was out on the roof.

Something led him to a point he judged roughly to be over number five mercury unit. And here he found another peculiar set-up. A strongly-built fabricated steel arch had been bolted through the roof to trusses beneath. In

the center of this arch was an inclosed mechanism of some sort, from which ran two cables that dropped through a ventilator into the location of the old induced draft fans. There were 2,000 volts DC down there for the variable speed motor drives.

A rhythmic click could be heard from the mechanism. About twice a second, Vance judged the sound to occur. And, with each click there was a sagging of the arch which supported the machine. Revelation came on the instant and Vance rushed to the penthouse and hurried down the stair. He could not wait for the elevator now.

On the level that communicated with the old coal conveyors, he ran headlong into none other than Bannerman. What was he doing up here, anyway? Unceremoniously, he shoved his former boss aside.

"Wait, Vance," Bannerman called after him. "You jackass, wait. Didn't you know that was an act I put on for Van Doren? Come back here, you—"

But Vance was out of earshot now; he slipped out onto the top gallery. Sure enough, Kirk was there in the shadows. And he held a candid camera to his eyes.

Vance followed the line of his vision to the turbine floor far below. The camera was aimed directly at the group huddled before number five boiler. And, upstanding in that group was Tomlinson. Camera—hell; that thing was a death ray!

In one leap he was upon the Atlas man, tearing the box from his grip and tossing it back on the grating far out of reach. And then he was in the battle of his life.

If Davis had been tough, Kirk was tougher. He was a madman in strength. He was fighting for his life and he knew it. His first perfectly timed punch caught Vance full in the mouth, bringing a salty gush of blood. His second almost closed his attacker's right eye. Vance countered with a barrage of solid body punches that drove the Atlas man against the rail. Kirk kicked up viciously with a knee, a foul of the vilest sort that doubled the ex-International man in pain. Going down, he snatched at his opponent's legs and pulled him down. Then they were rolling over and over on the grating, pummeling each other, trying wrestling holds that each seemed able to get out of. On his back, Vance kicked out with both feet with sudden violence and Kirk was flung back against the tiled wall. Then, panting, both were on their feet.

It was a sparring match now, for a time. Both men were good boxers; each was wary of his opponent. Kirk, edging away, was moving nearer to the death ray machine. As soon as Vance became aware of this he closed in, slugging with all his might, forgetful of his science. His reward was a swift uppercut to the jaw which rocked him and brought a host of new stars into being. He fought back blindly, taking brutal punishment but wearing Kirk down with heavy body blows which somehow found their mark. Then his foot slipped and he went down again; clinching, he brought his opponent down with him. They rolled perilously near the edge of the grating. Clinging to a stanchion, Kirk was trying to drag Vance over, to send him hurtling down into the depths. Vance heaved up to one knee, struggling to rise. And then it happened. Kirk, in his efforts to send his foe overboard, lost his own balance. His body rolled, teetered, slipped over the edge. With one arm crooked desperately around the stanchion he dangled helplessly in space. He was at Vance's mercy.

"Help!" he pleaded. "Help me back up. I swear I'll lay off. I'll do anything to square things. Vance, it wasn't *you* I was after."

The ex-International man laughed. He had not observed the audience.

There were no less than five men on the gallery behind him. He would not have acted differently had he known that among them were Bannerman and Van Doren.

"Help you?" he chortled. "One kick and you'd go down. Suppose I kicked that elbow. Just once."

"Vance, please."

"All right, you skunk, I'll get you back, if you confess."

"I will. Anything. Quick; I can't hold on much longer." Perspiration stood out on the Atlas man's forehead in great beads. Blood streamed from a gash over his left eye. His lips were swollen almost shut.

"You killed Curran? Had Davis do it for you, when you were in the showers?"

"I did. God help me, I did."

"And you were just going to do the same for Tomlinson—with your candid camera?"

"Yes. Quick, Vance. Please!"

The ex-International man got a grip on the wrist of the arm around the stanchion. "I'll hold you here until you tell it all. Then I'll haul you up."

"Everything. It was all my fault, everything that happened. You found out about the ground cable, you and Tom. Well, I broke the pipes, too; had started on three."

"With the long range magnetizer on the roof. I found that out, too," prompted Vance.

"And the arc was started with a beam of ionized air directed across the terminals."

Vance saw his audience for the first time. "And the emergency power failure and the circulating pump rotor?" he persisted.

"Y-yes. Everything." Kirk moaned shudderingly and his head dropped forward. He had fainted.

"Help me, some of you guys," Vance grunted.

Bannerman and Van Doren were the first to respond.

DAZEDLY, after Kirk had been safely stowed back against the wall on the grating, Vance stood at the rail looking down directly to the floor a hundred feet below. Something was pleasing him greatly. He did not pay much attention to Bannerman and Van Doren, who flanked him, one on either side. He had not noticed that two of the other men displayed badges, that handcuffs were waiting for the Atlas man's recovery.

Bannerman was telling him that he was still an International man, that promotion was coming, that the fiasco in the superintendent's office had been a misunderstanding. Van Doren was apologizing profusely, first to Vance, then to Bannerman.

But Vance, though hearing, was thinking of something else. And he was pleased, mighty pleased with himself. Of course, he was an International man, always had been, always would be. But this other thing was more important at the moment.

"What's the matter with you?" Bannerman was saying. "Vance, are you all right? Here, fellow, look at me. Punch-drunk?"

Vance looked and his eyes *were* a little glassy. "I'm all right," he averred. His gaze returned to the distant floor down there, straight down.

"What do you see down there?" Bannerman demanded.

Vance wheeled about and was grinning. "Nothing but the floor," he admitted. "But I like to look at it. I'm cured."

"Cured? Of what?"

"Acrophobia."

"Acro—what?" Bannerman's jaw sagged in amazement. For a man to be thinking of some fool phobia—fear, wasn't it?—at a time like this was ridiculous.

"Fear of high places. Used to have it something fierce. Now I'm rid of it. I was almost over the edge a couple of times. Never once scared. Isn't that great?"

BRASS TACKS

Guarantee: E. E. Smith's serial is a super-epic!

Dear Mr. Campbell:

The August Astounding contains the finest line-up of stories I've yet seen in your magazine; and that includes the memorable December '38 issue.

"General Swamp, C. I. C.," by Frederick Englehardt, is plenty potent. Dr. Smith's "Gray Lensmen" will have to be super-epic to top it.

Of the three very excellent novelettes, Lester del Rey's is unquestionably the best. I predict that Ignatz, the unlucky zloaht will go far in science-fiction. Please advise del Rey to dream-up a sequel, pronto. P. Schuyler Miller comes through with a winner after his dismal "Coils of Time," which appeared May last. "Pleasure Trove" was fascinating reading; obviously the work of a master. I'm sure "The Blue Giraffe" will prove to be very popular. Clever idea, amusingly told by the most significant author of s-f since S. Weinbaum. The super-excellent L. Sprague de Camp has never been better.

Finlay's cover was disappointing. He's done much better covers. Actually, Wesso is by far the more consistent of the two, and a cover by him is long overdue. As a matter of fact, you'd please nearly everyone by getting Wesso full-time, and letting him illustrate the entire magazine. Cartier, Gilmore, Isip and Knoll are worse than useless.

For the Analytical Laboratory I rate the stories as follows: 1—"The Luck of Ignatz"; 2—"General Swamp, C. I. C."; 3—"The Blue Giraffe"; 4—"Pleasure Trove"; 5—"Stowaway."—Stanley Wells, 235 Noe Street, San Francisco, California.

Gregor genuinely seems promising. He has ideas, and can handle them.

Cheerio Campbell:

A few score lines to comment upon the July and August issues of Astounding Science-Fiction.

I doubt very much if the July issue fails to win the honorable position as the "best issue of 1939," for almost each and every story in that issue can compete for "best story of 1939" honors. If you are able to surpass that July issue, I'll recommend to your boss that you be allowed a month's vacation, *with* pay!

"Black Destroyer," is, probably, your best 1939 yarn. I am betting that the Analytical Laboratory will bear me out on that! "Greater Than Gods" comes up a close second. Have gathered several figures concerning this issue for next year's *Yearbook* already, and they bear me out. So much for that.

The August issue contains the works of two people whom I want to comment upon—Lee Gregor and W. A. Koll. The former, not because I know him and am merely giving a fan a boost, but because, for a fan *or* professional, I believe he has turned out a beautiful story. It surprised me tremendously, for I was looking for typical fan writing and was nicely disappointed. And, too, the plot and idea were fresh enough to prevent others from branding him as "the latest hack." As long as Lee doesn't slip to writing insect invasions, and Mercurian invasions, and saving the world in innumerable ways, I am all for him.

Now for Koll, the artist you have added. The best illustrator you have added since Finlay! Extremely good, with a refreshing new style. While I wouldn't give you a nickel each for those illustrations on pages 139 and 144, he very admirably makes up for them and then some on pages 33, 113, 122, etc. In fact, I was led to believe it was Finlay under a phony! At any rate, I pray for more and more of him!

And let's have more July issues! Thanks for the artist credit lines.—Bob Tucker, Science-fictionist, Box 260, Bloomington, Illinois.

Pass to Grade I?

Dear Mr. Campbell:

In this, my first letter to you, I shall attempt to give my impressions of the August issue, using an A-B-C-D-E-F system of grading the stories. That "E" rating is necessary, because I generally reserve the "F" for fan fiction; but don't worry—Astounding hasn't seen either in many a moon.

"General Swamp, C. I. C.," Part One. B. This

story's merit lies in its realistic treatment of the military campaign, its concise style, and its general avoidance of hackneyed phrasing and situations. Its faults are a certain atmosphere of brutal militarism and an insufficient realization of the changes that 300 years are likely to bring in the social structure and activities of our advanced but unstable civilization. Engelhardt's army of Venus still performs military drill, though such maneuvers lost their practical value at the close of the Napoleonic wars. And he still has Congress and huge monopolistic corporations going on as strong as ever.

"The Luck of Ignatz." C+. A fairly enjoyable tale, but it doesn't live up to your advance blurbs. The plot is archaic in so far as it concerns the human characters—this stuff about the heroic young man who loves the high-spirited daughter of a crusty old tycoon before whom he must redeem himself. Ignatz himself as a poor imitation of Johnny Black, and his trick of sleeping on steam pipes is unexplained and uninspired. His unluckiness has a superstitious tinge that seems incongruous with science-fiction.

"The Blue Giraffe." A—. De Camp, of course, not only knows his zoology backward and forward, but also knows how to use the English language in a literate fashion. Every character in the story has a distinct personality. He rates a "minus" sign because the climax of the story is foolishly melodramatic, with Mtengeni appearing in the nick of time, and because the story has no particularly new idea and is rather light in vein; significance of theme ought to count for something.

"Pleasure Trove." A. This is largely just an adventure yarn without much science, but it is so well written in style, characterization, suspense, and atmosphere that every paragraph is enjoyable. The planet Sheol and its strange inhabitants are described with realistic detail and at the same time have that aura of romantic fantasy which distinguishes the best science-fiction. And the final triumph of force and cunning is more true to life than the customary miraculous last-minute victory of good.

"Heavy Planet." B—. This story betrays occasional evidences of amateurishness, such as awkward references to Earth—it should have been told completely from Ennis' point of view—but on the whole, it is well-written and lacking in clichés. The ending is a little weak, since it is what the reader has been expecting all along; but the author smooths it out somewhat with the last line.

"Life-Line." A. I can think of nothing to criticize in this excellent little tale, and there are several episodes of unforgettable drama, such as the death of the young couple. Pinero's character is superbly delineated, and toward the end he takes on a truly great and tragic stature. The attitudes of the scientists and insurance companies are true to life and realistically presented. My only wish is that the story had been expanded and developed to novel length.

"Stowaway." C+. This story doesn't start off so well; the evidences of the captain's poker-cheating are too bald-faced, and furthermore, I am getting tired of all this pseudo-hardboiled space lingo à la Kent Casey. The ampie, however, is a diverting creature, and the new interpretation of the heaviside layer is interesting.

"An Ultimatum from Mars." C. The remarkably high level of literary quality that Astounding has reached is evidenced by the fact that this, the worst story in the issue, not only rates a grade of "average," but also is one of the best that Commings has turned out in some time, being refreshingly free from triteness. The climax, however, is a letdown, since it solves the problem too easily; pulling the solution out of the fourth dimension is like pulling it out of a hat. Much more ought to have been made out of the presence of the two Japanese; they lend a clever touch to the story but serve no real purpose at the interview with the Martian.

Willy Ley's "Space War" is, of course, excellent, though I hated to see my romantic illusions about ray-gun warfare exploded. De Camp's and McCann's short pieces were likewise interesting, and I hope you will keep us informed on the progress of the uranium fission reaction experiments. Don't let anyone induce you to cut down on either the short or the long articles.

Now for the art work. Unless Finlay did the cover in a hurry, I think he would be better on interior work than exterior. The colors and forms are good, but the detail is disappointingly bad; the latter is surprising, since Finlay's detail in his interior work is the chief reason for his being the best fantasy artist extant. Outstanding among the inside illustrations are Gilmore's first for "The Luck of Ignatz," Isip's conception of futural masculine costumes in "General Swamp, C. I. C.," and W. A. Koll's work for "Heavy Planet" and "Pleasure Trove." Hang onto this Koll fellow; he has a real artistic sense and is careful with his detail. I trust you have canned Fisk by now.

Well, I guess I have been more long-winded and caustic than most of your readers, but I believe that craftsmen and artists progress further under rational criticism than blind flattery. Anyway, in recent months Astounding's stories have rated above the average as consistently as those of your rivals have rated below it. Our magazine, however, deserves not only the best that is being written, but also the best that *can* be written.—Samuel D. Russell, 1408 West 28th St., Minneapolis, Minnesota.

De Camp got his material from English, not American sources, before the "20 gallon" error had been corrected to "20 ounces." Thanks for information on Coelocanth's interior workings.

Dear Mr. Campbell:

May I add a word of correction to L. Sprague de Camp's "There's Just As Good Fish—"

First, the report—which first appeared in *Life* magazine—that the Coelocanth exuded twenty gallons of oil was obviously an error. Supposing the composition of the oil was somewhere near that of the Class VII—fish and marine animal—oils, it would have a specific gravity of approximately 0.9205 at 15 degrees C. Now twenty gallons of this oil would weigh 153.54 lbs. But the fish itself weighed only 127 lbs. Thus, had the dead Coelocanth exuded oil weighing 26 lbs. more than itself, it would be a scientific curiosity in more ways than one.

Second, Mr. de Camp spoke of the time when dissection of the Coelocanth had progressed further, and said that the "entire internal organization of these fishes is, as it were, handed to them—paleontologists—upon a fish platter." Alas! the paleontologists had no such luck, for the curatrix—it was a woman—threw away the Coelocanth's internal organs because they had begun to decompose! Any paleontologist or zoologist will gladly verify this fact while endagering you with drowning in a flood of tears. But the loss is not so bad as it at first seemed, for since the capture of the East London Coelocanth three or four individuals reliably reported having either previously caught or seen these Mesozoic fish but did not know what they were at the time. An expedition to fish for Coelocanth's has been fitted out and has fair prospects of success.—M. L. McKeen, 306 Oriental Avenue, Atlantic City, New Jersey.

Seems to be a divergence of opinion on "General Swamp."

Dear Mr. Campbell:

Before I start my usual plumming, let me say "Thank you." That, of course, is for the artist credit lines. For this innovation—in Astound-

ing, at least—I'll give you the special award of ten plums; but this doesn't add into the score of the issue.

The award of ten plums makes me think of the Saturn cover last spring, and logically reminds me of the cover on this issue. Excellent. I might say extra excellent. We've finally got science-fiction covers back. After that era of dull, unscientific covers on the summer issues, the spurting spaceships are like the sparkling tang of October after the swelter of dog days. However, I still squawk—"Where's Wesso and Schneeman?" And I also repeat—Finlay fell down awfully on his highly awaited cover. (August number.) Too, I shall never forgive you for ruining that Saturn plate last April. Anyway, back to the September issue: Cover gets four nice juicy plums. (They will be cold storage before long, won't they? I guess I'll have to give an extra one during the off season to make up for it.)

Now about the stories. Number one on the list—but not highest ranking—is Wellman's "Forces Must Balance." Nothing spectacular about it, but the plot isn't as overworked as most of them. Three plums.

"The Last Hope," by Don Evans. Folks seem to be having a run on this type of story. This is about the third one on this theme I've read in as many months, but by far the best yet. Three and a half.

Vic Valding brings us another detective yarn of the future in his "Atmospherics." I wonder why it reminded me of Mark Hellinger? Two and a half.

"Masson's Secret" reeks of an emergency story—the kind you write when you need ten bucks in a hurry and think more of the pocket lettuce than the story. One, perhaps.

But "Ether Breather" is pretty good. Humor is excellently done; plot is good; style laudable. Three and a half.

And topping them all is the superbly written "General Swamp, C. I. C." This story showed care in planning, as well as care in writing. The kind of a story that makes me glad I discovered science-fiction. Four and a half.

The article, "The Other Side of Astronomy," was interesting enough to rate two, but no more.

Even if "Forces Must Balance" didn't get as high a rating as some of the others, it left a nice opening for a sequel. I kinda liked Duke Hudspeth. How about it, MWW? 'Nother one?

Besides, maybe the next one will be better. That has happened.

Also, I humbly beg for the return of Frederick Engelhardt in the near future. And I think a lot of the others will back me up.

News item, Mr. Campbell: The Maine Scientific Association has recently been organized; and I think it is the first State-wide scientifiction organization founded. However, be that true or not, may I take this method to invite all silent readers of our best stf. magazine interested in joining what we hope will be a worth-

while organization to communicate with the undersigned? Any residents of Maine, or any readers of science-fiction who consider Maine their home State, are eligible for membership. For further information, such as principles, dues, and so forth, write.—Gerald B. Clarke, 272 Main Street, Waterville, Maine.

Calling C. L. Moore—calling Miss Moore—

Dear Mr. Campbell:

I have before me the September, 1939, issue of Astounding Science-Fiction, and am fully prepared to present my opinion of stories and illustrations contained within it. But first I should like to discuss the cover.

And a very good cover I think it is, too. In my opinion, Mr. Rogers is the second best cover artist on your staff, Charles Schneeman being the best. Usually I do not like artists who have been brought to Astounding from the detective and other fields. (Graves Gladney is a fine example of that aversion.) But Rogers is different. Although a detective artist at heart, no doubt, he manages to capture the spirit of the fantastic even better than do Brown and Wesso, who, to the best of my knowledge, are primarily science-fiction artists. I am very glad to hear that Rogers is to do the "Gray Lensman" covers.

Now for the stories. Wellman's "Forces Must Balance," although not one of the best stories I've read, moves along very nicely, in the familiar Wellman style, and captures first position in the September issue. Little comment is necessary on the story, except to say that it is about the best of Wellman's stories of this type. I'm getting just a little tired of petal-pussed Martians, but, except for them, this yarn was very thrilling and absorbing. Schneeman's illustrations: not up to Schneeman's standard, but the best in the issue, nevertheless. If his drawings for "Gray Lensman" are as good as these, they will be far superior to Wesso's for "Galactic Patrol."

In second and third places, respectively, and nearly tied for those positions, are "Atmospherics" and "Ether Breather," two little yarns that certainly are not in line for a classification of "great," but are entertaining and well worth the time spent in reading them. Especial praise, I feel, is due Valding's story, which is the type of tale that, much to my disappointment, seems to be disappearing from science-fiction. It is the type of story in which human characters, instead of scientific theories, are the backbone of the story, in which the reader feels that the characters are in the story, not as mouthpieces for theories or dummies that propel spaceships and shoot ray guns, but as real live people who have minds, consciences, memories, bad traits, good traits, and other qualities that make them seem more human. I know that what I have just said is not original, but at least it expresses my views perfectly. So, thanks, Mr. Valding, for the character, Hugh Vendome. I hope you write more stories like "Atmospherics," and that I have the opportunity to read them.

Wesso's and Mayan's illustrations for the two stories were mediocre, with Mayan's somewhat the better, although it portrayed a poorly chosen scene, in my estimation. I am glad to see that you are cutting down on Wesso, just as you did on Binder. I rather hope you can Wesso completely, as you did Binder. Mayan is all right, but not good enough for Astounding. And—in defiance of Mr. Caleb Northrup—WE WANT DOLD!

Following closely on the heels of Valding and Sturgeon is Don Evans with his novelette, which seemed, strangely enough, like thirty thousand words instead of the five thousand you promised! Maybe "The Last Hope" seemed so long to me because I was expecting something so speedy that I could read it in five minutes! This was one case where your blurb in "In Times to Come" built me up for an awful letdown. Isip's illustrations were pretty good, but not good enough to warrant his having so many of them in one issue.

In fifth place is old-timer RZG, who seems to be having a terrible time finding a plot he can

do justice to. His last topnotch yarn was "Seeds of the Dusk." Except for a brief spurt with "Magician of Dream Valley," his work has been dull, drab, and uninteresting since then. The latest attempt is just a little bit too wild to be good. Although the plot is threadbare and worn out, Gallun tried to revive it with a new twist, but what he really achieved was a sort of despairing wildness. Then, hoping, no doubt, to rescue the story from the editor's wastebasket, he threw into it a bit of corny human interest that didn't ring true. (Into the story, I mean, not the wastebasket.) I read the story sadly, for I saw in it the decline of one of my old favorites. Come on, Raymond Z., snap out of it. Get to work and turn out an "old-time story." Show us that you've still got the old technique. Show us that "Masson's Secret" was just a mistake that won't be made again.

W. A. Koll's illustration was a disappointment. His work for the August issue showed real promise, but the September drawing is a flop. Unless Koll can reach again the heights attained in his artwork for "The Blue Giraffe" and "Pleasure Trove," I suggest that you can him—but immediately!

And last, and least, stumbling slowly along, comes the pitiful "General Swamp, C. I. C." I will say only this about it: It is the slowest, dullest, most hard-to-read-through-to-the-finish-without-falling-asleep novel I have ever read. Mr. Engelhardt will have to do a lot better on his next one if he expects me to read it. The same thing goes for Isip's illustrations for this story as did his for Evans' novelette.

Well, that just about finishes up my summary. But, let's condense the summary a little more. Now it reads like this:

Give us more Wellman and Schneeman. They both are progressing nicely. Valding and Sturgeon are good bets for short stories in the future. Can Wesso and give Mayan a couple more chances, so I can get a better line on him. Give Evans another chance on a shorter story. Cut down on Isip. Give Gallun another chance on a longer story. Work on Koll; see if you can get more inspired work out of him. Either can Engelhardt or try him on a shorter story—much shorter. Give us Rogers—in very large doses!

Well, there it is. There's a lot of criticism in it, I'll admit. But—and I mean this—every story and every illustration is above the average of any other fantasy magazine except *Unknown!* Which means, Mr. Campbell, that, with all your trials and tribulations, you have the two best fantasy mags on the market I make these criticisms of Astounding only in order that you may improve still more and become so much better than the other mags that even the editors of the other publications will have to admit that Astounding is tops!

Well, I've spouted long enough. But, before I go, a parting word. You can never give me too much of the great C. L. Moore. Her "Greater Than Gods" in the July issue is the best story you or any other science-fiction magazine has published in the year 1939. I can't understand why so many people rated "Black Destroyer" above it. Maybe I'm wrong, but "Greater Than Gods" still hits the spot with me.—Don Johnson, 3530 Kenwood Avenue, Kansas City, Missouri.

Huh? Most of P. 87 was the anecdote!

Dear Mr. Campbell:

I am most unhappy over Astounding's cover for September. It exhibits most of the same faults as most of Astounding's recent ones: foreground too close and indistinct; not enough detail; and general fuzziness. However, it's no worse than Gladney, if that's any consolation. The inner illustrations seem to be a little better, but I still want to see Dold back regularly. In fact, if you simply won't allow Paul to enter your pages, Wesso, Dold, and possibly Brown occasionally could very nicely carry the art burden. And get Brown back on the cover, where he belongs. Schneeman still does good work occasionally, but isn't consistent. His new style is some help, but not enough to rank him as a first-class artist. And all the other mob—

Brass Tacks is nice and long this month, just to my liking. Fifteen letters—much better than a measly half dozen. Now just double the present number and you'll be all right. But you used the wrong gender in replying to one—fooled by a pseudonym.

"The Last Hope" disappointed. Evans seems to have a pretty good idea of what fantasy should be like, but he gives the impression of having deliberately dragged down the writing to a very low pulp level. Then, too, the poison-ivy business was entirely too evident. And besides, I question Evans' psychology in having the oldsters decide to condemn the girl—their "last hope" was the survival of the race, and it would seem that they would even risk death themselves to assure an offspring for Olaf and Iola.

"Forces Must Balance" was much better. A fair plot, but Wellman seems to put a vital spark of life into anything he writes. The basic idea here is good, but the manner in which it is worked out seems rather poor. And at the same time, when reading this you don't mind the latter in the least. Running the risk of plowing headlong into the Rogers-Asimov dispute, I might say that the female element here looked as if dragged in to fill up the necessary wordage to convert the yarn from a short into a novelette—the woman *is* an integral part of the plot, true, but even so seems somehow unnecessary.

My pick of the best yarn this time won't be nearly the most popular, but I'll stick by "Ether Breather," anyhow. This is one of those stories which could have fit either Astounding, *Unknown*, or any half a dozen other magazines—or, with a slightly different working-out, even the slicks. Sturgeon did a good piece of work—let's hope he sticks to this type, now that it seems to be his element.

"Masson's Secret" seems rather futile or pointless. Pretty good yarn, but not nearly up to Gallun's standard of late. Or maybe I expected too much from the gent whom, I believe, has contributed as many stories to Astounding under S & S as any other author—or am I wrong?

"Atmospherics" fair. No comments.

"General Swamp, C. I. C.": I still don't like it. In another issue somewhere you said it defied tradition by ending in a sane manner; and that's one of its worse features. Simply fell flat, that's all, when a better ending might have salvaged at least a little something out of the wreckage.

"The Oher Side of Astronomy" is an excellent article. In fact, I ask for a sequel to it, or maybe a couple dozen of them. This was cut off entirely too soon, just as the author was getting warmed up. But what is the meaning of that reference, page 87, first nine lines? Looks as though you either cut something out of the article shortly after that, or else Richardson forgot to give the anecdote that should follow.

Editorial very good; ditto "In Times to Come." Astounding's departments may be rather few—actually only three, you might say—but at least they're consistently good. However, the readers' sections still belong at the back, and the ads behind them.—Harry Warner, Jr., Spaceways, 303 Bryan Place, Hagerstown, Maryland.

Dan Evans is not a pseudonym—certainly not for Stuart. That would make the whole thing kinda complex!

Dear Sir:

We fans have a kick coming. How do you expect us to select and classify the stories in Astounding if you keep up the high average of the past few issues? It is almost impossible to tell which is worst! Because all are so good and of such a high caliber that they rank with the *good* science-fiction published. That is indeed a high mark for a magazine to maintain. It is

hoped that you can continue. The September issue was up to the high standard the fans have learned to expect from Astounding. An attempt at rating follows:

Cover. *Very* good. Real stf. that carries all it implies.

Editorial—newsy and interesting. We like the introduction of new authors with new viewpoints. Keep it up.

"Forces Must Balance"—B plus. A new slant at the old power politics. Timely and with a human touch to it.

"The Last Hope"—A minus. Unquestionably the best story of the issue. More by Don Evans.

Could Don Evans be a pseudonym for Stuart? The writing has that certain slant that shows the practiced author. If an amateur, well, another Weinbaum has been born.

"Atmospherics"—C plus. Fair, humorous, and a human story. My ratings have gone up, so a C plus for an Astounding story is equivalent to a B in any other magazine.

"Masson's Secret"—B. Good, touching action with a melodrama that is always new and sometimes a "pain in the neck." The hero shouldn't make all the sacrifices. However, Gallun handled it very well.

"Ether Breather"—C. The poorest in the magazine, but still the best compared to many other magazines.

"The Other Side of Astronomy"—good. Again an article rates about second place. Glad to get the low-down on astronomers—I know it in regard to chemists, physicists, engineers, biologists and mathematicians. For years I have contested that scientists are very, very human, with all the weaknesses and petty jealousies that one sees every day. Again, very good.

"General Swamp, C. I. C."—B. Very logical and shows real military tactics. How like our own revolutionists are the actions of the Venus Swamp Men!

As usual, the departments are interesting and well handled. I was interested in Asimov's letter. The boy can think fairly well when he tries hard—in fact, his letter was the best in the issue. However, we *never* agree on covers. Perhaps we react differently to colors—better get De Camp to do an article on the interpretation and subjective influence of colors on people.

A word in regard to the novel in the last *Unknown*. "None But Lucifer" was so good that I asked two of my friends to read it—something I seldom do. It is next to "Sinister Barrier" as being the best published in *Unknown*. It also illustrates the foolishness that is paid to the supposed influence of the supernatural on man. Whether Earth is Hell or not makes not the slightest difference. It is still merely relationships between matter, energy, time and space. So what?

I am looking forward to Stuart's story in *Unknown*. I am sure I will not be disappointed.—Thomas S. Gardner, P. O. Box No. 802, Kingsport, Tennessee.

We've already got that serial—and man, it's a yarn!

Dear Mr. Campbell:

Astounding: September, 1939.
1. "The Last Hope"
2. "The Other Side of Astronomy"
3. "Ether Breather"
4. "General Swamp, C. I. C."
5. "Atmospherics"
6. "Forces Must Balance"
7. "Masson's Secret"

I have no objection at all to long installments, provided you can find a good follow-up serial in four months as well as you might in eight. Mayan's picture for "Atmospherics" and Isip's for "C. I. C." are best, Koll's poorest.—P. S. Miller, 108 Union Street, Schenectady, N. Y.

SCIENCE DISCUSSIONS

So—we're all dead men!

Dear Mr. Campbell:

I have just made an important discovery which proves mathematically that the human body cannot withstand traveling at such high speeds as 100 miles per hour. Probably human life is impossible above 30 miles per hour. This discovery proves conclusively that everyone who has taken an airplane flight, ridden on a streamline train, or driven an automobile above 50 miles per hour is dead. Or—maybe I'm wrong?

Anyway, I can prove to you—mathematically—that if a man walks through a 100-mile-an-hour streamliner and bumps into a closed door, it will crush him to a pulp. Absolutely.

See: Say the man is walking forward in the train at 4 miles an hour relative to the train. Then he is moving 104 m.p.h. relative to Earth. It is clear that his kinetic energy can be measured—assuming a mass of 200 pounds for convenience — as $\frac{1}{2}mv^2=\frac{1}{2}(200)(104)^2=1{,}081{,}600$ (This is not foot-pounds, but we can consider the relative units readily enough for the purpose.) At 100 m.p.h., his kinetic energy would be $\frac{1}{2}(200)(100)^2=1{,}000{,}000$ units.

That is, if our man walked into a closed door, he would dissipate 81,600 units of K. E. If, on the other hand, he had been riding in an automobile at 28.56 m.p.h., and had driven into a stone wall, he would have had to dissipate 81,600 units of energy. Wherefore, we can say that walking into a closed door in a streamliner going 100 m.p.h. is equivalent to driving into a stone wall at about 30 m.p.h. Obviously, if he should make a similar mistake on a 200-mile-an-hour air transport, the result would be yet more terrible.

You say, perhaps, that we must confine ourselves to the 4 m.p.h. difference, referring his speed only to the train or plane, and not to Earth? But no—his kinetic energy is real, and measurable. Suppose he stepped from his 100 m.p.h. streamliner into another streamliner on a parallel track going 104 m.p.h. The amount of energy needed to bring him to rest would be definitely measurable by known instruments and methods, and would be 1,081,600 units, an ex-

cess of 81,600 units over his previous 1,000,000 unit energy.

Agreed: there is something exceedingly fishy about this, in as much as, clearly, a man can't do as much work as would, seemingly, be necessary to raise his kinetic energy 81,600 units. Nor could his heart accelerate the blood through his body if such enormous loads were required of it. Wherefore, men couldn't live in high-speed vehicles. Pilots couldn't move their hands forward to grasp controls in 450 m.p.h. pursuit ships. But they can, and do.

The man going 104 m.p.h. *does* actually have the 81,600 extra units of energy.

The above figures are accurate, but the effects described are not experienced.

Problem: Where's the joker?

Incidentally—in a 400 m.p.h pursuit ship, the man walking forward at 4 m.p.h—crawling, in this case, perhaps, would be better—has 321,600 extra units of energy! His 4 m.p.h energy is more than the total energy of a man going 55 miles per hour!—Arthur McCann, 761 Scotland Road, Orange, New Jersey.

The readers may be interested in Jameson's qualifications for discussing space battle. He does have a background!

Dear Mr. Campbell:

Herewith is the article on strategy and tactics. I excluded treatment of plotting and tracking and any further consideration of ballistics, as it would have made the article much too long. I think those items are sufficiently interesting to be worthy of an article of their own.

As to my previous experience in ordnance and gunnery, here is a skeleton record.

In 1916, with the rating of Ordnance Draftsman, I was engaged in the reconstruction of splash patterns and the study of dispersion of great guns fired at long ranges. The data was obtained from photographic measurements made with paired photo-theodolites. This was a very narrow specialty, and up to that time only a few high-ranking naval officers and Dr. W. S. Stratton, who had suggested the method, understood it. The pressure of the War gave them all too much else to do, so that it was left to me to develop and expand the work—an expansion that was urgently needed on account of the demands made by the War.

In 1917 I went to England with a naval mission to acquaint the British with our practices, but upon arrival there found the British somewhat skeptical that we could do what we claimed to do. It proved to be a very interesting experience, as it took me to their very secret experimental station on Whale Island, where we had to pass tests they had devised. After that we were sent to Scapa to join the Grand Fleet, and lectured there to all the officers interested in gunnery, beginning with Admiral Beatty and his flag captain, Chatfield, and working down through the various division flagships.

I was quartered on a light cruiser and went to sea with her whenever they raided the German coast and also had the opportunity to witness the firing of many capital ships. Viscount Curzon was designated to take over this work from me and, after instructing him and his men, we turned our equipment over to them, and I returned to the United States.

Back at home I continued to do similar work in our own fleet and equipped one of the ships with laboratory and plotting room so we could do our work afloat as we had in the North Sea. I took part in the battery tests of the *Mississippi*, and the following year was a member of the board that conducted similar tests on the newly built *New Mexico*, and later drew up plans for the calibration firing of the Brazilian ship, *Sao Paolo*, then being overhauled in Brooklyn Navy Yard. During 1918 and 1919 I measured the fall-of-shot of every major-caliber salvo that was fired and got well acquainted with every ship in our fleet.

So much work showed up the faults of our equipment and it was necessary to completely redesign our instruments. Most of the actual work was done by various experts at the Bureau of Standards, but it was under my direction. My chief contribution was criticism; I was the

fellow who had to go to sea with them and make them work under all conditions. But while this was going on I wrote a book on the subject which was issued under the authority of the secretary of the navy and distributed to the fleet. Copies were also sent to some of our allies.

In 1919, not wanting to specialize too closely, I turned this job over to a relief and went to the naval proving ground at Dahlgren, where I was assistant proof officer. The duties there were extremely varied. My particular assignment was as range officer. My province, primarily, was from the muzzles of the guns onward—exterior ballistics, in short. We checked and extended range tables, sent up sondage balloons and airplanes for high-weather observation, observed shells in flight and where they fell, and a number of other things. At times I helped out at the battery where we proved guns, projectiles, powder, fuses, armor plate, new types of mountings such as railway mounts and caterpillars, and tested out new inventions. (They actually do, disgruntled inventors to the contrary notwithstanding.)

Proving-ground work is closely allied to design and manufacture, so I had frequent occasion to visit the ordnance bureaus of army and navy, the gun factory, and I also visited the army proving ground at Aberdeen and their arsenal at Watertown, where I saw types we did not use, such as the fourteen-inch howitzer.

Upon returning to sea I was assigned to a twelve-inch turret on the *Minnesota*, but never got to fire it, as I was shortly afterward appointed aid to General Crowder, at Habana, and spent some months with him during the crisis of 1921. After that diplomatic interlude I found myself at New London on the submarine *O-8*. My job, strictly speaking, was that of engineer officer, but on a little ship everybody does everything, so I acquired some experience with torpedoes and the little three-inch A. A. popgun she carried.

The next two years I spent aboard the *North Dakota* as assistant to the gunnery officer—the last year of it in command of the fire-control division. My battle stations, in the order named, were: operator of plotting board; spot two—in maintop; in charge of plotting room; spot one—foretop. All range finders, target-bearing indicators, directors and such instruments were in my charge, and I had supervision over the magazines and all ordnance stores.

We fired all forms of practice both day and night and did well with all of them. I got to spot antiaircraft and the three-inch field gun as well as the main battery, also went on the small-arms range to qualify for rifle, pistol and machine gun.

When that ship went out of commission I was sent to the Naval Ordnance Plant at South Charleston, W. Va., where I was executive officer. That is a very extensive plant, representing an investment of around $30,000,000, and covers more than two hundred acres, but it was shut down while I was there. However, the chief of bureau had me write a descriptive book on the place, together with an estimate as to its working capacity and the time needed to get it into full production. This entailed a vast amount of study, as I had had no previous acquaintance with steel manufacture and many of the processes that had been carried on there. At that place they are equipped to turn out all kinds of armor plate, gun forgings up to eighteen inches, and projectiles of every description, starting from pig iron and scrap. After some months I finished that monograph and was quite startled to receive a letter of commendation for it.

From that place I went to sea again, on the China coast, but thereafter had little to do with gunnery. Out there my duties were mainly navigational or administrative, with considerable police work ashore.

I do not know of any subject that is more interesting than gunnery, a term that includes all ballistics as well as fire control, or one that is more useless in commercial life. But I do not regret for a moment the time I devoted to it, for it taught me a great deal about physics, geodesy, and meteorology, not to mention mathematics and chemistry—one of the departments at the proving ground is the naval powder factory.—Malcolm Jameson.

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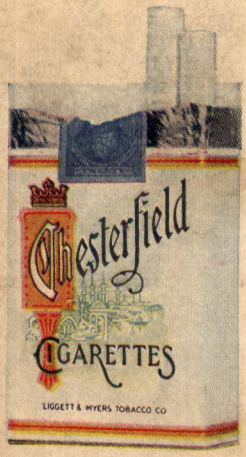

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